Chapter 1
POWER UNIT

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

DESCRIPTION

Introduction

1. This chapter describes the power installation, the airborne auxiliary power plant and the engine starting system, gives certain servicing information and recommends the method of removal from and assembly to the aircraft of certain major components. The fuel, oil and fuel tank pressurisation systems are described in Chapter 2, 3 and 6 respectively of this Section. The power units are fully described in A.P.102C-0402-1 and the airborne auxiliary power plant in A.P.4617A.

General

2. The Olympus 201 or 202 series jet turbine engines are housed in pairs inside the main plane centre section, outboard of the bomb bay and between the front and rear spars. Leading edge air intakes supply air to the engines and making-up pieces, connecting the intakes to the engines, are secured with manacle type clamps to facilitate speedy removal during servicing.

3. The airborne auxiliary power plant, hereafter referred to as the A.A.P.P., is mounted, together with its associated fuel tank and electrical components, within the starboard main plane outboard of the engines and aft of the main alighting gear bay. Air for the unit turbine and the alternator cooling, is supplied from a ram air scoop mounted below the installation in the outboard access panel.

4. Under normal circumstances, engine starting is by compressed air, delivered through the hot air system, from an external source or compressed air for rapid engine starting from storage systems within the aircraft.

5. Engine starting controls are grouped on the aft portion of the cockpit port console and the throttle control levers are mounted in a quadrant between the two pilots. Disposition of the controls and indicators may be seen on the illustrations in Sect.1, Chap.1 of this publication.

6. Low pressure fuel is supplied to the engines from the aircraft fuel tanks by submerged pumps. Warning indicators on the pilot's centre instrument panel illuminate when this pressure falls below 4.5 lb/in^2. The submerged pumps, together with the recuperators in the fuel supply lines, maintain a positive pressure in the fuel delivery lines to the engine fuel system pumps, thus preventing de-aeration and vapour locking. Fuel flow from the tanks is controlled by L.P. fuel cocks and these must remain ON during engine running. A Vokes filter assembly on each engine is interposed in the pipe lines between the fuel tanks and the engine-driven pumps. The high-pressure fuel system is contained within the engine and is fully described in the relevant chapter in A.P.102C-0402-1 to which reference must be made for further information.

7. The engines embody a complete oil system, the oil tank of which is integral with the engine air intake fairing structure. Details of the system, including information on the fuel-cooled oil cooler, are contained in A.P.102C-0402-1.

8. Accessories are driven by each engine, the only gearbox fitted being the drive assembly for the English Electric constant speed unit which in turn drives the alternator. Hydraulic pumps are fitted to No.1, 2 and 3 engines and driven by shafts geared to the H.P. compressor. Tachometer drive generators are fitted to the starboard side of each engine and driven via gearing from the L.P. compressor.

9. To localise engine bay fires each engine bay is divided into zones by bulkheads which are integral with the engine and seal pneumatically onto the aircraft structure. The area forward of the front bulkhead is designated zone 1. Aft of this, the area containing the engine fuel system is divided by an intermediate bulkhead immediately forward of the combustion chambers, these two zones are designated from front to rear, 2A and 2B. Any inflammable vapours which may accumulate in these areas are dispersed to atmosphere via an induced breather system and by ejector action from the exhaust duct tunnel. A REFRASIL blanket lining, over the inside of the engine bay walls, is provided to protect the rib structure against overheating.

10. Drainage from the engine fuel system dump valve, combustion chambers, turbine annulus and exhaust outer cone is piped to a collector tank, self-emptying in flight through an outlet in the rear engine door, and a drain tube open to atmosphere through the fairing aft of the rear engine door.

11. Air is tapped from the engines through compressor bleeds for the cabin conditioning and the main suit ventilation systems (Sect.3, Chap.8) and the airframe de-icing system (Sect.3, Chap.9). This interconnecting pipe system between the engines is utilised as mentioned in a previous paragraph, to provide part of the engine air starting system.

12. A separate compressor tapping supplies air to the ancilliary pneumatic systems, i.e., fuel tank pressurisation (Sect.4, Chap.6), bomb

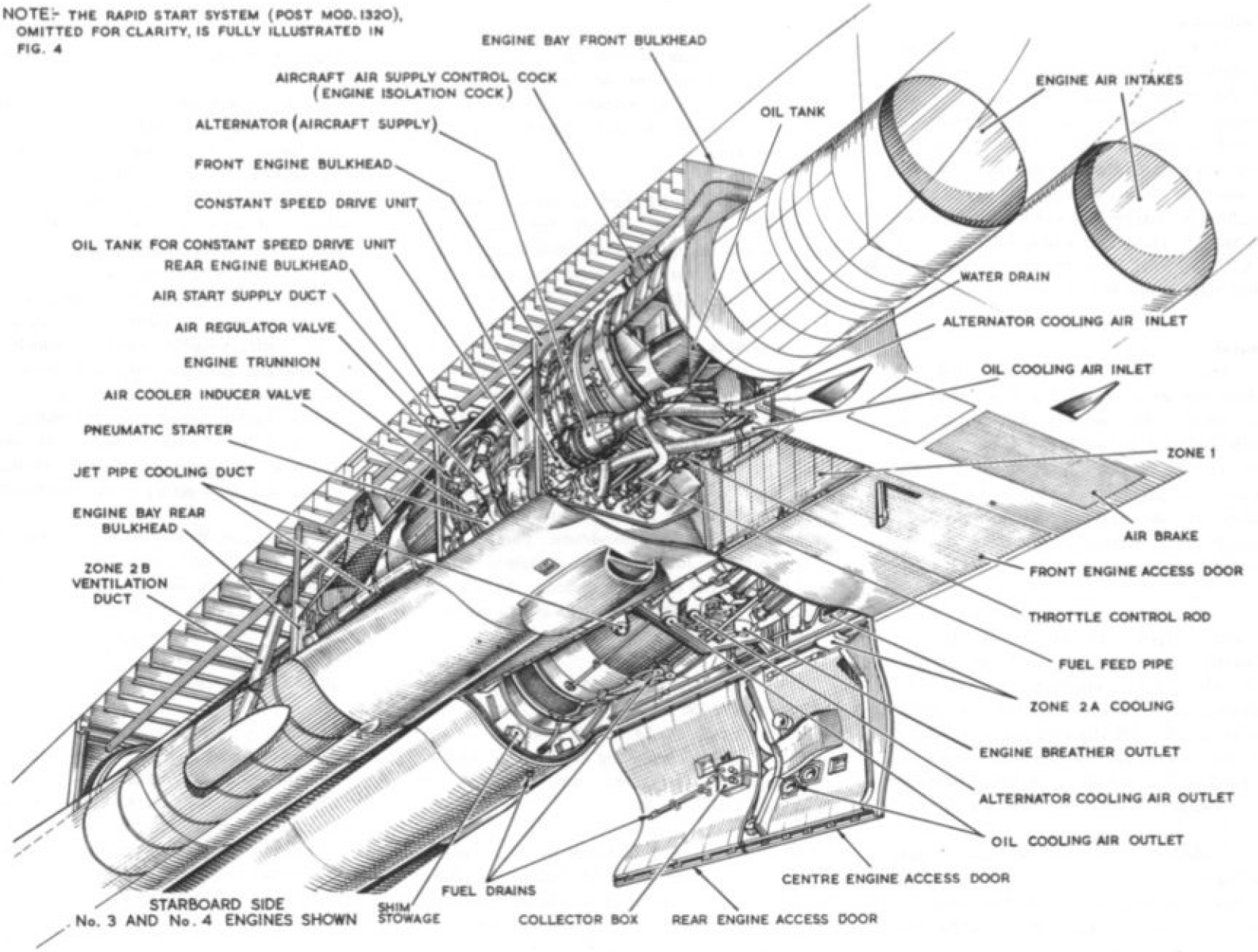


Fig. 1. Engine installation

bay door seals (Sect.3, Chap.7) and the rear fuselage equipment (Sect.3, Chap.16).

JET PIPE MOUNTINGS

13. Jet pipes are attached to the engine exhaust outer cone, which is bolted to the turbine annulus flange, by quick-release type manacle clamps. To allow for linear expansion, each jet pipe incorporates a bellows assembly and is supported on rollers which run in guide rails in the jet pipe tunnel. Jet pipes and outer cones are encased in REFRASIL shrouds, made up in half sections, which reduce the spread of jet pipe heat and protect the adjacent structures.

ENGINE MOUNTINGS

14. Each engine is mounted in its bay by the three-point method. The attachment points integral with the engine consist of trunnions, one on each side of the engine, and a single adjustable front suspension link bolted to a bracket which is mounted at the top of the L.P. compressor casing. The side trunnions engage in spherical bearings, fitted in removable bearing housings secured to the side walls of the bays, one on each side of the engine centre rib, one on the outboard face of rib 63.5 and one on the inboard face of rib 162.5. The bearings at the centre engine rib are fixed and the bearings at ribs 63.5 and 162.5 are free floating (fig.2). Engine lateral position can be adjusted to suit installation requirements by permutating adjustment washers fitted on each side of the fixed trunnions. The front suspension link is secured to the engine bay roof structure by a bolt which passes through reinforced intercostals and the top eye of the suspension link.

15. The free floating bearings cater for lateral expansion. The front link is free to swing fore and aft and allows for linear expansion forward of the trunnions.

ENGINE CONTROLS

16. Four throttle levers in a gated quadrant, between the first and second pilot's positions, control the engine high-pressure fuel system and consequently the rev./min. When the levers are moved initially through 15 deg., the H.P. fuel cocks are opened, and are again closed when the levers are moved rearward to the closed stop.

17. The four engine control runs are similar in construction and operation and consist of tubular push-pull rods supported in triple-roller bearings with bell-crank levers fitted where change of direction is required. The engine control system is illustrated in fig.9 and 10.

18. From the quadrant in the cockpit, two control runs pass down each side of the cabin, through pressure seal bearings in the rear pressure bulkhead to the nose-wheel bay. Aft, of the nose-wheel bay, the control runs are directed outboard and aft along the outside of the bomb bay and enter the inboard engine bays, port and starboard, through the front bulkheads. From here, the control rods are turned outboard to their respective engines, the top rods to the inboard and the bottom rods to the outboard engines. In each engine bay the control rods connect to a torque shaft which is the final coupling to the engine unit.

ENGINE-DRIVEN ACCESSORIES

19. With the exception of the alternators, accessories are driven direct by the engine. A constant speed drive unit and gearbox is fitted between the engine and alternator to convert variable engine output to the constant speed required by the alternator.

20. All four engines are equipped to drive c.s.d./alternator assemblies, the drive and associated equipment being positioned on the starboard side in each case. Provision is made on the port side intermediate casing of each engine to drive a tachometer generator via gearing from the L.P. compressor.

Constant speed drive units (c.s.d.)

21. The c.s.d. is driven by a quill shaft which is geared to the H.P. compressor and rotates in an anti-clockwise direction looking on the drive pad, ratio 0.97 : 1. Each c.s.d. is provided with a functionally independent self-contained oil system, the tank, filter and cooler of which are attached to the engine in a compact group about the drive assembly. The oil tank (capacity 11 pints plus 5.5 pints air space) is pressurised by means of an air bleed connection from the L.P. compressor casing and the oil, OX-38, upon which the c.s.d. operates, is used both as lubricant and hydraulic fluid.

22. Cooling of the alternator and associated c.s.d. equipment is achieved by air from an intake in the lower forward surface of the main plane leading edge. Two ducts convey cooling air from the intake and connect, one to the alternator, the other to the c.s.d. oil cooler. After circulating round the components the air is ducted to exhaust apertures in the centre engine door and discharged to atmosphere. C.S.D.U. oil temperatures are shown on two temperature gauges mounted in a panel on the port side wall (A.E.O's station) just above the A.A.P.P. control panel.

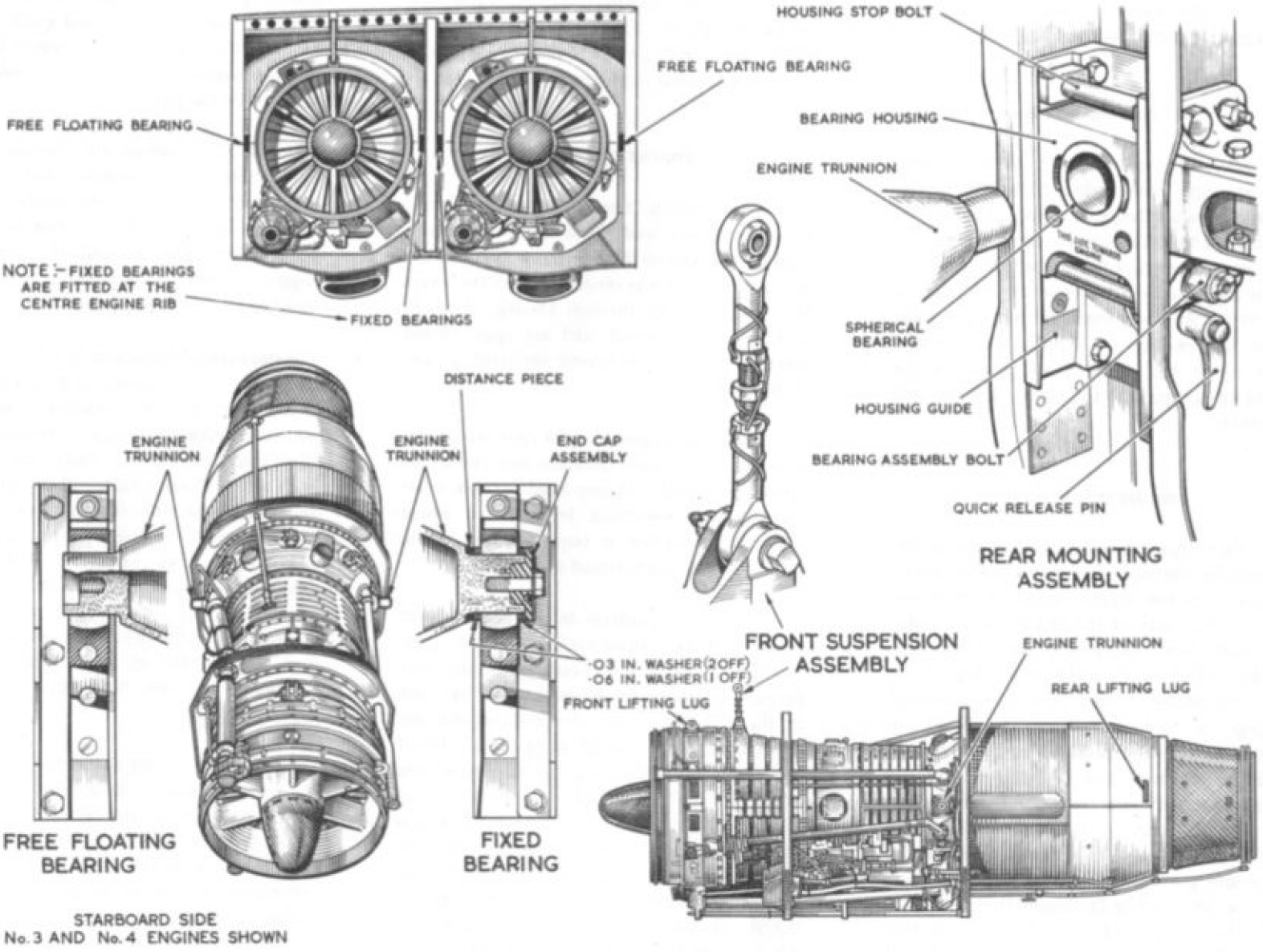


Fig. 2. Engine mounting

23. The English Electric constant speed drive unit used on this aircraft is fully described in A.P.103E-0106-16A to which reference must be made for information on servicing of the components. The alternators are described in A.P.4343 and details of the aircraft a.c. electrical system are given in Sect.6 of this publication. For information on the drive gear assembly on the engine, and its associated oil system, reference must be made to relevant chapter in A.P.102C-0402-1.

Tachometer drive

24. Provision is made on the port side of each engine, in the intermediate casing just aft of the front bulkhead, for mounting and driving a tachometer generator. The drive is geared to the L.P. compressor, ratio 0.635 : 1, and rotates in an anti-clockwise direction looking on the drive pad. A hand-turning connection is provided adjacent to the drive housing for use during servicing operations on the L.P. compressor or turbine system.

Hydraulic pumps

25. Hydraulic pumps, fitted to No.1, 2 and 3 engines only, are mounted on the front face of the auxiliary scavenge pump and driven by a quill shaft geared to the H.P. compressor. Provision of a shear-neck on the drive shaft prevents damage being caused to the internal gearing of the engine should any fault develop in the hydraulic pumps.

ENGINE STARTING SYSTEM

General

26. The following paragraphs contain descriptive information on the starting systems and their associated components, outline the starting procedures and provide information on certain precautions which are to be observed when engine starting operations are carried out. Electrical systems associated with the starting facility are described in Sect.6, Chap.8, App.1.

System installation

27. Each engine embodies its own Rotax air starting system Type CT.1303, air being supplied from a ground air starter unit for normal starting or from a compressed air system for rapid starting. Compressed air from a running engine can be used to start the other engines singly or simultaneously provided the appropriate air switches on the pilot's starboard console are at open.

28. The Rotax air starting system, fully described in A.P.1181G, Vol.1, and 6, consists basically of a combuster unit and a pneumatic starter, the latter being geared to the engine.

29. The combuster unit, incorporates an air/fuel chamber, divided by a floating piston in the upper portion, and a combustion chamber with flame tube, ignition plug etc., in the lower portion. The lower portion is connected directly to the pneumatic starter. Fuel is supplied to the combuster from the main low pressure fuel system when a fuel pump, for that side of the aircraft, is selected ON. A small spring-loaded valve between the air/fuel chamber and the combustion chamber, retains the fuel until required, i.e., when a rapid start sequence begins.

30. The pneumatic starter is supplied by air through either one of two annular air ducts incorporated in the manifold assembly. One supply is from the combuster unit, the other supply from the ground starter supply. To prevent the collection of unburned fuel in the turbine of the starter, the result of an abortive start or a leaking valve, a drain is provided, in the base of the starter, which joins an outlet to atmosphere when the engine centre access door is closed. Air exhaust from the starter turbine is also ducted through this door in a similar manner, fig.5 and 6 refer.

Air supply

Normal starting

31. The ground air starter connection is situated on the underside of the starboard main plane immediately outboard of No.4 engine. A feed duct from the connection and a supply duct from the A.A.P.P. join into a common duct which passes inboard and forward to join the aircraft main air supply system above and between No.3 and 4 engines An air inlet duct connects the main air supply system to the pneumatic starter via an air control valve just above the starter The air supply from the A.A.P.P. is utilised by the main air ventilated suit system for operation on the ground. Non-return valves isolate each independent supply to prevent the air from one source passing into the other.

32. Fig.3 illustrates the aircraft air system adapted for engine starting. Symbols indicate the position and attitude of the various cocks and valves when the No.4 engine is to be started.

