

CHAPTER 1

POWER UNIT

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Introduction

1. The power unit consists of a single Avon Mk.203 axial flow gas turbine installed centrally within the fuselage with its air intakes in the leading edge of the wings and a straight through jet pipe which exhausts at the tail end of the aircraft structure. The engine is started through the medium of a Plessey Iso Propyl Nitrate liquid fuel starter unit which is fitted on the front of the engine with its ancillaries in the fuselage adjacent to it. Fuel flow to the burners is controlled by a manually-operated throttle valve, the initial opening of which opens the high-pressure fuel cock. The engine incorporates a top temperature control system to maintain jet pipe temperature within permissible limits (Sect.5, Chap.2 of this volume and A.P.4481C, Vol.1). There is no oil tank, all the necessary oil being carried in the engine sump.

DESCRIPTION

Engine bay

2. The engine is located aft of the main spar frame in the fuselage, engine removal necessitating withdrawal of the rear fuselage from the remaining structure to gain access. To facilitate this work, special equipment, which is described later in this chapter, must always be used. The accessories gearbox is also housed in the engine bay and is driven from the engine by two universally-jointed shafts with a turret drive arm mounted between them. The twin air intake ducts are in front of the engine and are fed from their respective air intakes in the stub wings. A fire wall at frames 29 and 30, seals the engine bay from the engine starter bay and a similar firewall at frame 38 isolates the rear fuel tanks. Air extractors and cooling ducts are provided to maintain the temperature of the engine bay at a permissible value.

Engine mounting (fig.1)

3. The engine is provided with four attachment points which consist of a trunnion on either side of the turbine nozzle box and a front suspension linkage on either side of the engine compressor casing. The trunnion mountings are located on the horizontal centre line of the engine and the front suspension linkages a little above the centre line. The port trunnion is provided with a locating flange.

4. The engine is mounted centrally with its front suspension linkages attached to mountings on frame 34 by means of universally-mounted turnbuckles which, in conjunction with a special key (auxiliary lifting key), enable the engine to be raised or lowered into its correct position. When the engine has been initially centred, the turnbuckles should be locked with 20 s.w.g. nickel alloy wire to Specification DTD.268 and should not be subsequently disturbed. The rear mounting trunnions are secured to the structure at frame 40A by hinged fittings, each of which carries a split bearing housing. These bearing housings are provided with steady attachments which are bolted to thrust members located between frames 38 and 40. The engine is fixed 0.10 in. to port by the flanged locating trunnion on the port side of the engine, when cold, but is free to slide central in the starboard trunnion bearing under expansion. The provision of the split bearings permits the mountings to be swung away from the trunnions when the bearings are dismantled, thus facilitating engine removal and installation.

Air intakes

5. The two air intakes are situated one in the leading edge of each stub wing, the entry being at the wing roots adjacent to the fuselage. They are shaped to permit the maximum intake of air with the minimum of resistance. In addition, two small spring-loaded air intake slots are incorporated in the leading edge of each stub wing, one being on the

underside of the wing and the other on the upper. They open automatically to give increased air flow when the engine is being started. To prevent the ingress of foreign matter when the aircraft is on the ground, sealing covers are provided for the air intakes. These covers must be fitted at all times when the aircraft is on the ground, except during an engine run, or air intake inspection. This air intake inspection, to ensure that no tools, rag or other foreign matter has been left in the intakes, must always be carried out before attempting to start the engine. Safety guards, which can be fitted in lieu of the sealing covers, are provided for the protection of personnel during ground running of the engine.

NOTE...

It is important that the safety guards be fitted at all times when the engine is being ground run and equally important that they are removed before flight.