Rapid starting

33. An engine rapid starting and air storage system is installed on both sides of the aircraft, one system supplying both engines on that side. Both systems are practically identical, therefore that on the starboard side only is described and illustrated on fig.4. Five

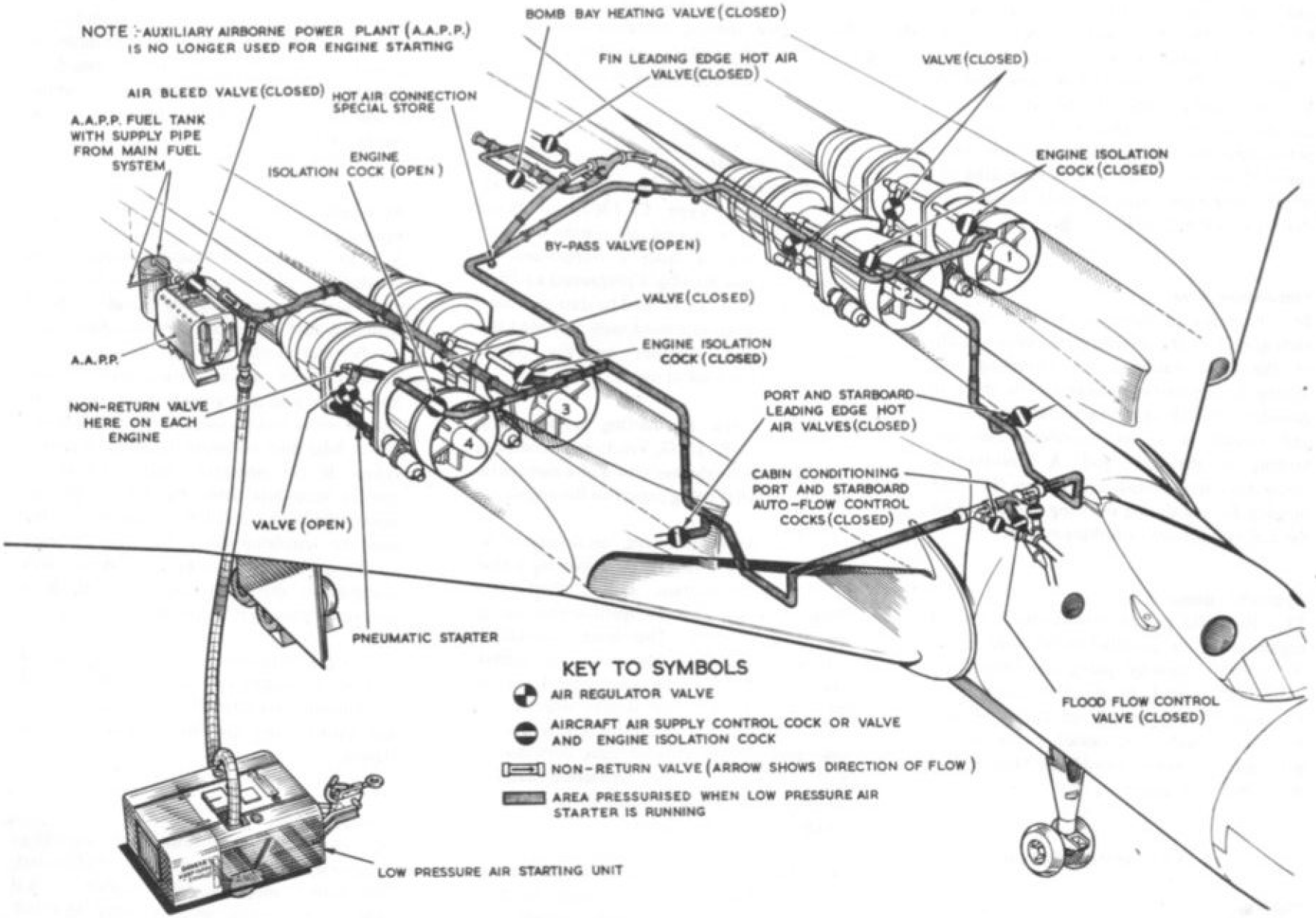


Fig. 3. Engine starting system

◄ *Valve selection changed* ►

wire-bound high-pressure air storage cylinders, 4 260 litres capacity at 3 500 lb/in², provide the compressed air facility, although the high-pressure portion of the system, i.e., aft of the shut-off cocks, is in fact part of the storage system, all pipes and components in this group being pressurized whenever the system is charged. Forward of the shut-off cocks, the pipe between the cock and the inlet side of a 3 300 to 300 lb/in² pressure-reducing valve is, for all practical purposes, part of the high-pressure system but contains high-pressure air only when the shut-off cock is open and a start sequence is in progress. A short pipe carries the reduced pressure air supply from the reducing valve outlet to the combuster unit on the engine starting system.

Operation

Normal starting

34. With engine master switch ON, the ignition switch ON, the air selector switch NORMAL and a ground air supply connected, air is fed through the aircraft air system up to the engine air cocks. The by-pass valve opens automatically on selection of the engine master switch ON. Air is then fed to the pneumatic starter by selecting the appropriate engine air switch OPEN and pressing the individual engine start button which opens the pneumatic starter air control valve.

35. When starting the remaining engines using air supplied by a running engine, this must be either No.1 or 4 engines. The running engine must be set at 70 per cent rev/min for individual engine starting and at 90 per cent rev/min for a simultaneous start. Air is supplied to the pneumatic starter as described in para. 34.

Rapid starting

36. With the engine master switch ON, the ignition switch ON, and the air selector switch to RAPID, operation of the rapid start push-button simultaneously opens the four shut-off cocks in the air storage systems and energises the engines and starter ignition circuits. Compressed air at 3 300 lb/in² is released from the high-pressure system, passes through the 3 300 to 300 lb/in² pressure-reducing valve and enters the combuster unit to be directed two ways. Part of the supply enters the combustion chamber to flow over the flame tube as a cooling agent, the remainder passes through drillings in the combuster unit casing to enter the air compartment above the piston in the fuel chamber. A pressure of approximately 250 lb/in² in imparted to the piston and fuel is forced, through the retaining valve and a calibrated orifice in the base of the fuel chamber, to enter the combuster flame tube in the form of vapour.

NOTE

Calibration of the orifice, in the base of the fuel chamber, is relative to the time factor involved, i.e., two seconds (para.39). Thus the amount of air and fuel used in each start sequence is controlled automatically.

37. Ignition of the vapour occurs on entry to the flame tube, and the resultant high energy gas discharge (36 lb/in² at 1 000 deg. C), into the starter turbine, is sufficient to spin the engine at a rate which enables IDLING speed to be reached in 19 to 22 seconds.

38. When the start is successful, a centrifugal trip switch, incorporated in the starter motor, causes the shut-off cocks to close and the combuster ignition circuit to be isolated. The resultant loss of pressure, in the air compartment of the fuel chamber allows the piston to rise and the fuel retaining valve to close. This will occur approximately 10 to 12 seconds after the rapid start button is pressed, the engine self-accelerating to IDLING in the next 9 to 10 seconds. At this stage, i.e., approximately 19 to 22 seconds after the button is pressed, the four alternators will be 'on line' and all P.F.C. motors will be running, the aircraft is ready to 'move off'.

39. Should the combuster fail to ignite and an abortive start results, a pressure switch, incorporated in the unit, fails to trip and the start system on that particular engine will not lock in. This failure is detected, within approximately two seconds, by a time switch and the start sequence (on that particular engine) is cancelled. This arrangement ensures that sufficient air is retained in the system to provide a 'second shot' for one engine. The timer continues to cycle and, after 12 seconds, resets the start system for the second attempt. When the second attempt is made, the individual start button for that engine must be used, not the rapid start button, otherwise four engines will be involved in a second start sequence when, presumably, three are already running. Should the second rapid start attempt also fail, it will be necessary to start the engine in the normal manner with air from ground equipment or, by selecting the appropriate valves, using bleed air from the other engines.

AIRBORNE AUXILIARY POWER PLANT

General

40. The Rover airborne auxiliary power plant is a self-contained unit installed in the aircraft to provide sufficient electrical power for continued use of essential flight services should a failure of the normal supply occur. A supply of air to the main air ventilated suit system and electrical power can be supplied when the aircraft is on the ground.

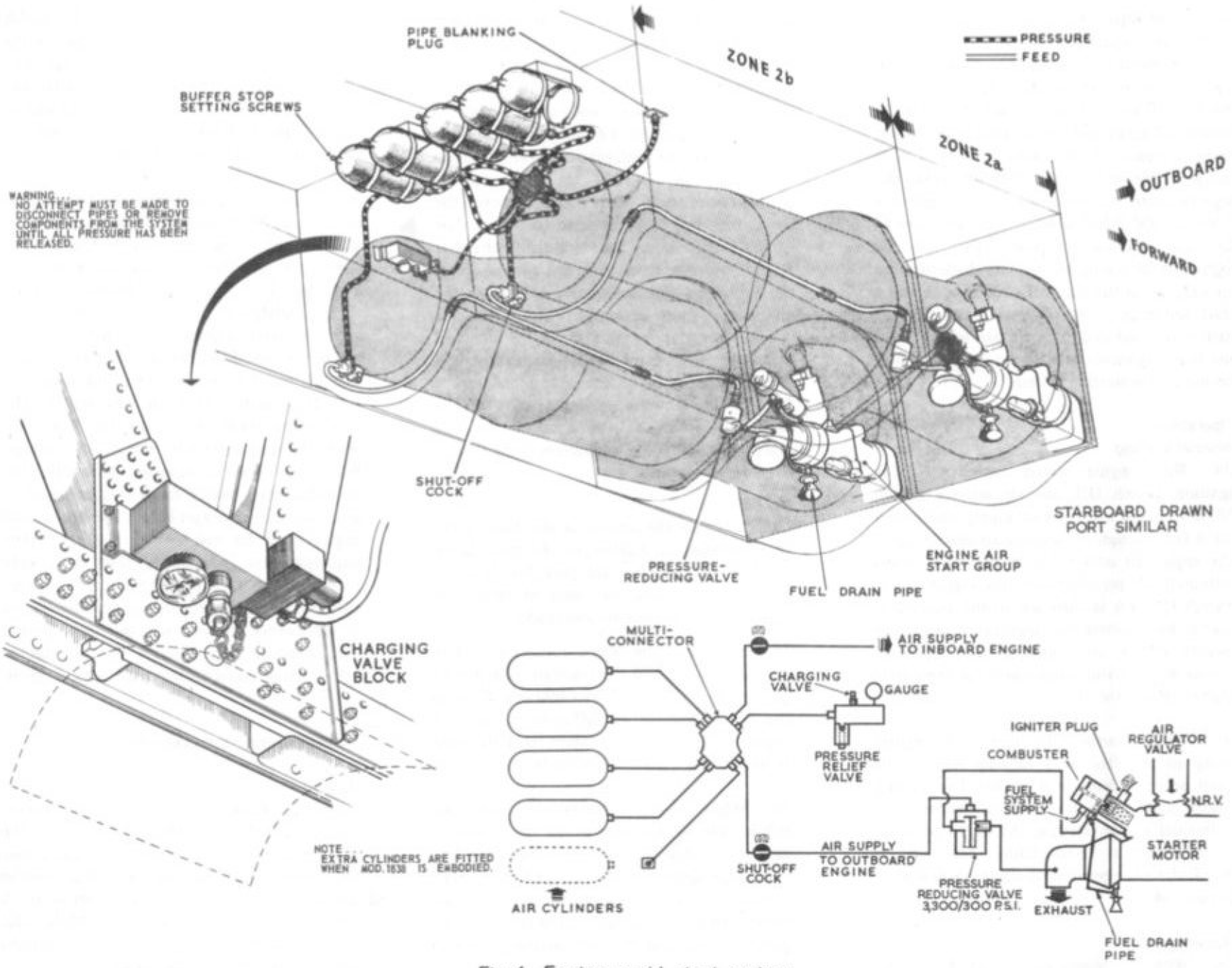


Fig. 4. Engine rapid start system

41. A full description of the unit together with relevant servicing information is contained in A.P.4617A. Information on the electrical system and components is provided in Book 2, Sect.6, Chap.5 of this publication. The following paragraphs describe the unit installation with its associated systems, fuel, air, oxygen, etc., and fig.6 is provided so that components referred to are easily recognised and located.

Installation

42. This power plant is contained in a stainless steel nacelle, the side panels of which are removable for servicing purposes, and the complete assembly is housed in a compartment in the starboard main plane just aft of the main undercarriage bay. Two large access panels, which form the base of the compartment, fit flush with the main plane under surface and are secured with Dzus fasteners. The air intake scoop, the outlet apertures of the engine and cartridge start unit exhaust systems and an inspection window are incorporated in the structure of the outboard panel of these two main panels, therefore care must be exercised during its removal.

Fuel supply

43. Fuel is supplied to the A.A.P.P. from a tank (capacity 10 galls.) which is housed in a light-alloy container and mounted on the aft face of the power plant compartment rear bulkhead. This bulkhead together with the web of the undercarriage bay outboard rib and the aft plate form three sides of the container which are fixed, whilst the fourth side the inboard plate, and the drip tray which forms the base, are removable for servicing purposes. The inboard side plate is secured with Dzus fasteners, the drip tray with 2 B.A. screws and anchor nuts. This complete assembly is revealed when the large panel, aft of the two A.A.P.P. access panels, is removed from the underside of the main plane.

44. The A A.P.P. fuel system, fuel tank and tank components are described in Sect.4, Chap.2 of this book.

Air supply

45. Air supplied to the A.A.P.P. from a retractable scoop intake incorporated in the outboard access panel below the installation. From the scoop, a ducting assembly is branched two ways; one branch to the engine turbine intake, and the other to the alternator cooling system. Exhaust gases from the engine and alternator cooling system are ducted to atmosphere through an aperture in the rear portion of the outboard access panel.

46. The scoop is operated by a hydraulic jack which is spring-loaded to retract when hydraulic pressure is shut off. The scoop is normally in the lower position (jack ram retracted) when the aircraft is on the ground with engines stopped. When the engines are started, hydraulic feed pressure overcomes the spring, the jack ram is extended and the scoop is closed. In flight, the scoop may be opened automatically when the ram air turbine is ejected, or by manual selection of the MASTER SWITCH on the A.A.P.P. control panel at the A.E.O.'s position.

Oxygen enrichment

47. In certain circumstances conditions are such that lack of oxygen will render the A.A.P.P. difficult or slow to start, this situation is avoided by providing an oxygen enrichment system as part of the unit. A supply of oxygen is carried in two storage cylinders (fully charged - 2,100 p.s.i.) which are mounted, together with a pressure reducing valve and a solenoid operated shut-off valve, on the aft face of the A.A.P.P. nacelle rear plate. This group of components and their associated connecting pipes form the major portion of the oxygen system. Two pipes leading aft from this group are connected to the charging panel components, one to the charge valve, the other to the system contents gauge. The charging panel is mounted on the base plate of the fuel tank container (para.62) and is accessible by removing a small access panel in the main access panel of that compartment.

48. Oxygen may be supplied to the A.A.P.P. automatically, when the ram air turbine is ejected, or by manual selection on the switch marked OXYGEN AND RELIGHT on the A.A.P.P. control panel. Either of these procedures will cause the solenoid operated valve to be energised open and oxygen will flow from the cylinders, through the pressure reducing valve (2,100/40 p.s.i.) and the pressure relief valve (80 p.s.i.) to the A.A.P.P.

Fire extinguisher system

49. A single methyl-bromide bottle mounted on the forward end plate of the A.A.P.P. nacelle is connected to the spray system on the power plant. The extinguisher is electrically operated when the guarded push-switch, marked FIRE, on the A.A.P.P. control panel is pressed. A fire warning system is also provided which, in the event of fire in the A.A.P.P. nacelle, will energise a fire warning indicator within this push-switch to illuminate red.

Unit mounting

50. Two mounting brackets are provided on the top plate of the A.A.P.P. nacelle which engage with corresponding lugs on the lateral support beam in the compartment roof structure. When the A.A.P.P. is installed, the two bolts which pass through the lugs and brackets are locked secure with nuts and split pins. Slightly

aft of the two main attachment points is a turnbuckle - adjusted steadying strut. This is attached to roof intercostal 25 and is locked secure with 22 s.w.g. chrome nickel steel wire when correct adjustment has been obtained.

ENGINE BAY AND JET PIPE COOLING

General

51. Engine bays, jet pipe tunnels and certain engine components are cooled by an induced air breather system, the major portion of which is contained within the structure of the centre engine door. The complete system is shown diagramatically in fig.5 and the centre access door, with part of the skinning removed to reveal the various air - ways, is shown in fig.6.

52. Cooling arrangements in all four engine bays are similar, therefore those of the starboard inboard engine only will be described in the following paragraphs and illustrated in fig.5 and 6. This arrangement, in addition to avoiding possible confusion, enables fig.1 to be used as an additional reference. Slight differences in each engine bay are made to suit the configuration of the aircraft and do not merit individual description.

System installation

53. The alternator and c.s.d. oil system are cooled by air ducted from an air intake in the main plane leading edge. Zone 2A, 2B and the jet pipe tunnel are cooled by air from two intakes in the appendage below the centre engine access door. This assembly, enclosed in a single fairing, consists of two air intakes forward and three exhaust ducts aft. The exhaust ducts are connected via airways in the door structure, to the outlet flanges of the engine breather, alternator cooling and c.s.d. oil cooler systems. Duct connecting flanges engage when the engine access door is closed, the mating flanges of the engine breather duct having sufficient all round clearance for the extraction of hot gases from zone 2A. Waste gases are drawn from zone 2B through a single duct which terminates in an extractor attached externally to the underside jet pipe fairing aft of the bay. Jet pipe cooling airflow is assisted by the jet pipe blast passing through the end cap; the arrangement of jet pipe and end cap is shown in fig.6.

54. To ensure adequate cooling of the engine bays, jet pipe tunnels and engine components during ground running, inducer nozzles fed from tappings in the engine compressor system casing are introduced into the outlet ducts of the various cooling systems. Electrically operated shut-off valves, mounted on the engine casing at the compressor tapping, are energised to open automatically when alighting gear 'normal' down is selected.

NOTE...

When 'emergency' down is selected, the electrical supply to the inducer valves is isolated with the undercarriage circuit and the inducer valves remain closed. Excessive engine running under such circumstances will cause overheating of the alternators, c.s.d. oil system, and zone 2B of the engine bay and must, therefore, be strictly limited. When essential, a maximum alternator load of 20 Kw. may be utilized for a maximum of 15 minutes, and engine speeds should be kept at 'IDLING' so far as is practicable.

54A. Each engine bay is equipped to accept Olympus 202 series engines when Mod.934 is embodied. These engines are identical to the 201 series except for a redesigned oil separator breather system with an outlet at the top of the engine front casing. The airframe modification provides a drain to atmosphere from this repositioned outlet. From the flexible coupling at the separator breather outlet the pipe passes aft along the engine bay roof and into the jet pipe tunnel. Just forward of the rear spar, the pipe passes through the tunnel skin and is continued externally, terminating with an open end at a point just forward of the jet pipe end cap. The external portion of the pipe is covered with a detachable shroud.

SERVICING

General

55. Servicing information given in the following paragraphs applies to the Olympus 200 series engine installation. Most of the routine checks specified in A.P.101B-1902-4 do not require explanation but the following instructions are considered helpful. Should it be necessary to remove an engine component, reference must be made to the appropriate chapter in the Olympus 200 series engine publication A.P.102C-0402-1.

56. It is important that the following general instructions are observed

(1) When the aircraft is on the ground, the engine bay centre access door may be opened, but before any other doors are opened, jury struts Ref.No.26DC/95006 must be inserted in the main-wheel bays (Sect.2, Chap.1, fig.6).

(2) All engine access doors must be closed before the aircraft is towed or taxied.

(3) When it is necessary to raise the aircraft on jacks, all engine doors must remain closed until beam Ref.No. 26DC/95005 and universal jacking trestle No.18 with Type A or B brackets (less beam) are positioned below the aircraft nose section.

(4) Protective covers Ref No. 26DC/9505 are to be fitted to the air intakes before any servicing of the engines.

(5) Fit suitable blanks immediately to any aperture resulting from the removal of a component or the disconnection of a pipe.

(6) Carefully examine all jointing and gland rings removed during servicing and renew as necessary. Renew all expendable locking devices such as split pins and tab washers, and use 22 s.w.g. stainless steel wire for all wire-locking.

(7) Use ground supply unit when an electrical supply is required for servicing.

(8) On completion of servicing, thoroughly clean the engines and bays, removing all loose articles such as nuts, split pins and discarded pieces of wire.

(9) If air has entered the fuel system during servicing, it will be necessary to bleed the system before attempting to run the engines.

BLEEDING THE FUEL SYSTEM

57. The fuel system is bled to remove air or inhibiting oil from the supply lines. The method of bleeding is as follows:-

(1) Ensure that the throttle levers are in the H.P. COCK CLOSED position, i.e., fully rearward.

(2) Ensure that the engine IGNITION switch and the M.SW. (master) switch are in the OFF position.

(3) Attach an external 200 volt. 3 phase supply at the ground supply plug or, alternatively start the A.A.P.P.

NOTE . . .
There are seven bleed points in the fuel system, two on the L.P. filter below the engine, one on the combuster unit on the starboard side of the engine and four on the rate reset blocks on the port side of the engine.

(4) Slacken the locknut on the water drain/bleed point in the lower rear portion of the L.P. filter casing and attach a length of rubber tube, directing the other end of the tube into a suitable container.