Jet Pipe (fig.1)

6. The straight through jet pipe is mounted to the engine exhaust unit by a flange which slides over a gas seal fitted in an annular groove around the outer periphery of the exhaust unit. It is secured by a pair of keeper plates, one on each side of the unit, each of which is provided with its own access door (Sect.2, Chap.4, Fig.2)). The attachments are illustrated in Sect.3, Chap.1, Fig.12. The rear of the jet pipe is secured by two rectangular blocks located at the horizontal centre line. The blocks are free to slide in a fore and aft, or in a lateral direction, thereby allowing for jet pipe expansion. A door adjacent, may be used to gain access when making adjustments to the height of the mounting. To ensure that the blocks approach the mounting at the correct angle when the jet pipe is being assembled to the aircraft, small guide rails are fitted inside the fuselage. These are pivoted at the rear end and are attached to mountings at the forward end, thus

remaining in alignment when adjustments are made. Along the top, at the vertical centre line, a guide rail is attached inside the fuselage, and twin rollers attached to the top of the jet pipe, run along this rail to facilitate assembly of the pipe. No weight is exerted on the rail by the rollers when once the jet pipe has been secured in position. When the operation is completed, the lifting rods are removed through the adjacent access doors. A sealing cover is provided for fitting to the jet pipe outlet when the aircraft is on the ground. This cover must be fitted at all times when the aircraft is on the ground and the engine is not running. It must, of course, be removed before any attempt is made to start the engine.

Accessories gearbox and drives (fig.3)

7. The accessories gearbox is located at the bottom of the fuselage between frames 29 and 30. Forward of frame 29, it drives the hydraulic pump and the two electrical generators which provide all the hydraulic and electrical power for the operation of the aircraft's services. The drive to the gearbox is taken from the engine in the region of frame 36 by a universally-jointed shaft which connects to a bevel box at the top of a turret drive arm which is mounted on the aft face of the rear spar frame. From a bevel box at the bottom of the turret drive arm, a similar shaft extends forward to connect with a drive in the rear of the accessories gearbox at frame 30. The gearbox is sealed off on the aft face of frame 30 to isolate it from the forward fire zone of the engine bay. The turret drive arm is provided with its own oil pump and sump and, like the gearbox, has a filler and dipstick. Both the gearbox and drive are provided with a breather pipe which vents to atmosphere.

Engine starter (fig.4 & 5)

8. The engine is started by a Plessey Iso Propyl Nitrate liquid fuel starter unit. The starter

motor, which consists of a single-stage axial flow turbine unit, fitted with a reduction gear, is mounted on the front of the engine with its fuel pump and air blower unit adjacent to it between frames 26 and 27. The starter fuel tank is accommodated further forward on structure just aft of the main spar frame on the port side of the aircraft. The tank is provided with a combined pressure and suction relief valve (fig.6 & 7).

9. When the starting sequence is initiated, by means of a push-button switch in the cabin, air alone is first delivered into the combustion chamber of the starter, scavenging the fumes from any previous attempt to start the engine and providing clean air for initial combustion conditions. During this period, fuel from the starter fuel tank is being delivered, via a bypass valve, back into the tank again. Subsequently, the fuel is diverted into the starter combustion chamber, where it mixes with the air to form a combustion mixture and, is ignited, giving rise to an increase in pressure. During the initial combustion period, the air blower is automatically off-loaded by a dump valve while the fuel flow is maintained, resulting in a further rise in combustion chamber pressure to operate the starter motor. As the fuel line pressure rises with increase in combustion pressure, it operates a switch which provides automatic shut-down of the system in the event of failure to light, or flame blow-out. Normal shut down is accomplished by a speed sensitive switch which is built into the starter motor assembly and is driven by the motor turbine rotor. The switch is operated when the rotor reaches its peak working speed and, therefore, also serves as an overspeed control. Details of the electrical components used in the system together with a description of the cycle of operations of the starter electrical circuit, are given in Sect.5, Chap.1, Group C.1 of this volume. The procedure for starting the engine is given in A.P.4481C, Vol.1, and A.P.4347F, P.N. (Pilot's Notes).

SERVICING

General

10. The servicing of the engine and engine starter unit should be carried out in accordance with the instructions given in A.P.4481C, Vol.1, and A.P.1181B, Vol.1, respectively. The servicing of the engine ancillary equipment which forms part of the airframe installation, is given in the following paragraphs.

Precautions

11. The following precautions must be taken before any servicing of the engine, or its installation is commenced:-

- (1) If any of the work involves entry into the cabin, or the cabin hood is to be removed, ensure that the instructions given in the Ejection Seat Warning following the Introduction at the beginning of this volume, have been carried out
- (2) Ensure that the aircraft is electrically safe (Sect.5, Chap.1, Group A.1). If an electrical supply is required during servicing, use an external supply to eliminate the possibility of running down the aircraft's batteries.
- (3) Ensure that the protective covers are in position on the air intakes and jet exhaust, as well as any other covers that will not impede the progress of the work in hand.
- (4) Prior to ground running the engine, ensure that the jet pipe sealing cover is removed and that the air intake safety guards are fitted to the air intakes in

lieu of the sealing covers. Remove the remaining covers that concern the engine installation.

- (5) Prior to ground run, ensure that no personnel are in proximity of the air intakes, the jet exhaust, or starter exhaust and that they are warned to keep clear of these danger zones.
- (6) During servicing, particular attention should be given to the engine starter installation to ensure that there are no leaks in the starter fuel system. Leaking starter fuel will cause corrosion of certain metals and components and, in addition, will form a fire hazard if it is allowed to come into contact with hot pipes etc. Such leakage must be mopped up immediately and the cause of leakage rectified.

NOTE...

If the engine is started up with the engine starter access door open, the starter exhaust will impinge on to the starter electrical equipment which is mounted on the inside of the door, resulting in serious damage to these components. Before starting, therefore, it is essential to ensure that this access door is closed and effectively locked.

Engine controls (fig.2)

12. The combined throttle and high-pressure cock and the low-pressure cock should be checked to ensure that they come up against their stops before the system is strained. In no circumstances should the throttle and high-pressure cock stops on the engine be interfered with in any way as these have been set in the correct position by the engine manufacturers. Control settings are given in fig.2.

Throttle lever friction damper

13. The friction damper for the throttle control should be periodically examined for wear. It should be screwed up sufficiently to obtain the maximum friction without undue restriction of the movement of the control. This is most important, as insufficient friction will result in creeping from the selected position which, if undetected, may in certain circumstances, result in a serious accident.

Pressure and suction relief valve - starter fuel tank (fig.6 & 7)

14. The pressure and suction relief valve, located in the top of the engine starter fuel tank of aircraft manufactured prior to Mod.382 is different in design to that of the valve fitted to later aircraft (Post Mod.382). Although the function of the two valves is the same, it should be noted that the earlier valve (Pre-Mod.382) is provided with a protection tube which must be retained on the valve until the starter fuel tank is installed in the aircraft.

Re-light button

15. The engine re-light button should be examined periodically to ensure that it functions correctly.

Lubrication

16. Oil specifications and capacities for the engine, accessories gearbox and turret drive arm are listed in the Leading Particulars at the front of this volume. The units should be checked for oil level before flight and topped up as necessary (Sect.2, Chap.2). Lubrication of the engine controls is detailed in fig.2 of this chapter. The gearbox universal drive shaft couplings should be lubricated as described in para.29 of this chapter.

REMOVAL AND ASSEMBLY

General

17. The removal of the engine entails jacking up the aircraft at the specially prepared positions as shown in Sect.2, Chap.4, Fig.4 (with the exception of the rear fuselage) and the fitting of additional trestles under the centre fuselage as shown in Sect.3, Chap.1, Fig.7. When jacked, the alighting gear should be in the fully extended position with the wheels two or three inches off the ground and care should be taken to ensure that the aircraft is level in a fore and aft as well as in a lateral sense.

18. Access to the engine for removal purposes can only be obtained after the rear fuselage has been removed from the remaining structure. To facilitate this removal of the rear fuselage, a special trolley is provided and another is provided to accommodate the engine. These and other special equipment referred to in this chapter are listed in Sect.2, Chap.4, Table 1.