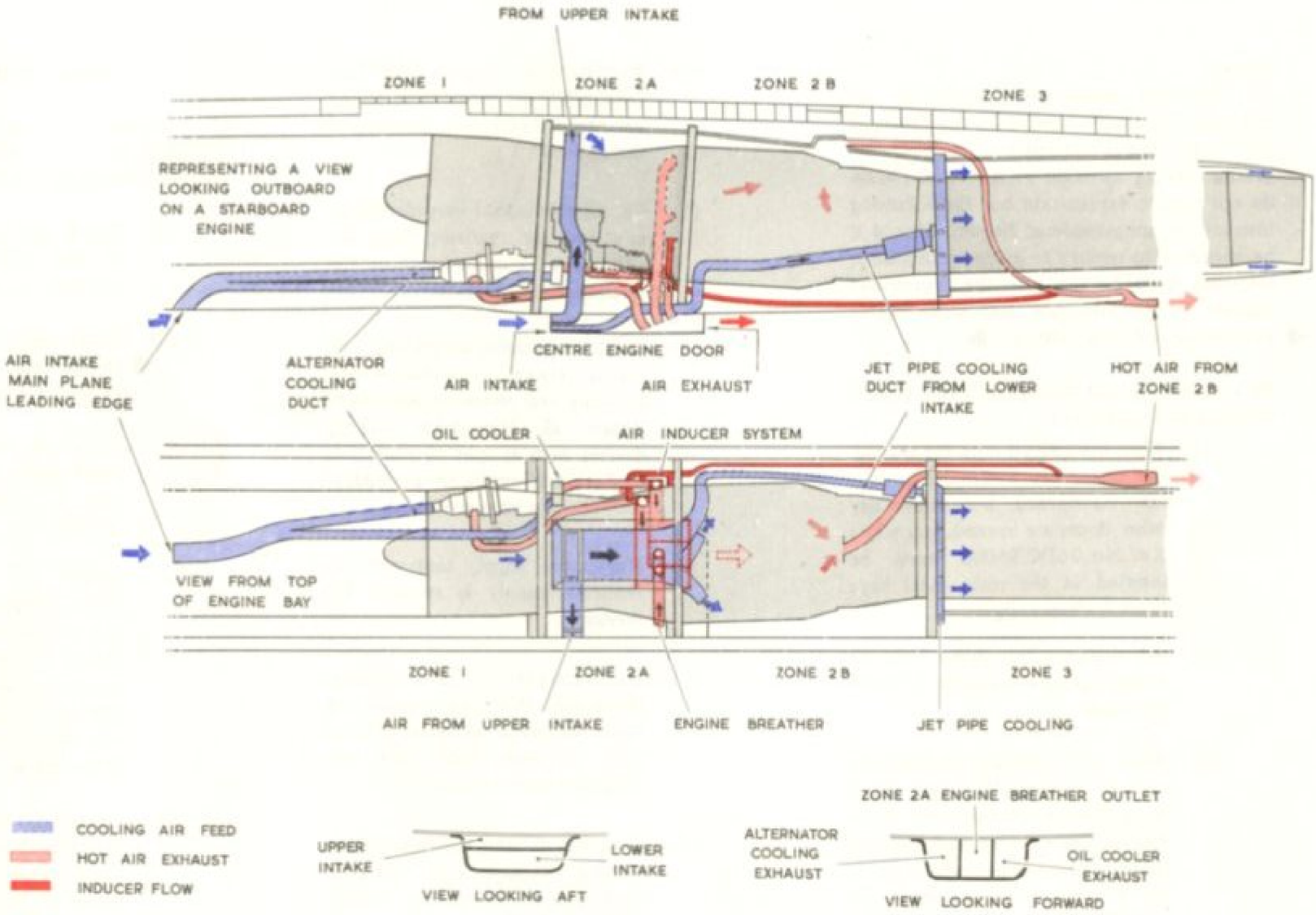


Fig.5. Engine bay and jet pipe cooling (1)

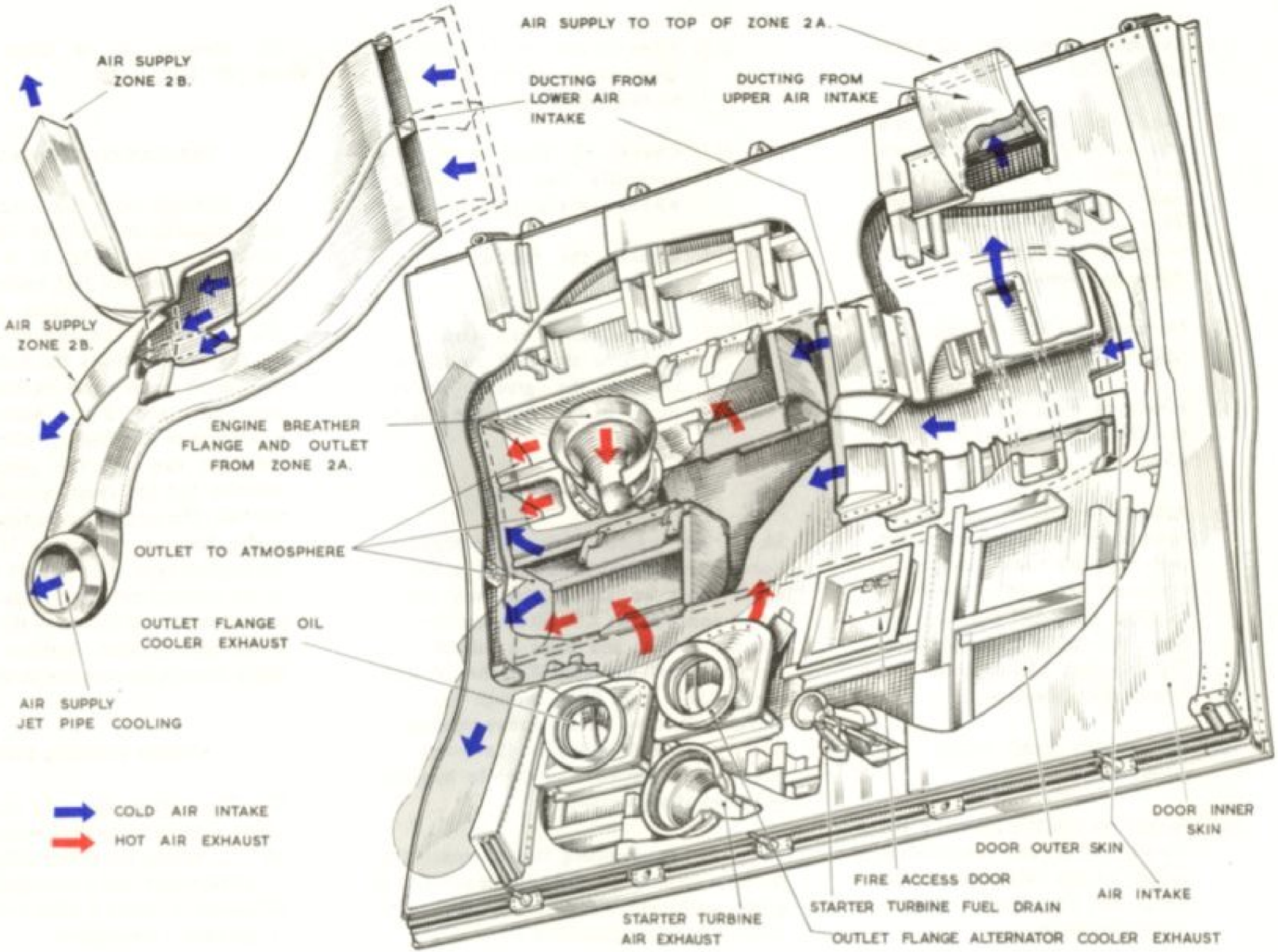


Fig. 6. Engine bay and jet pipe cooling (2)

(5) Switch the appropriate tank pump switch to ON.

(6) Slacken the bleed screw approximately half a turn to open the bleed port and observe the flow of fuel into the container. When a flow of fuel free from air, water or inhibitor is obtained, tighten the bleed screw.

(7) Remove the rubber tube and tighten the locknut.

(8) Repeat op. (4), (5), (6) and (7) at the forward bleed point on the filter.

(9) Attach the rubber tube to the bleed screw on the combuster unit fuel chamber and, using the container (op. (4)), bleed as required, until fuel free from air, water or inhibitor is obtained. Tighten the bleed screw and remove the rubber tube,

(10) Remove the hand turning gear covers.

(11) Repeat op. (4), (5), (6) and (7) at the engine fuel pump remote bleed points on the rate reset blocks, using the hand-turning gear to rotate the pumps.

(12) When the two remaining rate reset bleed points are opened, little or no fuel may be expected.

(13) Check all bleed screws and locknuts for tightness and wire-lock in the approved manner.

(14) Replace the hand-turning gear covers.

(15) Finally switch the tank pump switch to the OFF position and remove the ground electrical supply or shut down the A.A.P.P.

CLEANING FILTERS

58. A low pressure filter unit containing a Vokes filter element is interposed in the fuel supply lines to the engine-driven pumps. Before removing an L.P. filter, first clean the external housing and place a suitable drain container below the filter. With the L.P. cocks closed, drain the filter through the valve provided. Remove the set screws securing the filter cover and withdraw the cover and element. The element can then be inspected and renewed as necessary.

59. When re-assembling the unit ensure that the joint washer, recessed into the cover, is in good condition. Bleed the system before running the engine (para.57).

60. Cleaning of oil filters is given in ◀ A.P.102C-0402-1. ▶

DRAINING COLLECTOR TANKS

61. Although the port side tank, of the drain tank assembly in the rear engine door, is self-emptying in flight, it is necessary to remove any residual fuel before the door is opened. The same procedure must be taken after a wet start. The starboard tank, catering for any drainage from the fuel pump glands and the oil cooler, must be drained manually since this tank is not self-emptying. An accumulation of fuel in this tank is an indication that the fuel pump glands are defective and the cause must be traced and rectified. The method of draining both tanks is similar. Insert a screw driver into the slot of the bayonet-type valve to each tank, situated in the forward area of the rear engine door, push upwards and turn until the valve engages in the open position. Residual fuel will now empty through the common drain.

ENGINE CONTROL SYSTEM

62. The setting for one throttle control system is given in the following paragraphs as the four systems are similar. Slight differences do exist however, and a note dealing with these differences is inserted after each appropriate paragraph or sub-paragraph.

63. Initial setting of the throttle control rod and lever system in the neutral position ensures that at full movement clearance is available at all the lever assemblies. The positive throttle control setting is carried out as a final operation when the system is married-up to the engine throttle unit.

Basic setting

64. To set the port outboard throttle control system refer to fig.9 and 10 and proceed:-

(1) Adjust the connecting rod, between the throttle lever and the lower arm of the countershaft lever assembly, to 18.375 ± 0.01 in. and connect the two levers.

(2) Set the throttle lever so that its centre line is in line with the neutral mark on the throttle console and lock the levers by moving the throttle locking lever upward and forward.

(3) Adjust the connecting rod, between the top lever of the countershaft assembly and the forward arm of the bell-crank, lever assembly below the pilots' floor, to 18.375 ± 0.01 in. and connect the two levers. The centre line of the lower arm of the bell-crank below the pilots' floor should now be at an angle of 90 deg. to the floor (fig.10, detail B).

NOTE . . .
When setting the control system for an inboard engine, the control rod (sub-para.3) should be adjusted to 19.61 ± 0.01 in.

(4) Secure the control rod between the lower arm of the pilots' floor bell-crank lever and the upper arm of the inner torque shaft lever on the torque shaft assembly, also situated below the pilots' floor, adjacent to the fuselage wall. Adjust, as necessary, on the forward end of the control rod to position the centre line of the upper torque shaft lever arm at an angle of 90 deg. to the centre line of the control rod.

(5) Secure the control rod between the lower arm of the inner torque shaft assembly and the take-off link on the lower complementary control rod. Adjust, as necessary on the forward end of the control rod to position the take-off link pin centre six inches from the datum face of former 316F (fig.10, detail D).

(6) Complete the assembly of the four control rods commencing at the torque shaft assembly and connect them to the upper arm of the upper inboard bell-crank lever at former 115.5F. Adjust, as necessary, on the last but one rod until the centre line of the upper arm of the inboard bell-crank lever is at an angle of 90 deg. to the centre line of the last control rod, (fig.10, detail E).

(7) Secure the control rod between the rear arm of the upper inboard bell-crank lever and the forward arm of the lower inboard bell-crank lever situated at former 115.5F, and adjust, as necessary, at the lower end of the rod until the centre line of the forward arm of the inboard lower bell-crank lever is at an angle of 90 deg. to the centre line of the control rod. This setting is similar to that in sub-para.6 and shown in fig.10, detail E.

(8) Connect the rear arm of the lower inboard bell-crank lever, situated at former 115.5F and the rear arm of the lower bell-crank lever, situated at the junction of the bomb bay rib and bulkhead 63.19 in the engine bay, with a set of five control rods Adjust, as necessary, on the adjusters, until the centre line of the rear arm on the lower bell-crank lever is at an angle of 90 deg. to the rib web (fig.10, detail F).

(9) Assemble the two control rods between the forward arm of the bell-crank lever assembly adjacent to the bomb bay rib and the lower arm of the intermediate lever assembly on the aft face of the outboard engine bay front bulkhead and connect the levers.

(10) Fit the control rod between the top arm of the lever on the intermediate lever assembly and the torque shaft control arm fork end

(fork uppermost) on the control spindle assembly, (fig.10, detail J).

(11) Adjust the two rods at the intermediate lever assembly until the angles formed between the centre line of the lever and the centre lines of the top and bottom rods are equal (fig.10, detail H).

NOTE...
When connecting a port inboard control system, the last control rod is connected to the torque shaft control arm fork end with the fork pointing down (fig.10, detail G).

(12) Release the throttle lever friction lock and check the controls for freedom of movement.

(13) Set the throttle control lever to the H.P. cock closed position (47 deg. back from neutral) and secure with friction lock.

(14) With the aid of the socket on one end of the torque shaft, carefully turn the engine throttle unit spindle until the uncut serration is at t.d.c., this operation will place the engine throttle unit in the H.P. cock closed position. Remove the torque shaft.

(15) Insert the spindle end of the torque shaft into the sleeve of the torque shaft control assembly and, with the notch on the sleeve in line with the groove in the spindle, engage male and female splines. The spindle is inserted until it is stopped by the shaft of the universal coupling at the forward end of the sleeve.

(16) Raise the torque shaft so that the universal coupling socket at its aft end is in line with the serrated spindle of the engine throttle unit. Ensure that the uncut serrations on both components will mate correctly and move the complete torque shaft rearward until the lateral hole in the socket is in line with the groove around the engine unit spindle. Insert the locking-bolt through the torque shaft socket, ensuring the head of the bolt is on the underside of the torque shaft with the H.P. cock in the closed position. Secure with nut and split pin.

(17) Release the throttle lever friction lock and check each throttle control system for freedom of movement.

(18) Check the co-ordination between the pilots' levers and the engine throttle units of each engine/throttle control installation as follows:-

(a) Set pilots' throttle lever at IDLING and check that the pointer on the engine F.R.F.C. indicates 22 deg. ± 4 deg.

(b) Set pilots' throttle lever fully OPEN and check that the F.R.F.C. pointer indicates 90 deg.

(c) Set pilots' throttle lever at H.P. COCK SHUT and check that the F.R.F.C. pointer is at 0 deg.

NOTE...
Ensure that there is an additional ¼ in. spring movement at each end of the range of the pilots' throttle lever.

(d) If the settings are not satisfactory, adjustment must be made on the aircraft throttle control rods.

NOTE
Setting and checking of the engine mounted controls to the throttle valve is described in A.P.102C-0402-1.

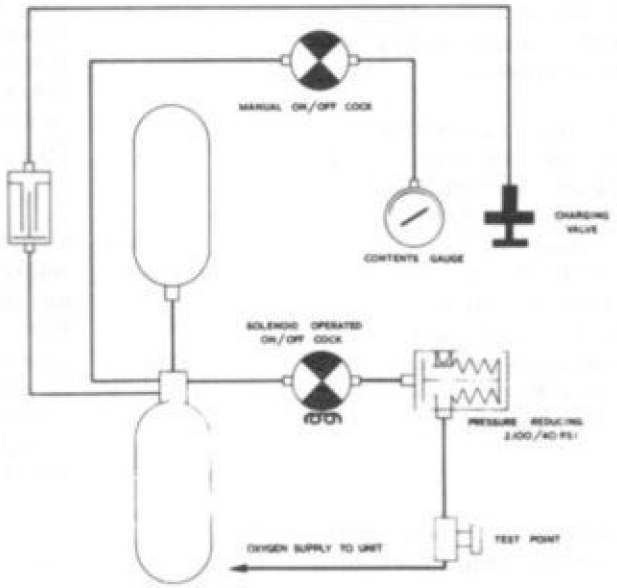


Fig.7. A.A.P.P. oxygen system

(19) Fine adjustment may be achieved by shortening or lengthening, i.e., screwing in or screwing out, the fork end attachment lever on the torque shaft control assembly. After any such adjustment, ensure that the lock-nut is replaced correctly.

(20) Ensure that all discarded materials; cleaning cloths, split pins, tab-washers, etc., are removed from the aircraft.

(21) Check the complete engine control system for full range and freedom of movement, and all locking devices for safety.

EXCESSIVE LEAKAGE OF FUEL FROM THE COMBUSTER

64A. If excessive leakage of fuel from the combuster is suspected the following checks should be made to determine the amount and source of the leakage. With the combuster in situ in the aircraft and with the combuster fuel chamber full of fuel under aircraft fuel boost pump pressure, but with the high pressure air supply turned off, proceed as follows:-

(1) Disconnect the fuel drain pipe Pt No.ZA.22901 from the union below the starter. Place a suitable container below the disconnected pipe and collect the leaking fuel for a period of five minutes. A leakage of 4 cm^3/per minute maximum is acceptable.

(2) Leakage, if in excess of the above limitation, may be due to leaking 'O' ring seals in the combuster. To change these seals remove the combuster, following instructions in A.P.102C-0402-6A, Sect.2, Chap.5A, and fit new seals following instructions in A.P.103D-0218-1. If, however, the excessive leakage is coming from the union below the starter and not from the fuel drain pipe, remove the combuster from the aircraft for overhaul.

(3) After replacement of the seals, fit the combuster in the aircraft and repeat the leakage test as detailed in operation (1). If the leakage is still above the permitted rate, i.e., seal replacement has not cured the fault, remove the combuster from the aircraft for overhaul. If the leakage rate is found to be below the permitted rate proceed with operation (4).

(4) Connect the fuel drain pipe to the union below the starter and attempt a combuster start of the engine following instructions in para.78 to 82 of this chapter. If this is satisfactory repeat operation (1).

(5) If the leakage is still below the permitted rate connect the fuel drain pipe to the union and allow the combuster to remain in service. If, however, the combuster fails to operate correctly or if excessive fuel leakage is observed after the start remove the combuster from the aircraft for overhaul.

LUBRICATION

65. All connection points on the engine control system should be lubricated with grease, XG-287, N.A.T.O. Code No.G-354. The triple roller bearings are to be lubricated at their points of contact with the control rods; the metal rods passing through the bearings are to be lubricated with oil, OX-14, N.A.T.O. Code No.0-147.

ENGINE MOUNTINGS

66. Engine mountings must be examined for security of attachment and lubricated with grease XG-293 whenever the engine is removed.

JET PIPE MOUNTINGS

67. The jet pipe mountings will require general examination for signs of burning and damage. No other servicing is normally required.

INHIBITING AN ENGINE

68. The engines of a parked aircraft should be turned regularly at periods stipulated in current authorised orders, normally every seven days. When an aircraft is to be unattended for longer periods the engines should be inhibited in accordance with instructions contained in A.P.4471A, Vol.1. Similarly, any engine removed for storage purposes should also be inhibited.

WARNING . . .
No attempt must be made to disconnect pipes or remove components from any high pressure system until all pressure has been released. Pressure is released through an inflation adapter at the charging valve or A58 valve test point of the system concerned.

ENGINE RAPID START SYSTEM

Charging the system

69. Engine starting systems on each side of the aircraft are charged with air through their respective charge valves to 3 300 lb/in^2. The charge valve and associated pressure gauge and pressure relief valve are mounted on the outboard side of the centre engine rib bottom boom, just aft of the engine bay rear bulkhead position. Access to this assembly is gained by removing a detachable panel (Dzus fasteners) in the main plane underside, between the inboard and outboard jet pipe tunnel fairings. The system must be charged with clean dry air from an approved source, i.e., in this case, four high pressure cylinders on a trolley equipped with a Mk.5 regulator.

High pressure pipes

69A. When a pipe or components are removed during servicing operations, it is essential that their subsequent re-installation be carried out in the correct manner. The following instructions must be adhered to, otherwise unsatisfactory operation of the system may result. When tightening pipe connections, torque loading must be applied to the following figures:-

Rigid pipes	–	450 to 500 lb in
Flexible pipes	–	450 to 480 lb in
Charging pipe	–	150 to 200 lb in

It is equally important to ensure that olives are fitted correctly, special care being taken in the case of delivery pipes. The olives in these connections must be fitted with the tail pointing downstream, i.e., away from the cylinders. Ensure also, when fitting pipe securing clips to the rigid pipes, that excessive clamping is to be avoided, otherwise the pipe will be unable to 'give' when subjected to the severe shock load of released air.

Pressure sealed joints - leak test

69B. When Mod.1790 and 1791 are embodied in the aircraft, certain components in the existing starter groups will be replaced by components which, when assembled into the starter group, incorporate air pressure sealed joints. This method of sealing is introduced to prevent leakage of fuel vapour into the engine bays when the rapid start system is used. Joint seals are pressurised with air tapped from the combuster air inlet union (approx. 250 lb/in^2) and are, therefore, effective whenever the start system operates.

69C. After either initial installation of the start-components of whenever the joints have been disturbed, a pressure test must be carried out to prove that gas leakage does not occur. It is essential that this proving test be satisfied before a rapid start sequence is attempted. A brief description of an initial installation is given together with the necessary leak test.

(1) Assemble the air control valve to the starter motor and fit the two main insulating blankets.

(2) At this stage, it will be found advantageous to fit a length of locking wire through the hole in the pressure pipe union on the starter/control valve joint. Difficult manipulations in the confines of the engine bay can thus be reduced.

NOTE . . .
Although the two small saddle blankets are not fitted at this stage, it is recommended that a trial bench fit be made and any defects, thus exposed, rectified ready for final assembly.

(3) Fit new oil seal to starter motor spigot and offer starter/control valve assembly to the engine - loosely secure with clamp.