19. A tethering strap is provided for use with the rear fuselage trolley, which in conjunction with a bumper pad fitted in a specially arranged cut-out in the trolley former, prevents any tendency of the rear fuselage to roll during removal. When the fuselage is in position on the trolley, the tethering strap should be at frame 52 and the bumper pad at frame 55. The engine trolley is fitted with rails which, in conjunction with rails provided for fitment into the centre fuselage, facilitate withdrawal of the engine.

20. If the batteries are not to be removed prior to engine removal, ensure that the battery isolating switch is put to the 'ground' position and, as an additional precaution, remove the leads from the batteries and stow them on the dummy terminals on the battery mounting platform.

21. Whether the cabin is to be entered or not, ensure that the safety pin securing the blind handle of the ejection seat is removed and placed in the sear of the seat firing mechanism.

22. To prevent the ingress of dirt or moisture, disconnected pipes should be effectively blanked off. Electrical leads should be taped immediately after disconnection to eliminate the possibility of fire due to shorts. This should be done irrespective of whether the aircraft's batteries have been immobilised or not, as there is always a possibility of the batteries being reconnected before the leads.

Unpacking and slinging

23. The procedure for unpacking the engine, the use of the transit stand, sling and trolley is described in A.P.4481C, Vol.1.

Removal of engine (fig.8, 9 & 10)

24. The removal of the engine is shown in the illustrations, the sequence of operations being given in the keys.

NOTE...

Under no circumstances may the engine-airframe joint pins or bolts be used to mount the engine on the transit stand. Special bolts are provided for mounting the engine on the stand and these bolts must not be used in the airframe installation.

Removal of accessories gearbox

25. For removal of the accessories gearbox, the drive is broken down at the splined connection on the bevel box at the bottom of the turret drive arm on the forward face of the rear spar frame, the sealing at frame 30 first being removed. For normal engine removal, the drive is broken down at the joint in the

ASSEMBLY

rear drive between frames 35 and 36. A special tool is provided to prevent the shaft from turning when slackening off the retaining nut during removal and tightening the nut on assembly. Access to the coupling is via a small access door (Sect.2, Chap.4, Fig.2) on the lower port side of the fuselage between frames 35 and 36. Prior to the removal of the gearbox, the hydraulic pump and the two electrical generators will, of course, have to be removed from their mountings on the gearbox. Where difficulty is encountered in manoeuvring the gearbox out of the airframe, the starter exhaust pipe, and other pipes in way of removal of the gearbox, may be removed to facilitate the operation. If the engine is to be removed, the difficulty will not arise if the engine is withdrawn before attempting to remove the gearbox.

NOTE...

Prior to removing pipes, care must be taken to ensure that all pressure is released first and that the usual precautions are taken to eliminate the possibility of the loss of fluid.

Removal of jet pipe (fig.11)