(4) Locate and align dowel-air control valve to supply duct - raise the valve slightly to engage the dowel, ensuring that the flange faces mate correctly. Tighten clamp.

(5) Fit flexible seal-pressurising pipe to the combuster air inlet union tapping connection and wire-lock. Assemble combuster to starter motor.

(6) Fit combuster retaining pin through the support bracket and combuster casing and secure with lock-bolts. Connect fuel supply pipe to fuel chamber.

(7) Connect the pressure-reducing valve pipes; one (the air supply) to the combuster air inlet, the other, (pressure relief valve outlet) to the starter motor exhaust elbow.

(8) Connect and tighten free end of flexible pressurising pipe to union serving the starter/combuster spherical joint. Do not wire-lock at this stage.

(9) Ensure that sufficient air pressure is available in the rapid start air storage cylinders. Note that for a single cycle (pressure switch inoperative) at 12 second period should be catered for, i.e., 1 200 lb/in^2.

◀ (10) Isolate the H.E. ignition circuit by disconnecting the cable from the rear face of the engine forward bulkhead and connect the cable free-end to the dummy stowage plug. ▶

(11) Support a light metal tube, at least 3 feet long and 6 inches in diameter, over the starter motor exhaust duct to prevent fuel mist being blown over components under test.

(12) Connect a 28-volt d.c. ground electrical supply to the aircraft.

(13) With the main engine ignition OFF, throttle levers set to H.P. cock SHUT, L.P. cocks OPEN and a booster pump in the appropriate group running; select RAPID on the start selector switch and PRESS the appropriate individual engine start button for 1 second and release.

(a) The starter and engine will rotate for approximately 12 seconds due to the pressure switch being inoperative. With the pressure switch operative, the cycle will terminate in 2 seconds.

(b) During the cycle, observe whether fuel drip occurs at the blanket joints or whether fuel mist is ejected from the combuster or control valve to starter spherical joints. When the cycle is completed, examine the joints for evidence of fuel 'dampness'.

(c) If no leaks are noted, wire-lock the pressure air pipes and fit and lock the saddle blankets.

(14) If fuel or fuel mist leakage is discovered, ensure that all components are correctly assembled, that pressure pipes are not blocked and are secure, then repeat the test.

(a) If leakage persists, remove the starter group and return for investigation by Messrs. Rotax.

NOTE . . .
No attempt must be made to dismantle spherical joints for 'on-site' rectification.

(15) When the system is proved satisfactory, check that all components are secure and that locking devices are correctly applied. Remove the deflector tube from the starter exhaust and clear the area of tools, discarded materials, etc.

(16) Switch OFF the booster pump, CLOSE the L.P. cock and disconnect the ground electrical supply.

(17) Restore the H.E. ignition circuit to normal.

AIRBORNE AUXILIARY POWER PLANT

70. The A.A.P.P. is serviced in accordance with instructions contained in the appropriate chapter of A.P.4617A, Vol.1, and the procedures listed in the aircraft Servicing Schedule. Functioning checks should be carried out in conjunction with an electrical tradesman.

OXYGEN CHARGING

71. The storage cylinders of the A.A.P.P. oxygen system should be maintained in a fully charged condition at all times. System pressure is 2 100 lb/in^2 and any loss is replaced through a charging valve mounted, together with an oxygen contents indicator gauge, in a small compartment below the A.A.P.P. fuel tank. Access to this charging panel is gained by removing the small access panel situated just aft of the two main access panels in the main plane underside. A diagram of the oxygen system is given in fig.7.

72. The oxygen charging trolley Mk.2 is used to replace any loss in the system. Charging procedure is as follows:-

(1) Gain access to the charge valve compartment by removing the small access panel in the area below the unit fuel tank.

(2) In accordance with the warning instruction on the label displayed within the compartment, check that the manually operated ON/OFF cock in the supply line to the contents gauge supply pipe is in the OPEN position. This cock is mounted on the aft face of the A.A.P.P. unit rear plate adjacent to the upper oxygen cylinder.

NOTE...
This warning label is removed when Mod.1608 is embodied and an instruction label, fitted adjacent to the cock, informs personnel that the cock must be closed only when the unit is to be removed.

(3) Refer to and carry out the instructions given in A.P.1464G, Vol.1, Part 2, Sect.5, Chap.38 regarding the correct use of oxygen charging equipment.

(4) Remove the blanking cap from the charging valve and connect the charge unit hose. Open the charge valve cock and charge the system to 2,100 p.s.i.

(5) Close the charge valve cock and, after closing the main stop valve on the charging trolley, disconnect the hose. Wire lock the charge valve cock in the approved manner.

(6) Replace the access panel.

73. An oil sump temperature indicator, for use during servicing, is mounted on the oxygen charge panel adjacent to the oxygen contents indicator gauge.

LUBRICATION

74. Replenishing of the A.A.P.P. oil system is in accordance with instructions contained in A.P.4617A, Vol.1. Access to the combined oil filler and overflow valve is through the starter cartridge replacement aperture in the main inboard access panel below the main plane.

A.A.P.P. GROUND RUNNING

Starting the A.A.P.P.

75. When the A.A.P.P. is to be run for an extended period without starting the main engines, i.e., for aircraft servicing, compass swinging etc., filter box (Part No.1/U1910), must be fitted over the scoop air intake (fig.11). When fitting the box, care must be taken to ensure that the pressure pads are not over-tightened, otherwise damage may be caused to the undercarriage fairing. To start the A.A.P.P. proceed as follows:-

WARNING...
The A.A.P.P. exhaust is directed downwards from the outlet below the starboard main plane, therefore, the area in this vicinity, just aft of the starboard main wheel, must be clear of personnel and equipment when the A.A.P.P. is to be started, and for the duration of the run.

NOTE...
Should three false starts, in succession, be experienced, it is essential that the cartridges be removed and replaced. This is necessary as continued false starts cause fuel to collect in the cartridge breech (vertical pipe). At the same time ensure that the cartridge 'O' seal rings are undamaged and positioned correctly.

(1) In conjunction with an electrical tradesman, ensure that all electrical loads not connected with A.A.P.P. starting are switched off (a special check should be made on the p.f.c. control panel), and that the ram air turbine release toggle is in the normal or "stowed" position.

(2) The following switches should be checked or selected as indicated:-

(a) Alternator switches (four)	OFF
(b) Battery isolation switch	ON
(c) Starting air, selector switch	NORMAL
(d) Oxygen enrichment switch	OFF
(e) A.A.P.P. low pressure fuel cock	ON
(f) Main fuel tank switches	ON
(g) Air ventilated suit system	OFF
(h) A.A.P.P. master switch	ON

(3) Press the A.A.P.P. start button for 3 seconds (maximum) A.A.P.P. will attain stabilized conditions in 15 to 20 seconds.

(4) Voltage and frequency (A.A.P.P. alternator) should be checked at the alternator control panel on the port side of the crew's compartment. These readings should be satisfactory after the A.A.P.P. has been running approximately 25-30 sec.

(5) Select extra supplies switch ON

76. Electrical loads can now be connected to the bus bars as required and

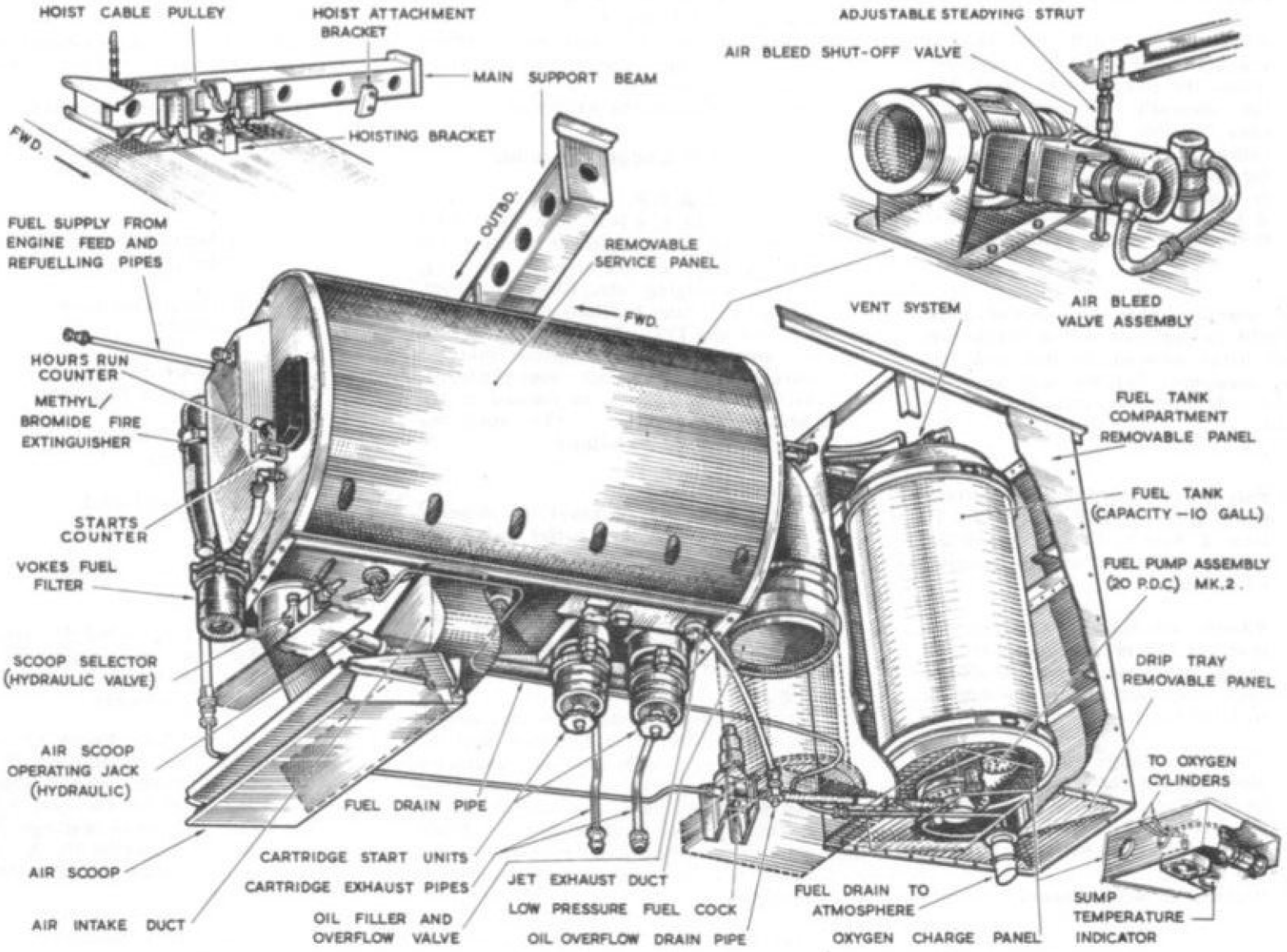


Fig. 8. Airborne auxiliary power plant

compressed air is available in the main air supply ducting, for the main air ventilated suit system.

NOTE
Whilst the engine is accelerating to maximum governed speed, excessive jet pipe temperatures may be achieved. These may be disregarded provided their duration is less than 10 seconds.

Stopping the A.A.P.P.

77. When the A.A.P.P. supplies are no longer required, it must be shut down in the following manner:-

(1) All electrical loads OFF

(2) A.A.P.P. H.P. cock switch SHUT (hold for five seconds)

(3) A.A.P.P. master switch OFF

(4) A.A.P.P. L.P. cock switch SHUT

(5) Battery isolation switch OFF

NOTE...
The filters in ground running filter box Ref.No. 26DC/95510 must be checked with a water manometer, at periods specified in A.P.101B-1902-4, in accordance with the instructions displayed on the front of the box, i.e., filters should be changed when manometer reading exceeds three inches W.G. Replace screwed blanking plug after filter check.

OLYMPUS ENGINE GROUND RUNNING

Engine starting (ground supply)

78. The air supply required for starting the main engines may be obtained from an external source (ground air supply unit) or by cross-bleed from an engine already running. Either one or a combination of both of these sources may be used to start the main engines and, though the starting order may be varied to suit individual circumstances, it is recommended that the starting order of No.4, 3, 2 and 1 be used.

79. The main engines are normally started with air from a trolley, air starting L.P., Mk.4, Ref.No.4FA/3235 or a trolley, air starting L.P., Mk.10, Ref.No. 4FA/3962. Certain precautionary and preparatory measures which must be observed before engine starting operations begin, are as follows:-

(1) Ensure that all aircraft starting checks have been carried out, i.e., brakes ON, chocks in position, engine doors closed (desirable so that ventilation and cooling is maintained), or secured with struts if open, undercarriage bay jury struts in position and all intake, breather and jet pipe blanks removed.

NOTE...
Should pressure in the brake system be considered insufficient, switch on the power pack and charge the brake accumulators.

(2) Check that the engine and c.s.d. oil tanks are correctly filled and that the aircraft fuel tanks contain sufficient fuel.

(3) Ensure that all unnecessary ground equipment, i.e trestles, servicing trolleys, etc., are removed from the immediate vicinity of the aircraft, and that there are no loose objects; paper, cleaning cloths etc., in the area in front of the aircraft.

(4) Connect the air delivery hose from the L.P. air starting trolley to the aircraft socket below the starboard main plane just outboard of the main-wheel bay.

(5) Engage the air starting trolley electrical lead plug with the aircraft socket located on the rear bulkhead in the starboard main-wheel bay.

NOTE...
The air delivery hose must always be connected to the aircraft before the electrical lead and vice-versa when disconnecting.

(6) Connect the main ground electrical supply to the aircraft, the 200 volt a.c. system plug at the port side rear fuselage.

(7) Ensure that suitable fire extinguishing equipment is positioned in the vicinity of the aircraft.

(8) Start the air starting trolley but switch off the air bleed until required.

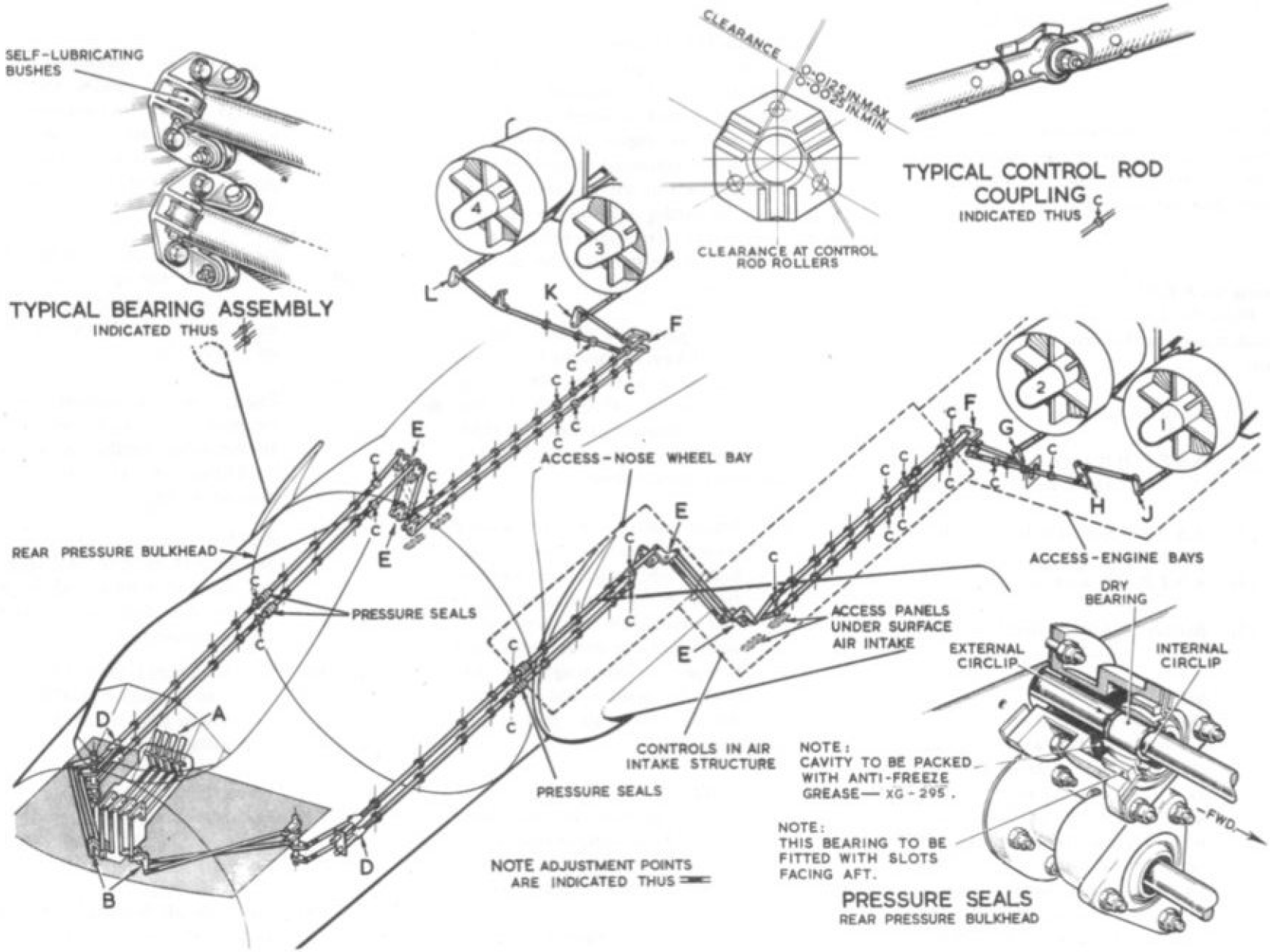


Fig.9. Engine controls (1)

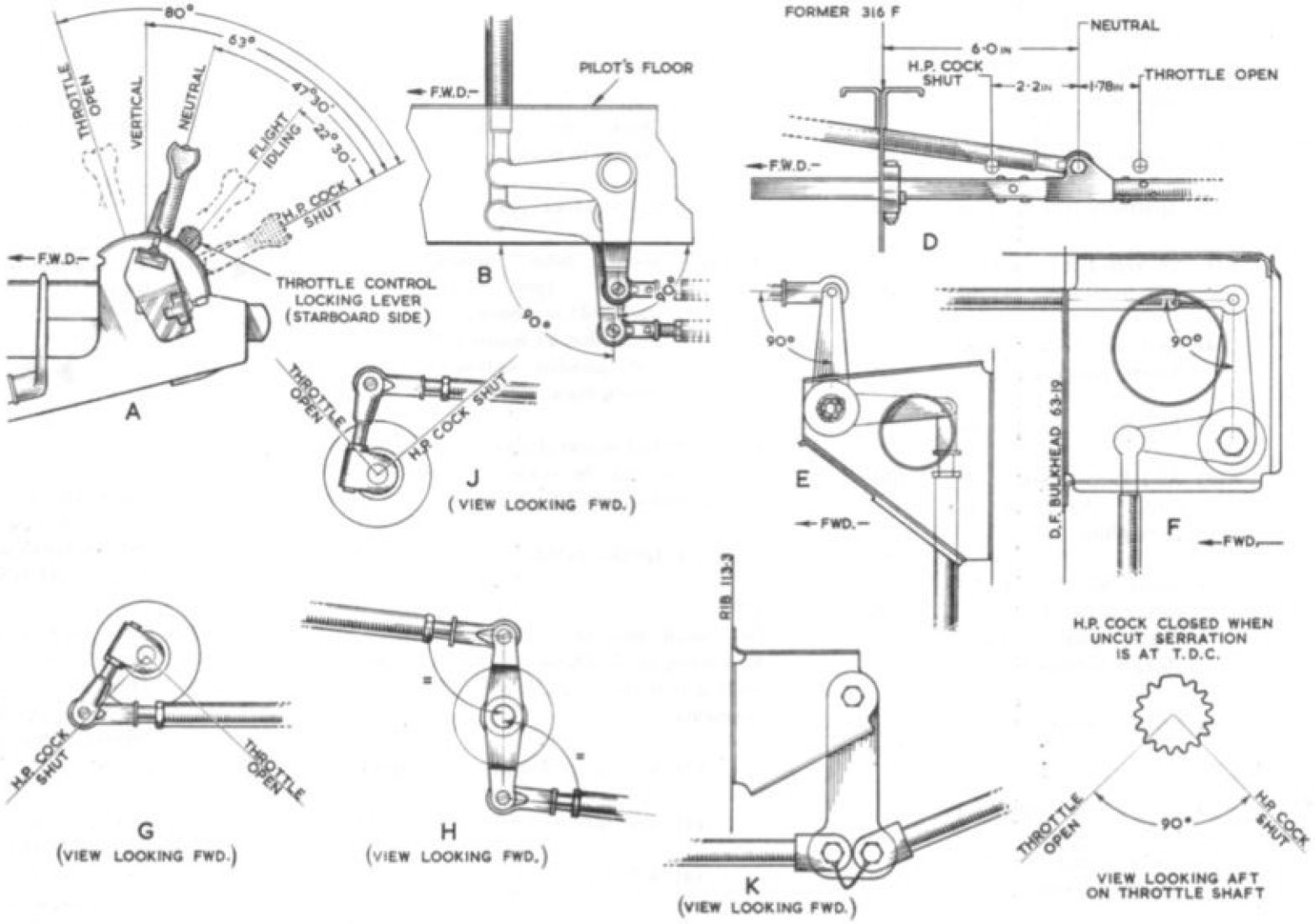


Fig. 10. Engine controls (basic setting) (2)

80. When the precautions have been observed and the preparations carried out, check the aircraft fuel system controls and indicators by selecting switches in the following order:-

(1) Battery isolation switch — ON

(2) Alternator switches (four) — OFF

(3) 28 volt T.R.U. and 115 volt transformer switches — ON

(4) No.1 or 7 tank (port) booster pump switches — ON

(5) Fuel auto/manual switch — AUTO

(6) All L.P. cock switches — OFF
Check that indicators show white.

(7) Select No. 1 tank L.P. fuel cock switch — ON
Check that indicator changes to black.

(8) Port engine fuel cross-feed cock — OPEN

(9) Select No.2 engine L.P. fuel cock switch — ON
Check that indicator changes to black.

(10) Aircraft cross-feed cock — OPEN

(11) Select No.3 engine L.P. fuel cock switch — ON
Check that indicator changes to black.

(12) Starboard engine fuel cross-feed cock — OPEN

(13) Select No.4 engine L.P. fuel cock switch — ON
Check that indicator changes to black.

(14) All cross-feed cocks — SHUT

(15) Select other booster pumps (port and starboard) as required and check that all engine L.P. fuel pressure indicators remain black.

81. If the fuel system checks are satisfactory, the engines may be started. To start four engines beginning with No.4 proceed:-

(1) Ignition switch — ON

NOTE . . .
This switch must be ON before commencing the starting cycle. Damage to the engine may result if it is switched ON after the cycle has commenced.

(2) Start selector switch — NORMAL

(3) Start master switch — ON

(4) R.P.M. governor switch — ON

(5) J.P.T. limiter switch — ON

(6) Anti-icing auto/manual switches — OFF

(7) Cabin air valves (port and stbd.) — SHUT

(8) Appropriate engine air switch — OPEN
Ensure other switches are closed.

(9) Main A.V.S. system switch — CLOSE

◀ (10) Throttle control lever — H.P. COCK SHUT ▶

▶◀

(11) Check with ground controller that L.P. air starting trolley is running and confirm clearance to start
Advise STARTING NO.4 - NOW

(12) Press No.4 engine starter button firmly for one second then release. This action supplies electrical power to energise open the air delivery valve in the air starting trolley.

(13) Check starter button light illuminates after two seconds and remains on. Should the light fail to illuminate, abandon the attempt to start and investigate the cause.

(14) When the oil pressure needle moves off the stop, open the throttle lever to the idling position taking approximately five seconds to complete the movement.

(15) Engine light-up will be indicated by rising jet pipe temperature, pressure and rev/min.

(16) Check starter button light is extinguished, indicating that the supply from the air starting trolley is cut off.

NOTE...
If starter light button is not extinguished stop engine and investigate cause.

(17) Check jet pipe temperature does not exceed 700 deg C.

82. When a normal start has been carried out, check the following:-

(1)	Start master switch	OFF
(2)	Ignition switch	OFF
(3)	Engine speed	29.5 to 30 per cent accessory load on. 32 to 32.5 per cent accessory load off.
(4)	Jet pipe temperature	250 to 300 deg C (normal)
(5)	Oil pressure	55 to 65 lb/in^2
(6)	Fuel low pressure warning indicator	Black
(7)	Hydraulic pressure	4 000 lb/in^2
(8)	Fire warning light	Out
(9)	Check in conjunction with an electrical tradesman, the a.c. generator voltage and frequency	
(10)	Engine anti-icing - appropriate wing and engine	OFF or AUTO

NOTE...
(1) The fin anti-icing is inoperative.

(2) Prolonged operation of the airframe anti-icing systems during engine ground running must be avoided. Failure to observe this precaution could result in damage.

(11) Ensure that the cooling air inducer valves are operating correctly by checking for air blast at the appropriate outlets, i.e., centre engine door exhaust for c.s.d. oil cooler and alternator and at the rear outlet in the underside jet pipe fairing aft of the engine bay for zone 2B.

83. The remaining engines can be started with the air starting trolley using the sequence given in para. 81 and 82.

Air cross-feed starting

84. With one engine running, which must be either No.1 or 4, the remaining engines can be started individually or simultaneously by cross bleed air from the running engine as follows:-

Starting one engine

(1)	Start selector switch	NORMAL
(2)	Start master switch	ON
(3)	Ignition switch	ON
(4)	Air cross feed indicator	OPEN

(5) Set the rev/min of the running engine to 70 per cent.

(6) Select the engine air switch of the engine to be started to OPEN.

(7) Press the appropriate start button firmly for one second and release.

(8) Repeat para.81 (13) to (17).

(9) Start the remaining engines and repeat para. 82.

Starting three engines

(1)	Start selector switch	NORMAL
(2)	Start master switch	ON
(3)	Ignition switch	ON
(4)	Air cross feed indicator	OPEN
(5)	All engine air switches	OPEN

(6) Set the rev/min of the running engine to 90 per cent.

(7) Set the throttle controls of the three engines to be started to H.P. COCK SHUT.

(8) Press the three appropriate start buttons and release.

(9) Follow the procedure in para. 81(13) to (17) and 82 for each engine.

(10) Should any engine malfunction, close the throttle control to H.P. COCK SHUT independently of the other engines but leave the master switch ON until the start cycle of the other engines are complete.

Failure to start

85. When an engine stops rotating after a failure to start, check for cause of failure. Before any attempt is made to re-start the engine two dry motoring cycles must be carried out to clear the engine of unburnt fuel (para.90).

NOTE . . .
Fuel ejected from the engine during dry motoring cycle operations must be caught in suitable containers, otherwise, the ground will be contaminated and a fire hazard will be created in the vicinity of the aircraft.

Engine starting (rapid start system)

86. The rapid start system, though essentially the means for starting four engines rapidly and simultaneously when a rapid take-off operation is initiated, can be used, in an emergency, for starting a single engine. Procedures for both multi and single engine starts are given. Before any engine is started however, the preliminary checking instructions given in para. 79 op. (1) to (3) and (6) and (7) and 80 must be adhered to. A check must also be made to ensure that the start system air storage cylinders are charged to the correct pressure, i.e., 3 300 lb/in^2. The minimum pressure required to start one engine is 1 100 lb/in^2 and for a multi-engine start the pressure is 2 100 lb/in^2.

Multi-engine start - rapid

NOTE . . .
The rapid start system must not be used for multi-engine starts when ambient temperature is below minus 15 deg C owing to the risk of high jet pipe temperature occuring. In these conditions the quickest way to start all engines is to start either No.1 or 4 engine by the rapid start method (para. 88C) using the individual start button and to start the remaining engines using the cross-feed method described in para.84.

87. This sequence is given on the assumption that the aircraft is at readiness with all ground supply connections in position and all services available as for stand-by prior to rapid take-off (Sect.2, Chap.2). To start the four engines with the rapid start system, select, or check as indicated, the following controls and switches.

(1) External electrical supplies — ON

(2) Alternator switches — AS REQUIRED

NOTE . . .
Alternators need to be selected ON only when a check is to be made on take-over of electrical loads. When the alternators are selected ON the failure warning lamps should begin flashing.

(3) Battery isolation switch — ON

(4) 28 and 115 volt T.R.U. switches — ON

(5) Check four fire warning buttons, ensure test filament illuminates — PULL

(6) Check that fuel tank contents are adequate for the test period. — PRESS

(7) P.F.C. stop buttons (ten), ensure button light comes ON — PRESS

NOTE . . .
The p.f.c. auto-start facility may be disassociated from the engine start sequence by removing fuse No.478 from panel 26P. Before this circuit is restored, the 200 volt a.c. supply must be disconnected from the aircraft and the following procedure carried out:-

With a 28 volt d.c. supply connected to the aircraft, fit fuse, wait 30 seconds, operate all ten p.f.c. stop buttons, ensure that all ten buttons illuminate. Only then, if required, must the 200 volt a.c. ground supply be connected to the aircraft.

(8) Check fuel pressure indicators — WHITE

(9) Check all L.P., cross feed and H.P. cocks — SHUT

(10) Fuel AUTO/MANUAL switch — AUTO

(11) Fuel tank pumps — ON

(12) Engine L.P cocks — ON

(13) Check L.P. fuel indicators — BLACK

(14) R.P.M governor/J.P.T limiter switch — TAKE-OFF

NOTE
At this stage the gyro hold-off circuit can be checked by pressing the hold-off button. This action will cause the following services to be de-energised. When the start master switch is selected ON the services will be restored.

(a) Artificial horizon

(b) M.F.S

(c) Auto stabilisation

(d) Engine J.P.T. limiters

(e) All group fuel content indicators

(f) All port and stbd. fuel content indicators

(g) All group refuelling control systems

(15) Engine governor isolation switch — OFF

(16) J.P.T. limiter switch — ON

(17) Engine air valves — SHUT

(18) Cabin air valves (port and stbd) — SHUT

(19) Engine and aircraft anti-icing valves — SHUT

(20) Fuel tank pressurisation switches — OFF

(21) Main air ventilated suit system switch — OFF

(22) Start selector switch — RAPID

(23) Ignition switch — ON

NOTE . . .
The ignition switch must be ON before commencing the starting cycle. Damage to the engines may result if it is switched ON after the cycle has commenced.

(24) Start master switch. — ON
Check hold-off circuit for restoration of services

(25) Throttle levers - leading edge of throttle levers to be at white line on throttle console. — 50 per cent approx

88. When all selections have been made and verified and all checks found satisfactory, establish clearance to start with ground controller. Press the RAPID START button firmly for one second and release. From this moment the start cycle is initiated and will proceed in the following manner.

WARNING . . .

(1) Personnel must stand clear of the starter exhaust.

(2) The relight button must not be pressed during a starting cycle.

(1) Upon pressing the start button
The system sequence timers start and the four on/off valves, in the engine start pneumatic systems, open simultaneously releasing high-pressure air to the combusters via the 3 300 to 300 lb/in² pressure-reducing valves. Combuster, main engine H.E. ignition and engine fuel system dipping valve circuits are energised. Unless previously isolated by removal of fuse No 478, the p.f.c. motor start sequence will begin.

(2) During the first two seconds
Air/fuel mixture in the combusters is ignited and the resultant pressure build-up causes a high energy gas discharge into the starter turbine and spins the engine. Successful light-up in the combusters is indicated by the individual engine start button lights which will come ON and remain on. Combuster H.E. ignition is terminated.

(a) Illumination of the starter buttons indicates that gas pressure rise in the combuster, following successful light-up, has

actuated the combuster mounted pressure-switch. When operated this switch provides a hold-in supply, via the sequence timer, to keep the air system ON/OFF valves open until the starting cycle is terminated, either by the timer cut-off at approx. 12 seconds, or the starter over-speed trip switch.

(b) Should any button light fail to come on at two seconds it indicates that the combuster on that particular engine has failed to light. The pressure switch is not actuated and the hold-in supply is not available, therefore, the ON/OFF valve will close and conserve the air supply for subsequent starting attempts.

(3) In four to eight seconds:-
Engine light-up will be indicated by rising jet pipe temperature, oil pressure and rev/min. (j.p.t. should not exceed 600 deg.C). Towards the end of this eight seconds period, jet pipe temperature will continue to rise as engines self accelerate toward idling rev/min. If any jet pipe temperature fails to rise and the lamp in the individual start button of that particular engine is ON, wait until the light goes OFF then attempt to start the engine using the appropriate individual start button.

NOTE . .
Should any engine produce a jet pipe temperature in excess of 700 deg.C. during a rapid start exercise it must be shut down immediately. The engine must be removed and returned for repair.

(4) As engine speed increases, the starters will be tripped-out by the overspeed or timer switch and circuit changes occur which cause the pneumatic system ON/OFF cocks to close, fuel dipper valve operation to cease and the lamps in the individual start buttons to be extinguished. This action will occur approximately 11 to 12 seconds after the start is initiated and the engines will continue to self-accelerate toward idling rev/min. Jet pipe temperature will now be in the region of 200 to 300 deg.C and rising. These circuit changes and results will still occur if, at the end of the 12 second period (time switch), any of the engines have failed to start.

NOTE . . .
(1) When the jet pipe temperature for any engine registers 600 deg.C immediately retract all throttle levers to the idling gate, jet pipe temperature will fall. Once the throttles have been retracted, they can be reset to give the required power.

(2) If a starter button light is not extinguished, stop the engine and investigate the cause.

(5) After approximately 12 seconds the whole start system circuit reverts to normal ready for attempts to be made to start any engine (or engines) not started 'first go'. By this time (approximately 14 seconds) gyro erection should be complete, p.f.c warning lights will be going out (one by one as p.f.c. motors run-up) and alternators will be beginning to take their own load. Alternator warning lights will be either flashing or steady at this time. Engines which are running will continue to self-accelerate to idling and should be in the region of 30 per cent rev/min within the next 4 to 5 seconds.

(6) Approximately 18 seconds after initiation, jet pipe temperatures will peak and begin to fall, normal peak temperatures are between 400 and 550 deg.C. The throttle levers should be retracted to idling position two seconds after peak jet pipe temperatures have been reached, then reset as required - engine handling now being normal. If the throttle levers are immediately reset to the take-off position, take-off rev/min will be reached in approximately the next six seconds.

88A. When a combuster or an engine fails to light the start sequence on that engine is cancelled. This arrangement ensures that sufficient air is retained in the storage system to provide a second 'shot' for one engine. In the event of a start being aborted after a

successful start sequence and a restart is required, retract that particular engine throttle lever to the fully shut-off position, wait for 15 seconds, reset the throttle lever to the 50 per cent rev/min position and press the appropriate individual engine start button, engine rev/min should build up to idling in 50 seconds. Should the throttle have been retracted to the shut-off position before the individual engine start button light was extinguished, wait for the light to go out, then immediately reset the throttle lever to 50 per cent rev/min position and press the individual engine start button, engine idling rev/min should be reached in 30 seconds.

88B. When making the second attempt to start an engine during a rapid start exercise, the individual engine start button must be used NOT the rapid start button, otherwise four engines will again be involved in a start sequence when presumably, two or three are already running. Should the second attempt also prove abortive, it will be necessary to start the engine in the normal manner either with air from a ground starter trolley or, by selecting the appropriate engine air valves, using bleed air from the running engines.

NOTE . . .
Starting limitations
Not more than two starts (combuster lit) are to be made on any one engine in any one thirty minute period, irrespective of the starts being successful or not. Ground starter trolley or cross-bleed starts are not included in this limitation.

Rapid start - single engine

88C. Any engine may be started by the rapid start system, If, after starting one engine, it is intended to start the remainder using cross-bleed air, the first engine started must be No.1 or 4. Single engine starts are carried out in the following manner. Ensure that all pre-starting checks called for in para.86 have been complied with, proceed

(1)	Battery isolation switch	ON
(2)	Alternator switches (4)	OFF
(3)	28-volt T.R.U. and 115-volt transformer switches	ON
(4)	P.F.C. stop buttons (10)	Operate
(5)	L.P. fuel cocks	OPEN
(6)	L.P. fuel warning indicators	BLACK
(7)	AUTO-MANUAL fuel switch	AUTO
(8)	Engine fuel cross-feed cocks	SHUT
(9)	Aircraft fuel cross-feed cocks	SHUT
(10)	Starting air selector switch	RAPID
(11)	Ignition switch	ON

WARNING . . .
The ignition switch must be ON before commencing the start cycle. Damage to the engine may result if it is selected ON after the cycle has commenced.

(12)	R.P.M. governor/J.P.T. limiter switch	TAKE-OFF
(13)	Engine governor isolation switch	ON
(14)	J.P.T. limiter switch	ON
(15)	M.F.S. gyro hold-off button	Press
(16)	Main A.V.S. system switch	OFF
(17)	Fuel tank pressurisation switch	OFF
(18)	Anti-icing AUTO-MANUAL switches	OFF
(19)	Cabin air valves	OFF
(20)	Engine air valves	SHUT
(21)	Start master switch	ON
(22)	Throttle lever (appropriate engine)	50 per cent rev/min.

WARNING . . .
The relight button on the throttle lever must not be pressed during starting.

(23)	Establish clearance to start with ground controller then press the appropriate individual engine start button for one second and release. The sequence of events which follow, though confined to the one selected engine, are identical with	

◀ those described for multi-engine start. Precautionary measure to deal with abnormalities, high jet pipe temperature, abortive first starts, etc., still apply and must be adhered to.

Stopping the engine

89 The following procedure is carried out when stopping an engine to prevent a vapour lock in the engine fuel pumps.

NOTE

Before stopping the engines, ensure that all electrical loads are switched OFF A special check being made on the P.F.C. panel (port console)

(1) Throttle back to idling and allow engine to cool, this instruction may be disregarded in an emergency.

(2) Move the throttle lever back to the H.P. cock SHUT position.

(3) When engine rotation has ceased, close the L.P. cocks and switch off the tank booster pumps.

Procedure for dry motoring cycle

90 To clear an engine of accumulated fuel after a wet motoring cycle or an abortive start carry out a dry motoring cycle as follows This operation may be performed using a supply of air from an air starting trolley or from an engine which is already running above 90 per cent rev/min

WARNING . . .

Do not operate the relight button during a motoring cycle.

(1) 28-volt T.R.U. and 115-volt transformer ON

(2) Ignition switch OFF

(3) Start selector switch NORMAL

(4) Start master switch ON

(5) Throttle control H.P. COCK SHUT

(6) Confirm clearance to motor with ground controller.

(7) Start button Press and release when indicator light illuminates.

(8) Start master switch OFF after 30 seconds but not more than 60 seconds after pressing start button.

(9) Check start button indicator light is extinguished.

(10) If motoring cycle has been carried out by cross-bleed air, move throttle of running engine to idling.

Wet motoring cycle

91 When a wet motoring cycle is required during ground servicing operations proceed as follows:-

WARNING . . .

(1) Do not initiate a wet motoring cycle using the air cross-feed method, owing to the risk of fire.

(2) Do not operate the relight button during the motoring cycle.

(3) To minimise fire risk ensure that suitable containers are placed under the drain outlets to collect fuel which will drain from the engine and jet pipe.

(1) Connect the L.P. air starting trolley hose and electrical lead. Start the trolley

(2) Connect a ground electrical supply

(3) Battery isolation switch ON

(4) Alternator switches (4) OFF

(5) 28-volt T.R.U. and 115-volt transformer ON

(6) Ignition switch OFF

(7) Start selector switch NORMAL

(8) Start master switch ON

(9) L.P. fuel cocks ON

(10) Check fuel pressure indicators show white

(11) Throttle control IDLING

(12) Fuel AUTO/MANUAL switch AUTO ▶

(13) Fuel tank pump switches ON
Check fuel pressure indicator shows black.

(14) Cross-feed cocks OPEN then SHUT

(15) Engine air switches (4) OPEN

(16) Auto/manual anti-icing switches OFF

(17) Confirm clearance to motor with ground controller.

(18) Press engine start button firmly for one second then release. Check that start button light illuminates.

(19) Select start master switch OFF 30 to 45 seconds after pressing start button Check that start button light is extinguished.

(20) Throttle control H.P. COCK SHUT

(21) Electrical supply OFF

(22) Allow e.c.u. to drain for one minute then carry out two dry motoring cycles (para.90).

A.A.P.P. COMPRESSOR WASHING

92 Prolonged ground running and/or cartridge starting in flight will cause fouling of the A.A.P.P compressor and diffuser which, if ignored, results in loss of power. If this fouling deposit is not removed at regular intervals it will become baked-on and extremely difficult to remove without stripping the unit.

93. Compressor washing, to prevent this undesirable development, must be carried out at the times specified in A.P.101B-1902-4. The washing procedure is as follows:-

NOTE . . .
The A.A.P.P. must be cold before the washing technique is applied, i.e., at least one hour should elapse after any running period.

(1) Remove the inboard access panel of the A.A.P.P. compartment

(2) Remove the breech caps and cartridges.

(3) Remove the A.A.P.P. inboard side panel.

(4) Disconnect the air/fuel ratio control valve compressor delivery pipe from the engine main air casing, and fit a blanking plug to the main air casing and pipe.

(5) Remove the fuel drain valve using tool Ref.No 64AF/14

(6) Connect the fuel drain pipe Ref.No.64AF/15 to the fuel drain union and place the lower end of the pipe in a suitable container.

(7) Remove the blank from the washing connection on the front end panel.