26. The removal of the jet pipe is shown in the illustration, the sequence of operations being given in the key.

General

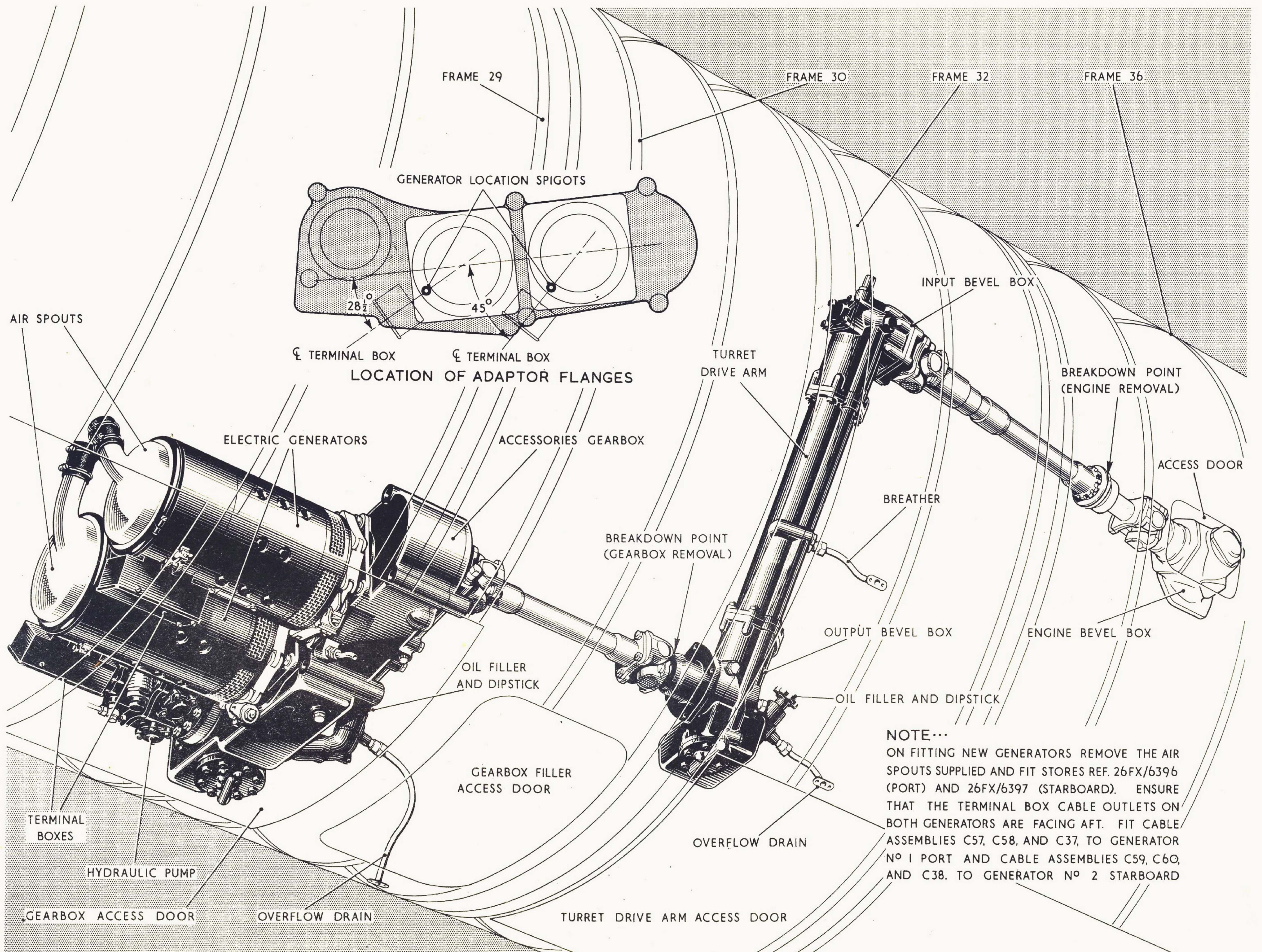
27. In general, the re-installation of the engine and its ancillaries is a reversal of the removal procedure. If a new engine is being installed as a result of compressor failure, or engine seizure, the pipe lines of the cabin pressurisation system and the air pressure pipes of the fuel system, must be examined to ensure that they are free from foreign matter.

Accessories gearbox

28. If the engine is already out of the airframe, the accessories gearbox should be re-installed first. Prior to installation, the gearbox should be filled with oil (Sect.2, Chap.2) and after the initial engine run, it should be checked for oil level and topped up as necessary. When installed, an examination should be made to ensure that the sealing at frame 30 is correctly fitted. When new generators are to be fitted, reference should be made to the assembly note contained in fig.3.

Accessories gearbox universal drive shaft couplings

29. The universal couplings in the drives between the engine and gearbox must be lubricated through the grease nipples with grease to Specification X.G-271 (Stores Ref.34B/208) before assembly and thereafter on every occasion when the engine is removed.