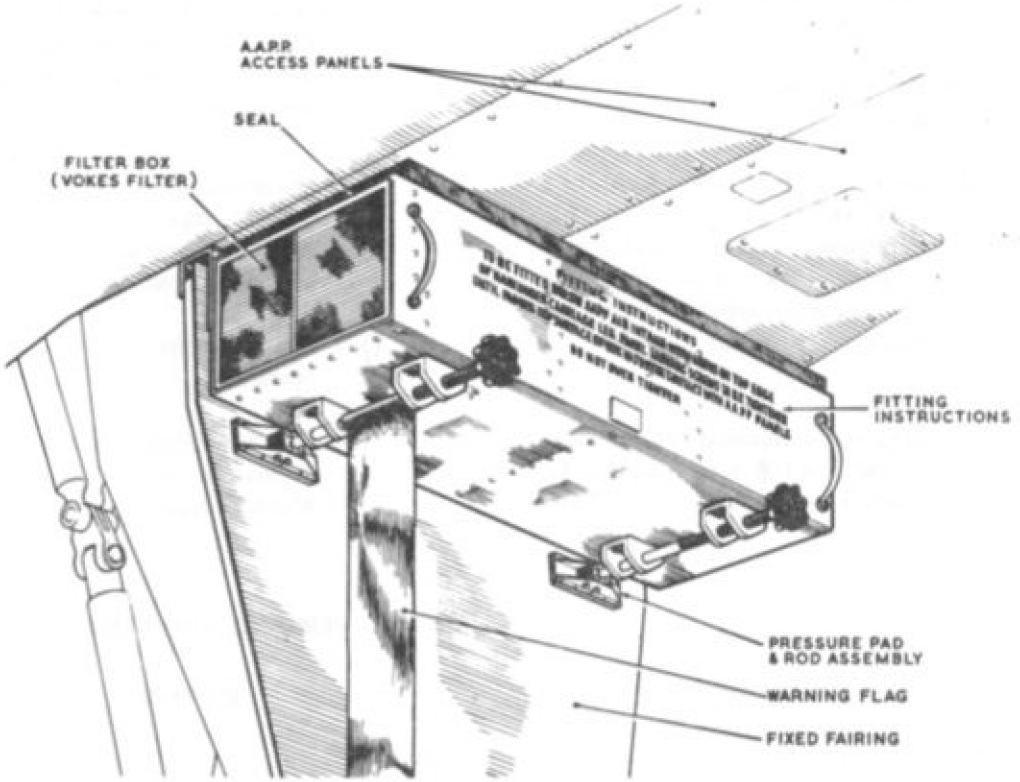


Fig.11. A.A.P.P. filter box - method of attachment

(8) Charge the fluid container of replenishing can Ref.No. 4G/5358 with the cleaning solution in the following proportions:-

Aviation kerosine	three pints
Turbex (SQ25)	¼pint
Distilled water	three pints

The Turbex must first be mixed with the kerosine and the water added to the resulting emulsion. Mix thoroughly by shaking the container.

(9) Connect the replenishing can delivery pipe to the compressor washing connection on the front end panel.

(10) Pressurise the fluid container to 30 lb/in^2.

(11) Dry cycle the A.A.P.P. (A.P.4617A, Vol.1 and 6), simultaneously inject the cleansing solution. The wash must be continuously applied until the engine ceases to turn.

NOTE . . .
Personnel are advised to stand clear of the A.A.P.P. intake during the washing period.

(12) Allow a minimum 15 minute soak and drain period.

(13) Empty the fluid container and replenish with six pints of distilled water. Pressurise container to 30 lb/in^2.

(14) Repeat op.(11) injecting the distilled water.

(15) Ignore the 15 minute waiting period repeat op.(13) and (14).

NOTE . . .
After three consecutive starts, dry or wet cycles, a period of not less than 30 minuted must elapse before attempting to re-energize the starter.

(16) Disconnect the replenishing can delivery pipe from the washing connection and allow a five minute period to allow the water to drain.

(17) Dry cycle the motor as a drying operation.

(18) Fit the blank to the washing connection on the front end panel. Wire-lock blank.

(19) Remove drain pipe from the fuel drain valve union and fit fuel drain valve.

(20) Remove the blanks and fit the pipe to the air/fuel ratio control valve. Wire-lock the union.

(21) Mop up all surplus fluid.

(22) Fit the cartridges and breech caps.

(23) Fit the A.A.P.P. inboard side panel.

(24) Run the A.A.P.P. and check to ensure that the drain valve is sealing satisfactorily by disconnecting the external union in the drain pipe on the underside of the A.A.P.P. bottom panel and check the escape of air. If no air escapes, reconnect the pipe. If an air leak is evident, remove the fuel drain valve, clear, refit and test.

NOTE . . .
It is essential to run the A.A.P.P. within three hours of a compressor washing, otherwise, if washing fluid is allowed to drain and collect, corrosion will occur, resulting in damage to the unit.

REMOVAL AND ASSEMBLY

HYDRAULIC PUMPS

94. Hydraulic pumps are removed in accordance with the instructions contained in A.P.102C-0402-1.

JET PIPES

Removal

95. To avoid endangering personnel and prevent damage being done to the jet pipe and aircraft structure a clamp must be fitted to prevent rearward movement of the jet pipe when it is disconnected from the engine. The clamp must be fitted as follows:-

(1) Fit the rubber lined end over the edge of the access aperture for one of the four end cap securing bolts.

(2) Loosen the wing nut and fit the hooked end of the clamp sliding portion over the rim of the jet pipe propelling nozzle.

(3) Tighten the wing nut to prevent further movement of the clamp sliding portion.

The clamp, illustrated on fig.11B, can be locally manufactured from the following materials:-

Material	Ref. No.
10 S.W.G. sheet steel	30A/538
Bolt, 1/4 in. B.S.F.	28D/1011238
Spring washer, 1/4 in.	28W/94116644
Wing nut, 1/4 in. B.S.F.	28M/803
Sheet rubber, 1/8 in. thick	32C/493
Bostik adhesive	33H/9129434
Paint priming, red oxide	33A/9106645
Paint red, Post Office	33A/9106804

95A. To disconnect a jet pipe from the engine either to remove the jet pipe or facilitate the removal of the engine the procedure is as follows:-

(1) Remove the jet pipe end caps.

(2) Disconnect the thermocouple terminals at the junction box on top of the jet pipe.

(3) Gain access to the jet pipe rear adjustment mechanism, via the access panel in the undersurface of the aft tunnel fairing.

(4) Remove the locking wire from the adjusting rod on the sliding ramp assembly and turn the rod clockwise, until the ramp is moved forward free of the lower roller.

(5) Remove the shim carriers, complete with shims, from below the jet pipe forward lower rollers. Remove the shims from the carriers and secure the shims to their respective stowage brackets on the front face of the engine bay rear bulkhead (fig.12). Fit the carriers in their original positions.

NOTE . . .
If the shims are not removed, the jet pipe forward lower rollers may locate aft of their respective shim stacks when the jet pipe is moved aft, and further movement of the jet pipe will only be achieved with difficulty.

(6) Secure the jet pipe with the restraining clamp (para 95) to prevent uncontrolled rearward movement when the retaining channel is removed.

(7) Release the single toggle clamp aft of the bellows assembly and remove the clamp.

(8) Release and remove the double toggle clamps between the bellows assembly and the exhaust outer cone.

(9) Slide the complete assembly aft on the jet pipe until the retaining channel is fully exposed.

(10) Move the complete jet pipe forward slightly to disengage the assembly, then move the retaining channel.

(11) The jet pipe is now free to be moved aft away from the engine and into the jet pipe tunnel.

96. Should the operations in para.95A been carried out to facilitate engine removal, no further action is necessary. The jet pipe may remain in the tunnel until the appropriate stage of replacement engine installation is reached. If the jet is to be removed from the aircraft, the correct type of trolley must be in position to receive it before the restraining clamp is removed. The correct trolleys are, Ref.No. 26DC/95348 when the aircraft is on its wheels or Ref.No. 26DC/95361 when the aircraft is on jacks.

Assembly

97. When the jet pipe is installed in the aircraft, sufficient clearance must be maintained between the jet pipe support rollers and their guide rails to accommodate the jet pipe in its heat expanded state. Movement of the jet pipe, due to varying temperatures, is catered for by shimming to a predetermined cold setting clearance at the front and the provision of a fixed ramp, over which

the support roller is free to ride, at the rear.

98. The jet is assembled to the engine by reversing the procedure given in para. 96, bearing in mind that efficient functioning of the bellows will be impossible if the exhaust outer cone is out of line or the flanges incorrectly engaged. To eliminate this possibility the following instructions must be adhered to:-

(1) Check the exhaust outer cone alignment by measuring the length of the cone in four diametrically opposite position on the horizontal and vertical centre lines. The horizontal or vertical centre line dimensions must not vary by more than 0.06 in.

(2) After the retaining channel has been fitted, slide the complete bellows assembly forward until the dowel on the bellows flange engages correctly with the flange on the engine exhaust outer cone This will hold the retaining channel in position.

(3) Assemble the rear bellows clamp straps (double toggle) to hold the two flanges secure.

(4) Move the complete jet pipe assembly aft until the forward flange of the retaining channel is felt to butt against the forward face of the exhaust outer cone inner flange, (a cross-section view of this assembly is provided in fig.14, detail A).

(5) Check that the rear bellows clamp strap is correctly located, then tighten both toggle bolts to a torque loading of 80 lb. in. Wire lock the toggle bolts in the approved manner fig.11A.

(6) Slightly lubricate the support ring and the inside faces of the upper and lower strap units, Part Nos. B289684 and B289683 with clean oil O.X.320.

(7) Lubricate the threads and the underside of the securing bolt heads with graphite X.G.285 and loosely assemble the units to the support ring. Remove any surplus oil or grease.

(8) Tighten the bolts finger tight, ensuring that the gap between the strap ends is equal at each side. Move the complete assembly rearwards until the rear strap edge abuts the support ring lip.

(9) Ensure that the assembly is positioned so that the gap between the two segments on the starboard side is approximately 7½ deg. below the horizontal centre line of the jet pipe, the axial slots in the support ring are centrally disposed under the strap ears, and the trunnions are clear of the bellows guard bolts.

(10) Check that the distance pieces are correctly engaged with their mating trunnions, then progressively torque-tighten each bolt alternately up to 90 lb. in. Ensure that the assembly remains positioned as in operation (8) during this procedure.

(11) Using feeler gauges, check that the overall general gap between the exhaust cone rear bellows bore and the jet pipe sealing ring outside diameter does not exceed 0.002 in. However at the two bolt positions the gap is acceptable up to 0.004 in. over a three inch length or 0.008 in. over a one inch length. The strap assembly may be slightly repositioned angularly to achieve this condition. If moving the strap assembly fails to achieve the above dimensions employ the following methods in sequence until the gap is within the required limits.

(a) Renew the strap assemblies.

(b) Change the exhaust cone rear bellows.

(c) Change the jet pipe.

(12) When a satisfactory fitting ia obtained, wirelock the two bolts.

NOTE...
The instructions in op. (13) apply at this stage when partial dismantling only has occurred, i.e., local investigation and/or rectification of a known source of gas leakage. When a complete installation operation is in progress however, these instructions will apply at the appropriate later stages - (16) (17) and (18).

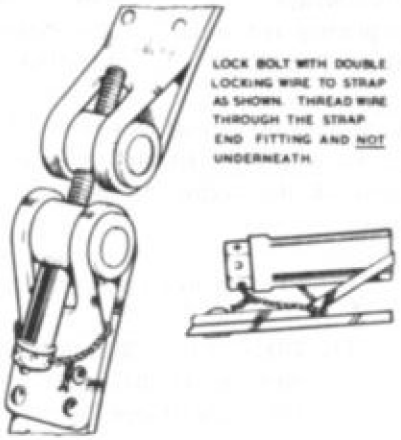


Fig.11A. Wire-locking - trunnion bolts

(13) After a ground run (to include max. continuous rev./min.) or, after an engine running period of not less than half an hour and not more than 15 hours, release the wire locking on the two lower bolts and check the bolts for correct torque-tightness; if necessary, torque-tighten to 90 lb.in. When satisfactory, wire-lock the bolts in the approved manner.

NOTE...
Do not slacken the bolts or disturb the strap assembly in any way when carrying out this latter check.

(14) Set the jet pipe rear ramp and rear roller clearances in the following manner:-

(a) Push the sliding ramp as far aft as possible and engage the tension rod with the trunnions, R.H. thread aft, and then rotate the tension rod to withdraw the ramp fully forward.

(b) Ensure that the jet pipe is correctly attached to the engine in accordance with op.(1) to (12) paying particular attention to op. (4).

(c) Fit the loading fork (Part No. 1/U.1893) in the ramp and screw the ramp aft until the aft face of the fork is just in contact with the forward face of the bottom rear roller.

(d) Now that the bottom rear roller is positioned correctly in the COLD position, at the peak of the ramp with the roller touching the fork (see fig.12), slide the aft end of the jet pipe laterally inboard until the inner rear upper roller is in contact with its track. Check that the clearance between the outer rear upper roller and its track is in the range 0.02 in. to 0.05 in. If the setting is not satisfactory, the jet pipe must be released from the engine and partially withdrawn from the tunnel to permit appropriate adjustment of the eccentric bottom rear roller (Olym. Mod. JP61). The full re-installation and clearance checking procedure as detailed above should then be repeated.

(e) Having made a final check that the bottom roller has been correctly in contact with the loading fork, and that the free clearance at the outer upper rear roller is within the acceptable range, remove the loading fork and wire-lock the ramp adjustment rod in the approved manner.

(15) Check front support roller clearances without shims, if these are in excess of 0.316 in., the engine angle and/or alignment may be adjusted after releasing the rear bellows joint.

NOTE...
(1) Whenever the roller clearances are checked, it is essential that the following conditions are observed.

(a) The aircraft must rest on its undercarriage.

(b) The mating engine must be installed.

(c) Both engine bay front access doors must be closed and the centre and rear doors open.

(2) Any adjustment to the engine angle or alignment must not exceed the permitted tolerance range, i.e. ± 0 deg. 10 min., and must be consistent with good assembly of the intake making-up pieces and engine bay bulkhead clearances. When the roller clearances are less than 0.316 in., connect rear bellows, clamps, etc., as for final assembly.

(16) Ground run the engine for 5 min. at maximum continuous rating with front and rear engine doors closed and centre door open.

(17) Allow the jet pipe to cool to 70 deg. C. or below, i.e., cool enough to handle.

(18) Clearance between the forward lower rollers and shim carriers should now be established, by the shims para.95A op.(5) and fig.12, to within 0.060 in.

NOTE...
The mating engine and jet pipe must also be installed for this running check. For new installations the mating engine should have completed op.(1) to (7) inclusive.

(19) Check and adjust as required the rear support ramp, i.e., ensure that the roller is in contact with the loading fork, and lock the tension rod with wire in the approved manner.

WARNING...
With the centre engine door open, the engine bay and jet pipe cooling system is not fully operational, therefore, these running periods must be restricted to the absolute minimum.

MATERIAL — 10 S.W.G. SHEET STEEL (0·128 IN.)

ALL SHARP CORNERS TO BE RADIUSED

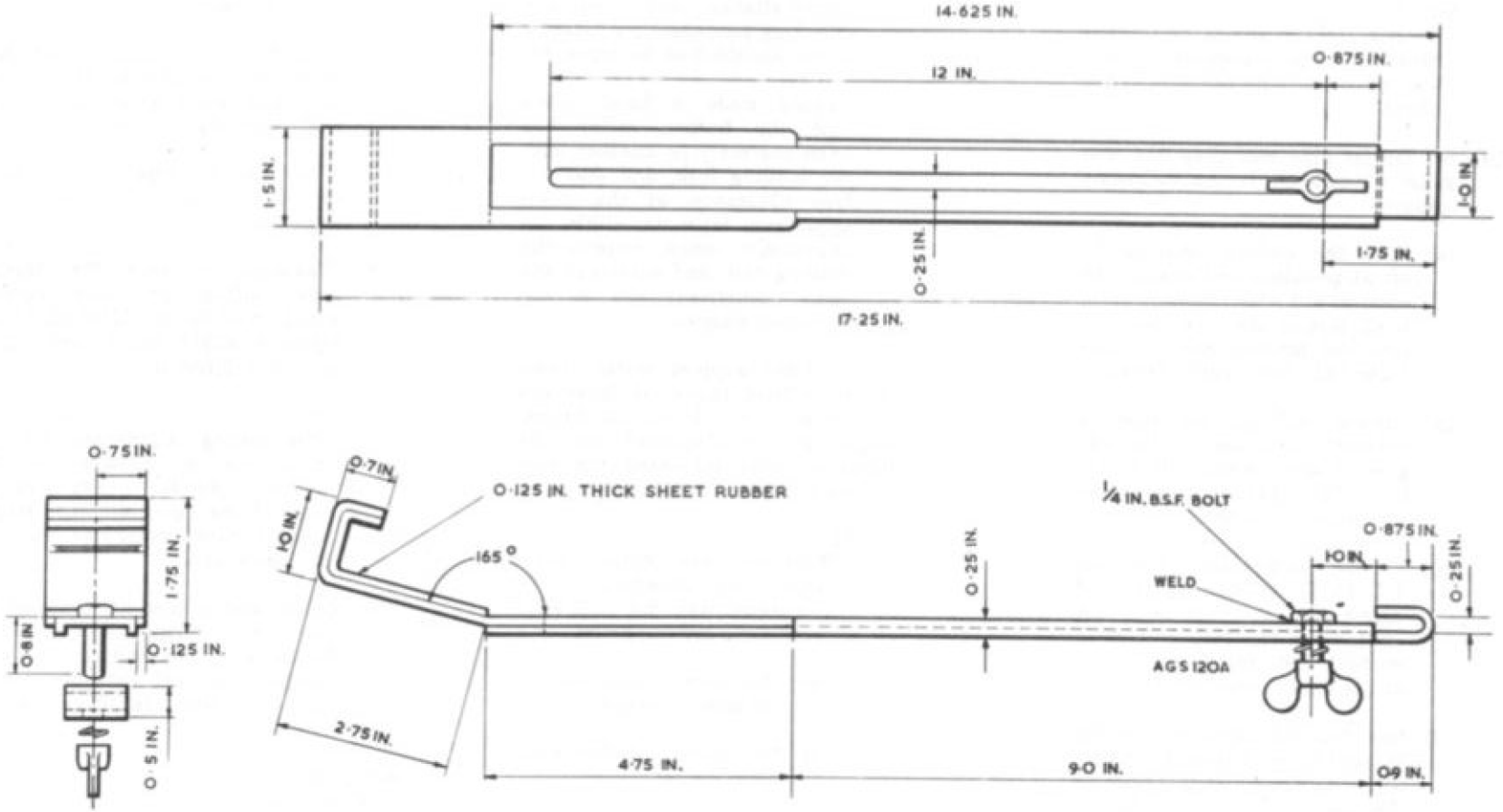


Fig. 11B. Adjustable securing clamp – jet pipe

CONSTANT SPEED DRIVE AND ALTERNATOR

99. Provision is made in the engine bay for removing the c.s.d./alternator assembly as a complete unit, or the alternator as a separate component. Fig.13 shows the method applied to both these operations and the following paragraphs give the recommended procedures.

100. With the exception of op. 5, the following procedure applies to both operations mentioned in the previous paragraph.

(1) Open the centre and front engine access door (para. 56, op.1).

(2) Disconnect and remove the cooling duct between the forward air intake and the alternator, and the exhaust duct between the alternator and the engine front bulkhead.

(3) After checking that the L.P. cocks are closed, disconnect the fuel feed pipe at the engine bulkhead and at the joint on the engine bay rib. Release the pipe support bracket on the front engine casing and remove the fuel pipe.

(4) Fit the mini-lift hoist attachment bracket (Ref.No.26DC/95450) to the front single bracket of the three brackets mounted on the starboard side wall of the engine bay.

(5) Depending on the operation to be carried out, pulley bracket (Ref.No. 26DC/95451) is to be fitted to one of the pair of brackets aft of the mini-lift hoist bracket. The front bracket for the removal or installation of an alternator, the rear bracket when the same operations are to be carried out on the c.s.d./alternator assembly.

Removal of the alternator

101. Prior to the removal of the alternator from the c.s.d., the alternator drive quill shaft must be withdrawn from the normal operating position within the c.s.d. unit by approximately 2.25 in. to obviate any possibility of damage to the shaft or shaft seal during removal of the alternator. To withdraw the shaft proceed as follows:-

(1) Remove the six nuts and washers securing the end cap of the alternator.

(2) Loosen the bolts on the dust cover which traps the lip of the end cap and remove the end cap.

(3) Locate the blanking plate revealed by the removal of the end cap. Remove the screws and spring washers securing the blanking plate and remove the plate.

(4) Remove the split pin from the quill-shaft extractor nut revealed by the removal of the blanking plate.

(5) Using a 7/16 in. A.F. box spanner turn the extractor nut 60 turns in a clockwise direction until approximately 2.25 in. of thread on the quill-shaft retainer is protruding through the nut.

NOTE...
Movement of the extractor nut will tend to turn the shaft of the a.c. generator when the quill shaft has been moved a sufficient distance.

102. On completion of the procedure given in para.101 the alternator is ready for removal. Proceed as follows:-

(1) Disconnect the electrical loads from the alternator.

(2) Engage the mini-lift hoist and assemble the cable and pulley with the lifting sling (Ref.No. 26DC/95372) to the appropriate brackets, (para.100).

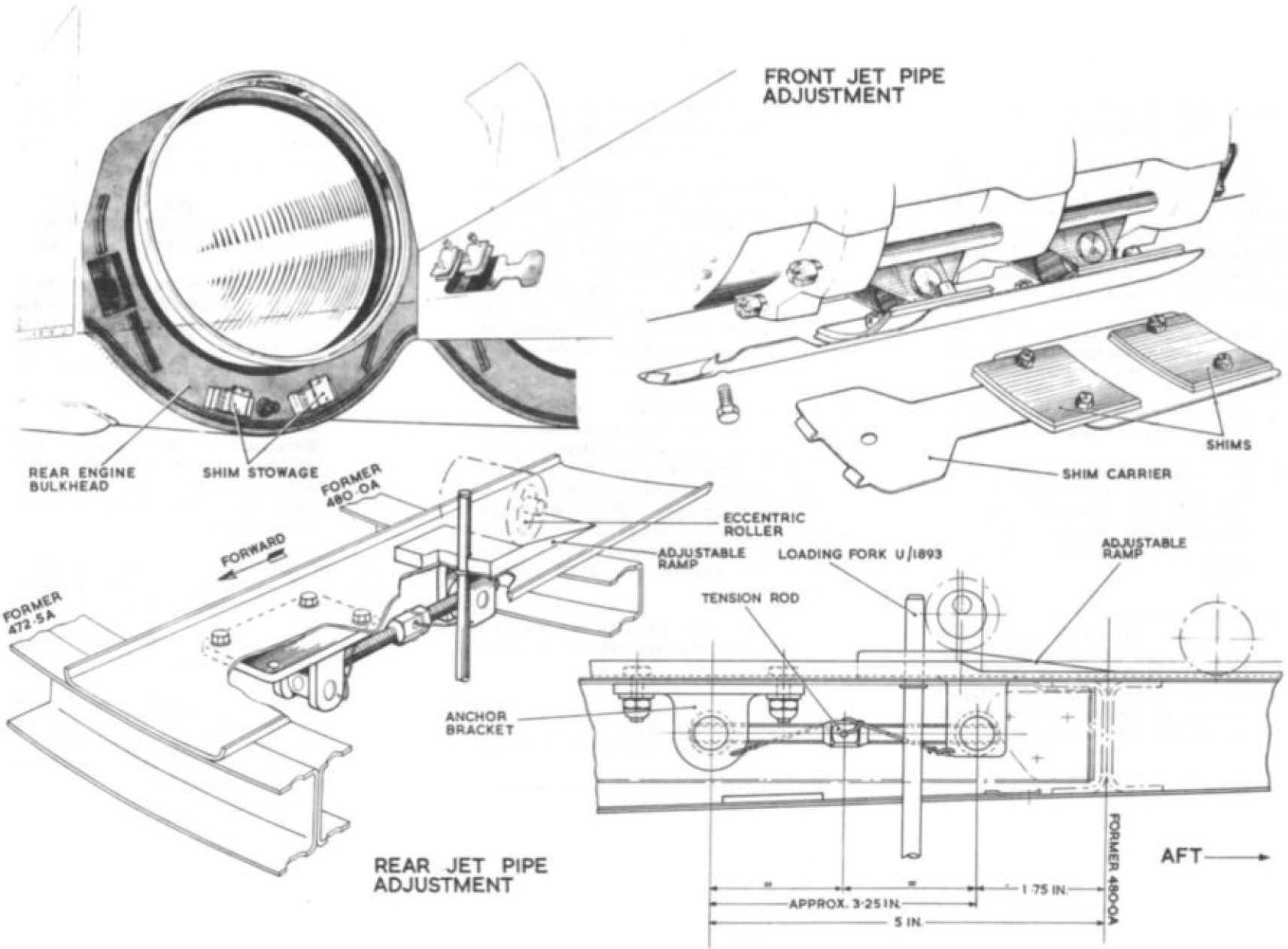


Fig. 12. Jet pipe adjustment

(3) Arrange the sling loops on the alternator as shown on fig.13 and take the weight of the alternator on the hoist.

NOTE .
Provision must be made at this stage to prevent the alternator swinging into the rib below the pulley. A check rope must be used as shown on fig.13.

(4) Ensure that the alternator is adequately supported and remove the manacle clamp securing the alternator to the c.s.d. unit.

(5) Withdraw the spigot on the alternator face from the c.s.d. unit and carefully remove the alternator.

(6) Steady the alternator and lower it on to a suitable stand.

Installation of the alternator

103. The procedure for installing an alternator is the reverse of that given in para.99 to 102. When assembling the clamp ring, apply grease XG-271 to the threads and internal cone and ensure that all sections of the clamp assembly are bedding correctly. Clamp ring securing nuts are to be torque tightened to 100 lb in. Slacken the securing nuts and torque tighten them three times to ensure that the ring faces have bedded correctly.

Removal of the c.s.d./alternator assembly

104. To remove a complete unit, i.e., the constant speed drive unit and alternator combined, proceed as follows:-

(1) Carry out the operations listed in para.100.

(2) Drain the c.s.d. unit oil supply ◀ tank (A.P.102C-0402-1). ▶

(3) Disconnect and remove the drain pipe between the c.s.d. unit and engine front bulkhead.

(4) Disconnect the electrical leads from the alternator and from the basic governor trimming motor, the pressure switch and the thermometer bulb on the c.s.d. unit.

(5) Disconnect the bonding clip - engine to c.s.d. unit support bracket.

(6) Engage the mini-lift hoist and assemble the cable and pulley with the sling Ref.No. 26DC/95327 to the appropriate bracket (para.100).

(7) Secure the sling link to the c.s.d. unit support bracket and take the weight on the hoist.

(8) Attach a check rope to the alternator assembly. (see note para.102 and fig.13).

(9) Remove the cup washers over the c.s.d. unit two securing nuts and remove the securing nuts and distance pieces.

(10) Carefully remove the c.s.d./alternator assembly. Swing it forward so that it clears the securing bolts and the bulkhead. Lower the assembly on to a suitable carrier.

Installation of the c.s.d./alternator assembly

105. For the installation of a c.s.d./alternator assembly, reverse the procedure given in para.104.

ENGINE CHANGE UNIT (E.C.U.)

Preparation for removal

106. Assuming that the engine access doors have been removed, the following paragraphs give the sequence for the removal of an e.c.u. beginning at the front and working rearward.

WARNING . . .
Before starting the removal procedure, isolate the high energy ignition unit by removing the input lead plug.

(1) After closing the L.P. fuel cocks, disconnect the fuel feed pipe at the 'King' coupling on the engine front bulkhead, and at the joint on the engine bay rib. Release the support bracket on the engine front casing and remove the pipe (fig.14, item (1)).

(2) Disconnect the three hydraulic pipes from the pump at the 'Avery' couplings on the engine bay wall (fig.14, item (2)).

(3) Disconnect and remove the cooling ducts between the intake and the alternator and the c.s.d. oil cooler (fig.14, item (3) and (4)).

(4) Disconnect the electrical cables

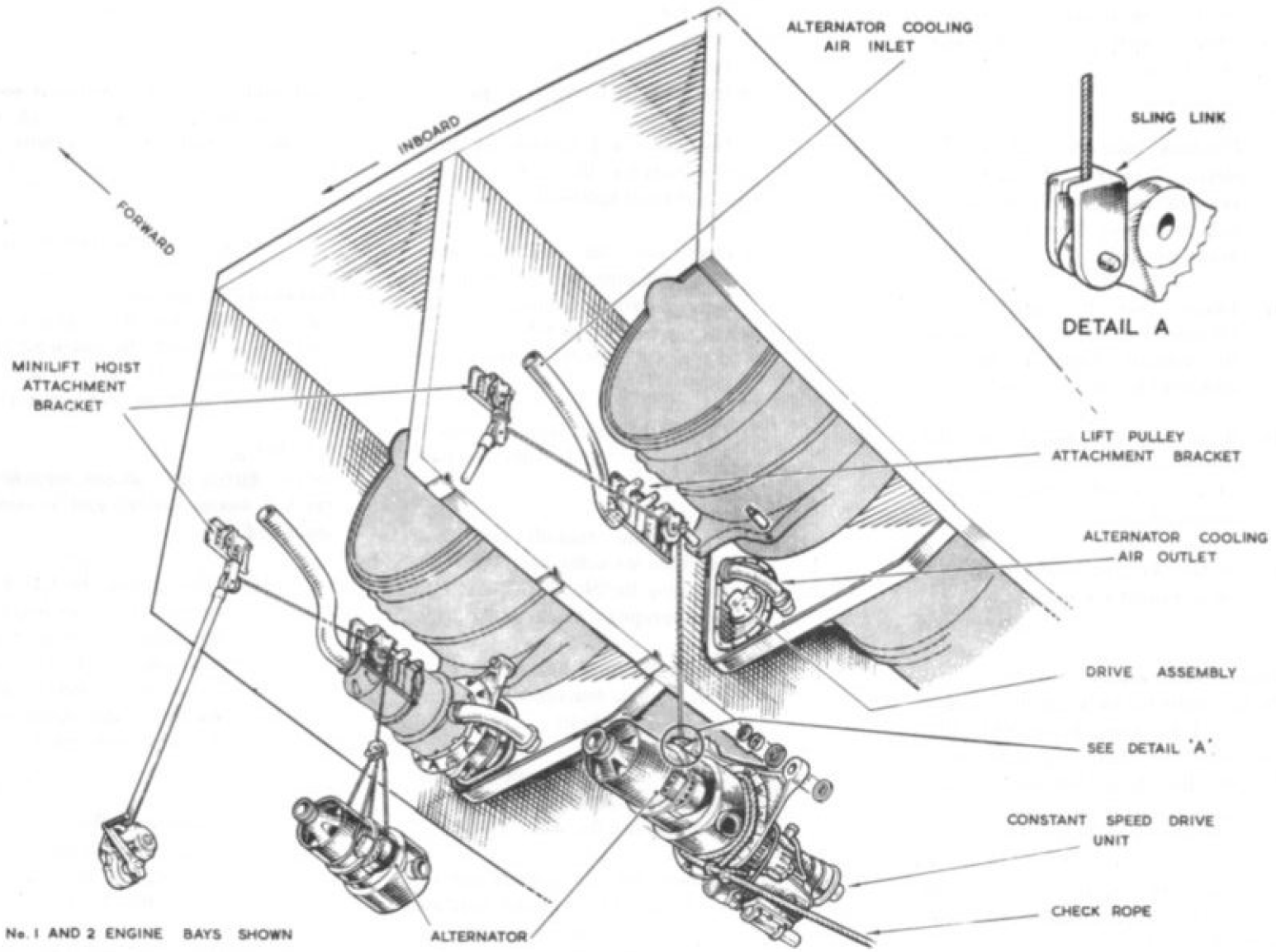


Fig. 13. Constant speed drive / alternator removal

from the alternator and secure the loose cables so as not to foul the engine when removal operations begin.

(5) Release and remove the engine control system torque shaft (fig.14, item (5)).

(6) Ensure that the electrical plugs for the following services are disconnected and secured so as not to foul the engine (fig.14, item (6)).

(a) C.S.D. governor

(b) Engine isolation cock

(c) Fuel flow meter

(d) Engine anti-icing actuator

(e) L.P. tachometer generator

(f) Low pressure warning (fuel system)

(g) Low pressure cock solenoid

(h) R.P.M. indicator

(i) Jet pipe limiter

(7) Release the toggle fasteners on the main air intake coupling clamps and the toggle fasteners on the duct (fig.14, item (7)), the assembly can then be removed in sections. Special care must be taken to ensure that the nose cone oil tank shroud is not damaged during this operation.

(8) Disconnect the aircraft air supply duct (fig.14, item (8)), at the engine isolation cock, and at the engine bay wall and remove the section of ducting.

(9) Remove the detachable making-up pieces from the lower position of the engine bulkhead.

(10) Disconnect and remove the lower pipes of the fire extinguisher system in zones 2A and 2B (fig.14, item (9)).

(11) Disconnect the ancilliary pneumatics supply pipe (fig.14, item (10)).

(12) Disconnect and remove the fuel drain pipe complete with expanding coupling (fig.14, item (11)), from the lower front face of the rear bulkhead.

(13) Disconnect the air inducer pipe at the rear engine bulkhead (fig.14, item (12)).

◀ (14) (See warning; para.106). ▶ Disconnect the igniter plug leads and remove the lead attachment brackets, as required, from the engine bay wall. Cables, plug leads and bracket must be coiled and stowed so as not to foul the engine during subsequent lowering operations (fig.14, item (13)).

(15) Disconnect the jet pipe from the engine exhaust outer cone (para.95 and fig.14, item (14)).

(16) Taking care not to damage the 'Refrasil' blanket, withdraw the jet pipe into the jet pipe tunnel and clear of the engine. Secure in this position with clamp (para.95).

(17) Remove the bolts securing the fire detector at the bottom of the rear bulkhead and position the detector inside the jet pipe tunnel (fig.14, item (15)).

E.C.U. removal equipment

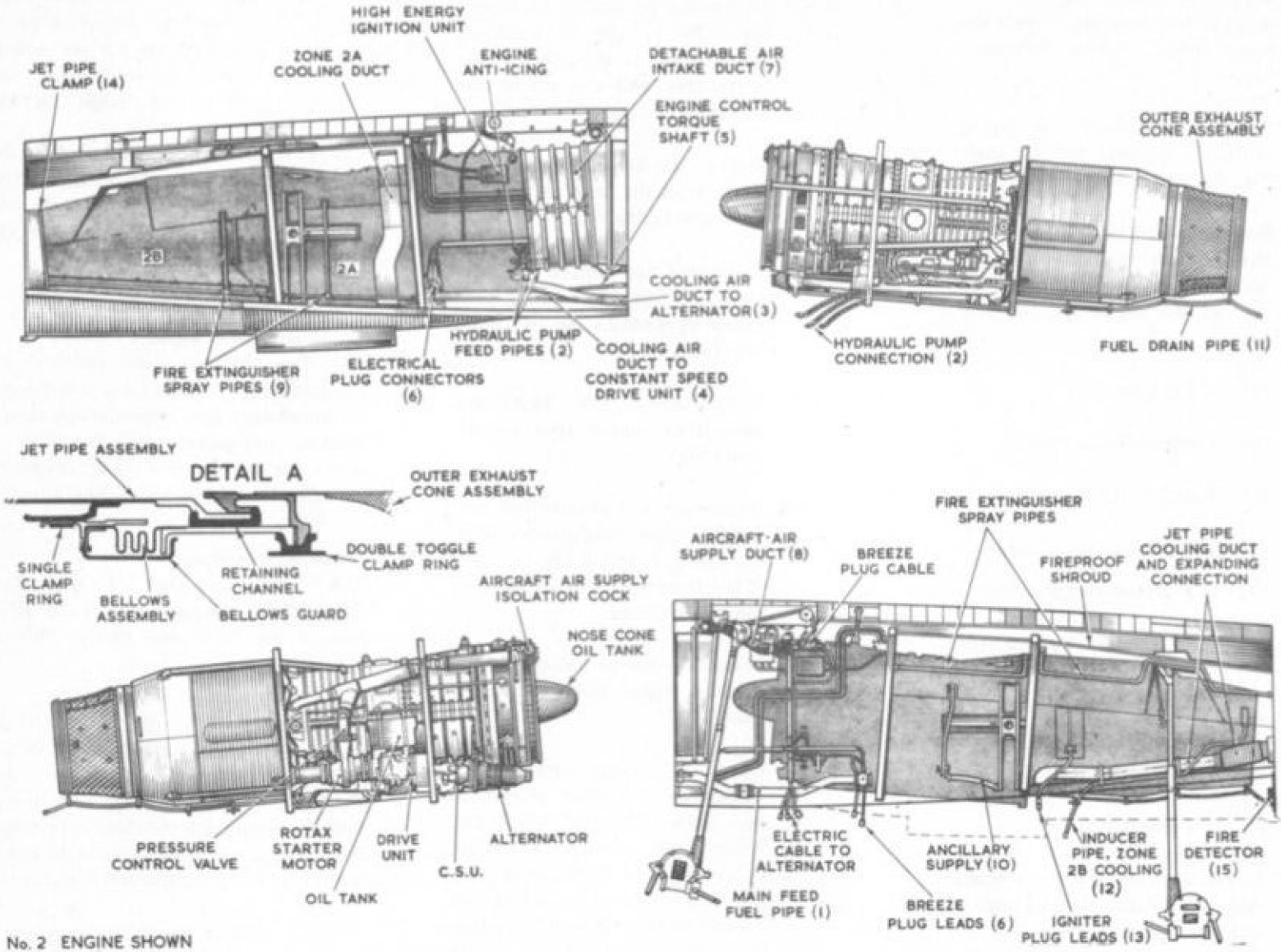
107. Two methods, using different sets of equipment, are used for e.c.u. removal and also for installation. One method uses a three-point hoisting arrangement and the other which caters for an increased all-up weight of the e.c.u. uses a four-point hoisting arrangement.

Three-point hoisting

108. Three engine hoists Ref.No. 26DC/95266 are positioned round the e.c.u., one at the front and two at the rear as follows:-

NOTE . . .
A slinging bracket Part No. 26/U.1579 must be attached to the cable end fitting of the forward hoist in place of the hook Ref.No. 26DC/95705. Hooks are only used on the rear hoists. A stowage is provided on the body of the hoist winch to accommodate either the bracket or the hook, whichever is not in use.

(1) Engage the forward hoist top hook with the lifting hoist attachment assembly in the roof of the engine bay, just above the engine nose cone. The hook will engage correctly only when offered with its point at the top and forward.



No. 2 ENGINE SHOWN

Fig.14 Engine removal (1)

(2) Secure the forward hoist by fitting the guard rail Ref.No. 26DC/95400 across the engine bay (fig.15).

(3) Withdraw the pivot pin from the front lift point pulley in the engine bay roof and remove the pulley.

(4) Route the hoist cable rearwards, through the roof structure intercostals, under the first roller and over the second, then down through the lift point pulley housing.

(5) Assemble the lift point pulley so that the cable passes over it from front to rear, then secure the pulley pivot pin with the quick-release lock-pin.

(6) Engage the slinging bracket with the forward lifting lug on top of the engine using the Pip-pin provided.

(7) Engage the rear lifting hoists, one at each side of the engine, with their appropriate hook attachment assemblies in the rear section of the engine bay roof. The point of the hook must face forward.

(8) Engage the hoist terminal hooks with the lifting points on the port and starboard sides of the engine.

(9) Proceed with the sequence of operations given in para.110.

Four-point hoisting

109. Four hoist assemblies each comprising an 18 cwt hoist Ref.No. 4GC/1276060, a top pulley sheath Ref.No. 4GC/1275820, an extension tube Ref.No. 4GC/1276891 and a handle Ref.No. 4GC/1275819 are positioned round the e.c.u. two at the front and two at the rear. The two forward hoists are attached to the e.c.u. using a lifting frame Ref.No. 4GC/1229657 and to the aircraft structure using a two piece suspension linkage Ref.No. 4GC/1229669. The attachment of the rear hoists is as given in para.108. Proceed as follows:-

(1) Assemble the four hoist assemblies.

(2) Engage the hooks on the sheath of the two rear lifting hoists with the appropriate port and starboard attachment assemblies in the rear section of the engine bay roof. The hooks must face forward.

(3) Engage the hoist cable terminal hooks with the rear lifting points on the port and starboard sides of the engine.

(4) Fit the lifting frame to the front of the engine air intake casing as follows:-

(a) Position the lifting frame with the two lower external shoes of the suspension packs around the outside rim of the engine intake casing V flange and the centre line of the top toggle in line with the top centre line of the engine.

(b) Tighten the internal shoes of the suspension packs against the inside of the engine intake casing flange using the knurled nuts.

NOTE . . .
The top knurled nut has a left-hand thread.

(c) Swing the top toggle over and secure using the attached Pip-pin.

(5) Withdraw pivot pin from the forward lift point pulley in the engine bay roof and remove the pulley.

(6) Fit the top beam of the suspension linkage in the engine bay roof with the hook facing forward and engaging the lifting hoist attachment in the engine bay roof structure. Secure the beam rear link to the lift point pulley attachment using the Pip-pin provided.

(7) Secure the bottom beam of the suspension linkage to the top beam with the Pip-pin provided. Use the forward hole in the top beam when the aircraft is in rigging position and the rear hole when the aircraft is at normal standing angle.

(8) Engage the hooks of the top sheaths of the two forward hoists with the attachment points on the

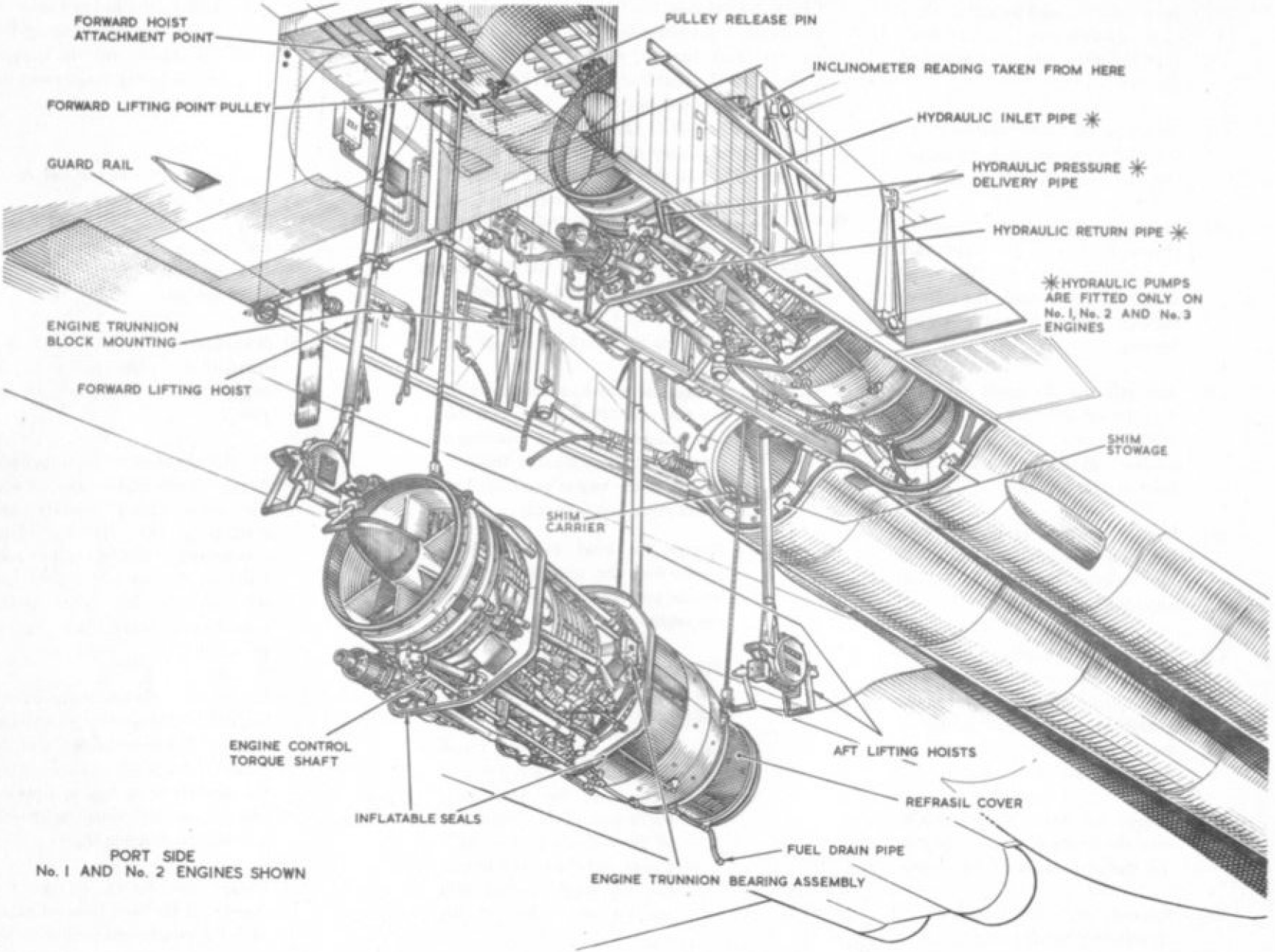


Fig.15 Engine removal (three-point hoisting) (2)

extremities of the suspension linkage bottom beam, with the hooks facing inward.

(9) Engage the forward hoist cable terminal hooks with the lifting lugs on the lifting frame.

(10) Proceed with the sequence of operations given in para.110.

Removal

110. With a suitable number of personnel stationed at each hoist and another person acting in a supervisory capacity, take the weight of the engine on the hoists and proceed as follows:-

(1) Remove the split pins and nuts from the two rear bearing assembly bolts, i.e., the one above the quick-release pin, and the wire-locking from the forward suspension link (fig.2).

(2) Withdraw the bearing assembly bolts and disconnect the forward suspension link.

(3) Operate the two rear hoists until the trunnion bearing housings contact the housing stops, and withdraw the quick-release pins.

(4) All hoists may now be operated, slowly, to lower the e.c.u., continuous checks being made to ensure that engine equipment and components are clear and in no danger of fouling the aircraft structure. When the e.c.u. is approximately half-way out of the engine bay, the lowering must be retarded on the rear hoists until the e.c.u. is horizontal. Special attention must be given to ensure all round clearance before resuming lowering operations.

(5) When the e.c.u. is clear of the engine bay, remove the bearing assemblies from the side trunnions on both sides of the engine.

(6) Position a servicing trolley/stand Ref.No. 4G/5570 below the aircraft to receive the e.c.u.

(7) With a simultaneous number of turns on each hoist, lower the e.c.u. on to the stand. Frequent checks must be made to ensure that no fouling occurs until the e.c.u. is correctly positioned on the stand.

(8) Remove the lifting hooks and secure the e.c.u. before moving the stand away from the aircraft.

(9) When the four-point hoisting method has been used remove the 'A' frame from the engine intake casing.

Installation

111. In addition to reversing the procedures given in para.106 to 110 the following instructions are considered necessary for the installation of an engine change unit.

(1) The interior and surrounding structure of the engine bay must be inspected for damage. Any evidence of damage, cracks, skin ripples, loose rivets etc. must be thoroughly investigated and the cause rectified before the replacement e.c.u. is positioned below the engine bay.

(2) After such rectification, remove all loose materials, rags, tools etc., these would be hidden from view after the engine is installed, and position the replacement e.c.u. and stand below the engine bay.

(3) Free the e.c.u. from the stand and check that all fittings and components are clear of and will not foul the stand when lifting operations begin.

(4) Where the four-point hoisting method is to be used, fit the 'A' frame to the engine intake casing (para.109).

(5) Engage the lifting cables of the hoists to their respective attachment points on the e.c.u. With a simultaneous number of turns on the hoists by each operator, raise the e.c.u. clear of the stand. This lift must be carried out slowly with continuous checks until clear.

(6) Fit the bearing housing assemblies to the two rear mounting trunnions of the e.c.u. Care must be taken on this operation and the following instructions are provided as a guide to the correct assembly.

(a) The fixed bearings are fitted

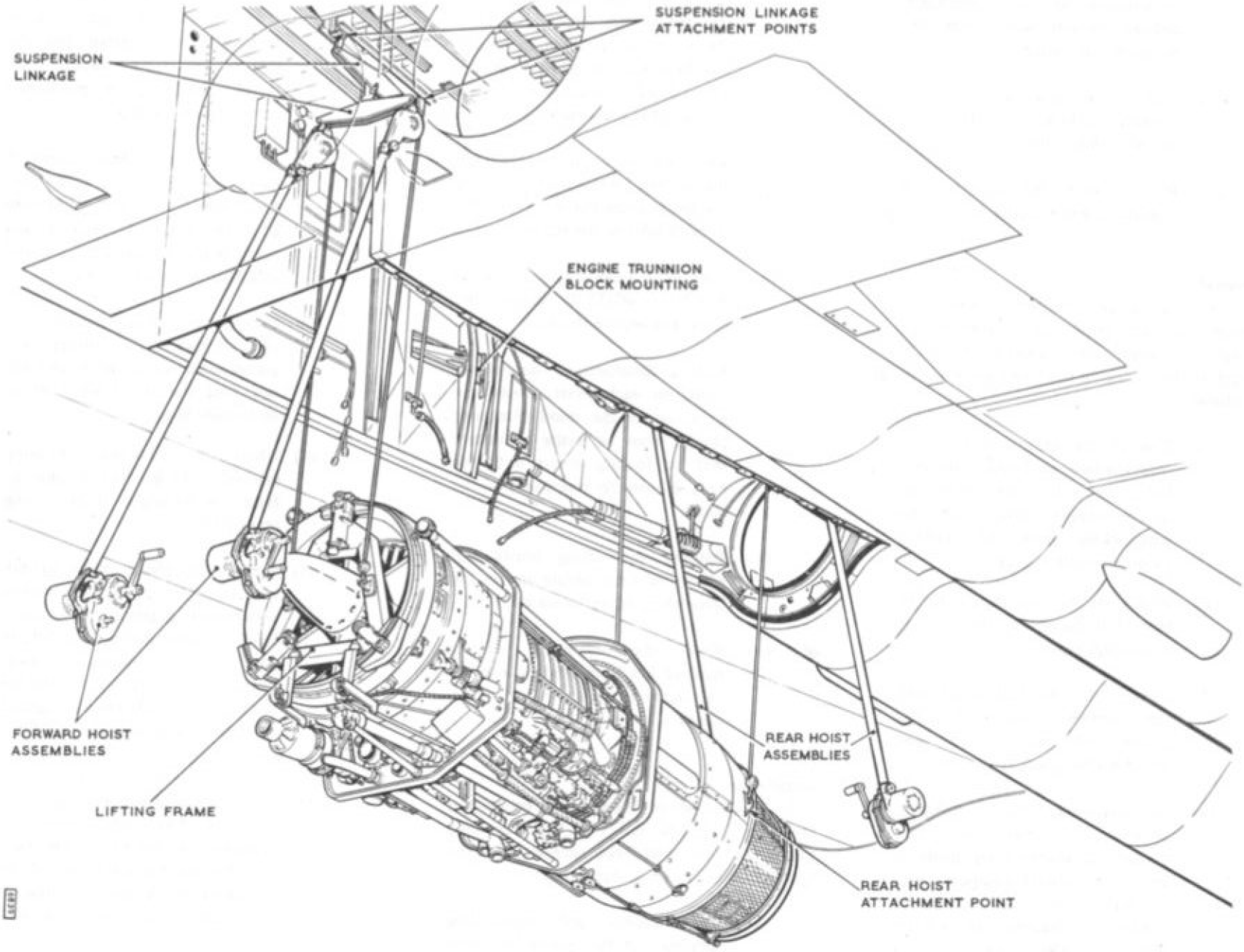


Fig. 16 Engine removal (four-point hoisting) (3)

on the inboard trunnion of the outboard engine and the outboard trunnion of the inboard engine.

(b) Lubricate the engine trunnions with grease XG-277.

(c) Fit the distance piece. Ref.No. 26DC/8545, with the bore radius towards the engine, on the fixed bearing trunnion.

(d) Fit the bearing assembly to the fixed bearing trunnion, following the instruction - THIS SIDE TOWARDS ENGINE - etched on the face of the bearing housing, together with two 0.03 in. distance washers (Ref.No. 26DC/8543) and one 0.06 in. distance washer (Ref.No. 26DC/8544) on each side of the bearing assembly.

NOTE . . .
The distance washer position in (5) (d) gives a correct theoretical engine position. The distance washer combination may be permutated to give an adjustment of up to 0.12 in. in each direction to suit installation requirements.

(e) Assemble the end cap, tab washer and bolt to the fixed bearing trunnion, ensuring that the locating pin on the end cap fully engages in the hole in the trunnion.

(f) Tighten the end cap securing bolt.

NOTE . . .
The end cap securing bolt must be locked using the tab washer when the final engine position has been established (op.(9)).

(g) Fit the bearing assembly to the floating bearing trunnion.

(7) Lift the engine, care being taken to ensure a 'clean lift'. When the side trunnion bearing assemblies enter the housing guides on the engine bay side walls, entry must be smooth and even, the engine being raised only until the bearing housings abut the housing stop bolts. When this contact is made, insert the quick-release pins then carefully lower the engine sufficiently to allow insertion of the bearing assembly bolts.

(8) Check the front suspension link for safety, sufficient threads engaged, insert and secure the engine front suspension bolt to complete the assembly. Slacken the hoist cables so that the engine weight is taken completely on the attachment points.

(9) Adjust the forward suspension link to obtain the correct engine angle. If the aircraft is on jacks and in rigging position, the engine is set at an angle of 10 degrees above horizontal, i.e., plus 5 deg. on the 5 deg. rigging angle. Should the aircraft be on its wheels, then the rigging angle will vary due to surface levels, tyre pressures, etc., and must be determined in the following manner:-

(a) Gain access to the main-wheel bay and locate the two 3/8 in. dia. holes in the inboard rib web.

(b) Insert a 3/8 in. dia. rod in each hole and place a straight edge across the rods.

(c) An inclinometer placed on the straight edge will indicate the aircraft rigging angle. This angle plus 5 deg. is the angle at which the engine must be set.

(10) Check the engine lateral position, adjust, if necessary, the distance washers on the fixed bearing trunnion.

(11) When the engine is set correctly wire-lock the front suspension link in the approved manner (fig.2) and split pin the connecting nut and bolt. Check that the fixed bearing end cap securing bolt is secure and locked with the tab washer.

(12) Remove engine hoists and, if four-point hoisting was used, remove 'A' frame from intake casing. Complete the engine

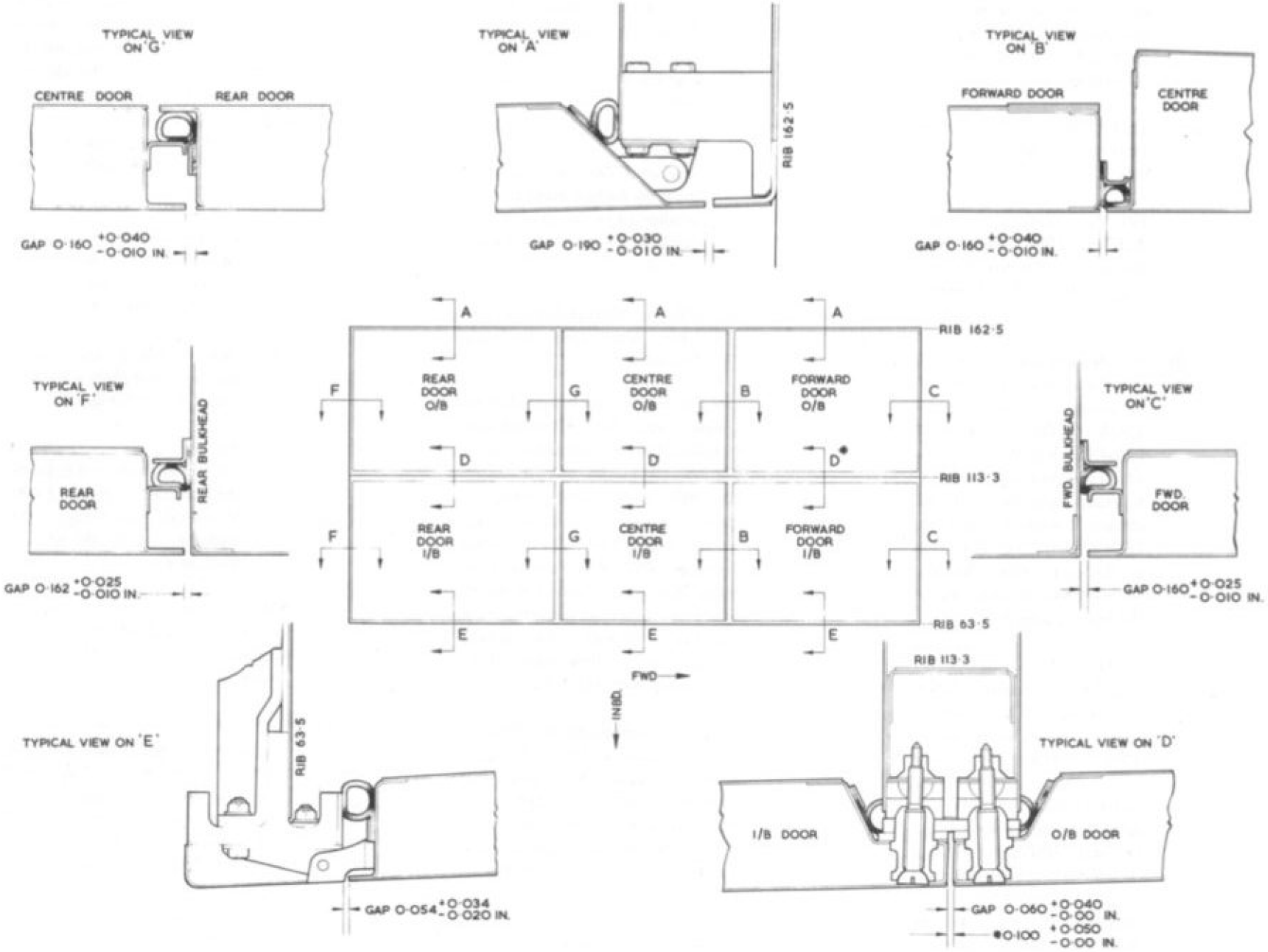


Fig.17 Gap setting-engine access doors

installation by reversing the procedure given in para.106. Lubricate the engine air intake clamp guide ring with grease ZX-28 before installing.

NOTE . . .
When the 'King' coupling connection is made in the main fuel feed pipe (para.106 (1)) the stiffnuts on the manacle clamp are torque loaded to 27^{+3}_{-0} *lb in.*

AIRBORNE AUXILIARY POWER PLANT

Removal of the A.A.P.P.

112. The following sequence of operations is recommended for the removal of the A.A.P.P. from its compartment aft of the starboard main-wheel bay. Transport stand Part No. T20834 must be available to receive the unit when the removal is complete.

(1) Release the Dzus fasteners securing the inboard access panel of the A.A.P.P. compartment and remove the panel.

(2) Disconnect the air-scoop operating jack at the ram attachment to the scoop and swing the jack forward to provide clearance when the A.A.P.P. is lowered. This eliminates the necessity for breaking down the hydraulic system.

(3) Disconnect the cartridge exhaust pipes at the unit.

(4) Release the Dzus fasteners securing the outboard access panel to A.A.P.P. compartment and remove the panel complete with air scoop and cartridge exhaust pipes.

(5) Disconnect and remove the fuel drain pipe between the unit and the rear bulkhead.

(6) Ensure that the low pressure fuel cock is closed and disconnect the fuel feed pipe at the unit.

(7) Close the manually-operated ON/OFF cock in the supply pipe to the contents gauge and disconnect the pipe at the gauge side.

(8) Disconnect the pipe leading to the charge valve at the top union of the two-way connector mounted adjacent to the top cylinder.

(9) Disconnect all electrical plugs from the unit and unclip leads where necessary.

(10) Disconnect the air bleed duct from the valve assembly at the top of the A.A.P.P.

(11) Engage the mini-lift hoist in the attachment lug on the main support beam and arrange the lifting cable over the adjacent lifting point pulley. Secure the cable ball-end in the socket of the A.A.P.P. lifting bracket.

(12) Take the weight of the unit on the hoist and disconnect the rear adjustable steadying strut.

(13) Remove the two main support bolts from the beam assembly and lower the unit on to the stand.

(14) Unless a replacement A.A.P.P. is being installed immediately, all disconnected pipes and plug sockets must be blanked off without delay.

Installation of the A.A.P.P.

113. Though a reversal of the procedure given in para.112 will serve to install an A.A.P.P., exceptional vigilance is required to ensure that fouling of components, pipes, cable etc., does not occur in the confines of the stowage when the unit is installed. During pre-installation checks, particular attention must be given to the set of the fire extinguishers armoured flexible pipes on the front end plate of the unit. These pipes are routed correctly when the front pipe banjo connection is positioned 20 deg. above horizontal and the electrical socket is 45 deg to starboard of the fore-and-aft line of the unit. With the pipes so positioned, the fire extinguisher cylinder must be clamped securely in its mounting.

ENGINE ACCESS DOOR GAP SETTING

114. When fitting engine access doors, all-round clearances must be maintained within the limits shown on fig.17.

ENGINE ACCESS DOOR SEALS

115. Door seals are secured in position by retaining strips bolted to the doors and forward and rear bulkheads (fig.17), Mod.2280

introduces improved seals of glass/nitrile reinforced silicone rubber material, which are to be fitted on replacement of individual seals. End caps, fitted to the seal tubes, minimise contamination by fuel, oil or grease.

Seal 1/SS4488 is replaced by seal 1/SS5823 and end caps 1/SS5824, supplied in 10 ft lengths see Note.

Seal 1/SS4615 is replaced by seal 1/SS5825 and end caps 1/SS5826, supplied in 7 ft lengths see Note.

NOTE . . .
Seals are supplied in these lengths to minimise wastage when cutting seals prior to fitting to the engine access doors and/or bulkheads.

Procedure for fitting seals

116. To fit seals post Mod.2280:-

(1) Remove bolts securing seal retaining strip to door/bulkhead, release strip and discard defective seal.

(2) Thoroughly clean door/bulkhead and seal retaining strip with M.E.K. Ref.No. 33C/1322.

(3) Cut new seal to required length and cut seal tube to clear where necessary. Ensure that end caps and seal glass/nitrile cover are free from contamination, clean with a cloth damped in M.E.K. if necessary.

(4) Apply a thin film of primer Ref.No. 33H/2201027 to inside of end cap and seal outer cover, allow to dry for 15 to 30 minutes at room temperature.

(5) Lightly smear inside of end caps and seal outer cover with RTV.733 and fit end caps to each exposed end of seal tube by engaging slot in end cap over retaining tongue of seal.

NOTE . . .
Ensure when applying adhesive to end caps that breather holes are left clear.

(6) Attach seal to door/bulkhead, position seal retaining strip and secure with bolts. Allow at least 24 hours for RTV.733 to cure before closing engine door.

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