NOTE...
 ON FITTING NEW GENERATORS REMOVE THE AIR SPOUTS SUPPLIED AND FIT STORES REF. 26FX/6396 (PORT) AND 26FX/6397 (STARBOARD). ENSURE THAT THE TERMINAL BOX CABLE OUTLETS ON BOTH GENERATORS ARE FACING AFT. FIT CABLE ASSEMBLIES C57, C58, AND C37, TO GENERATOR NO 1 PORT AND CABLE ASSEMBLIES C59, C60, AND C38, TO GENERATOR NO 2 STARBOARD

FIG 3. ACCESSORIES GEARBOX

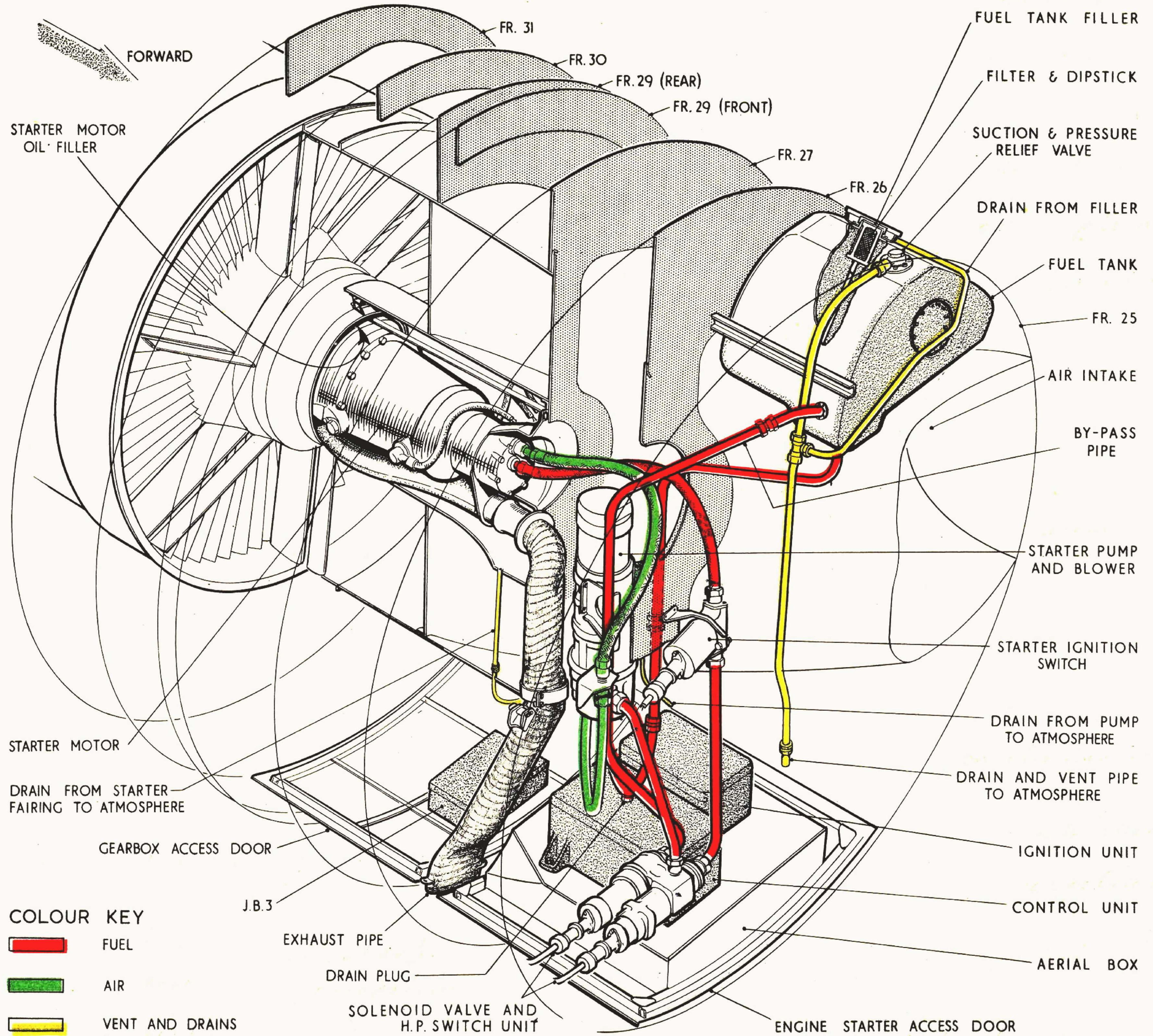


FIG 4. LIQUID FUEL STARTER INSTALLATION

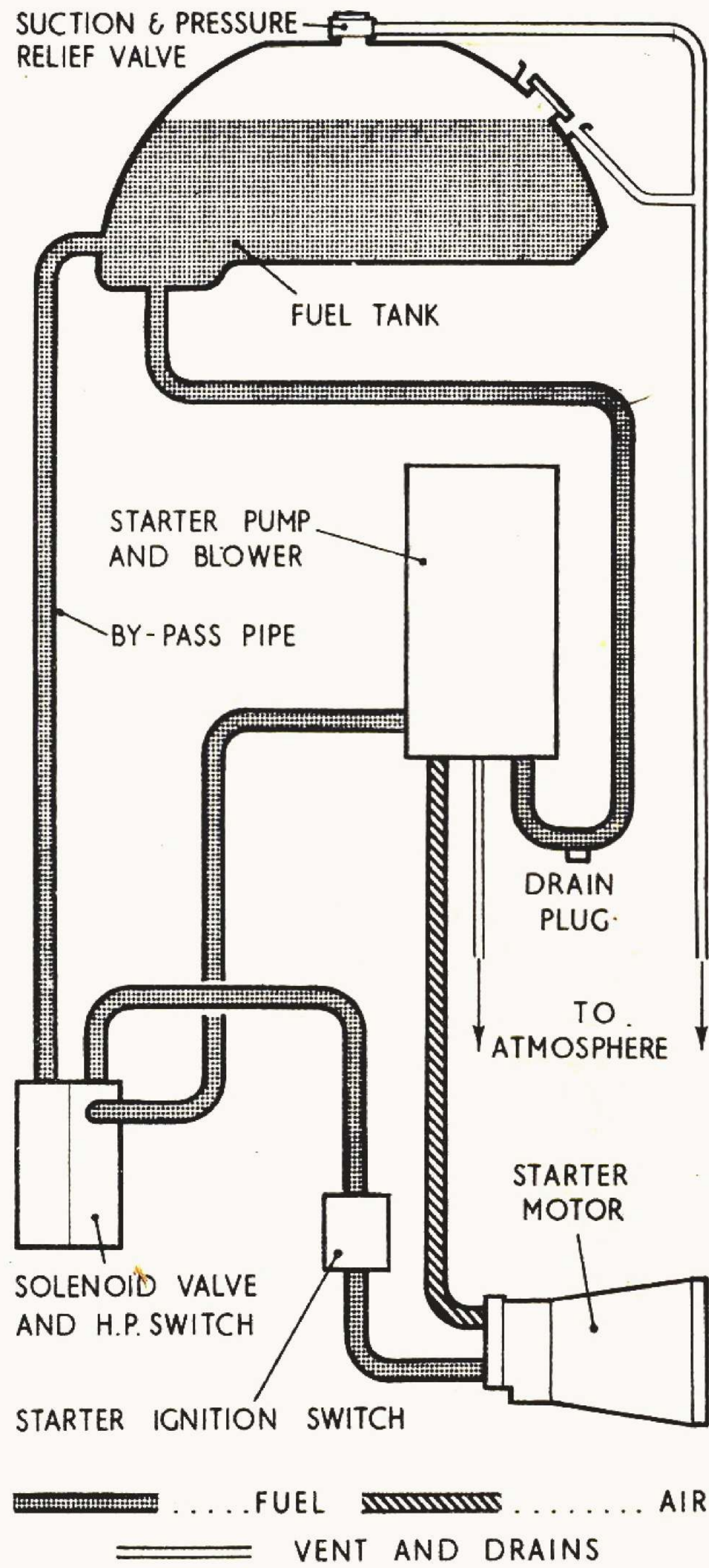


FIG.5. DIAGRAM OF LIQUID FUEL STARTER

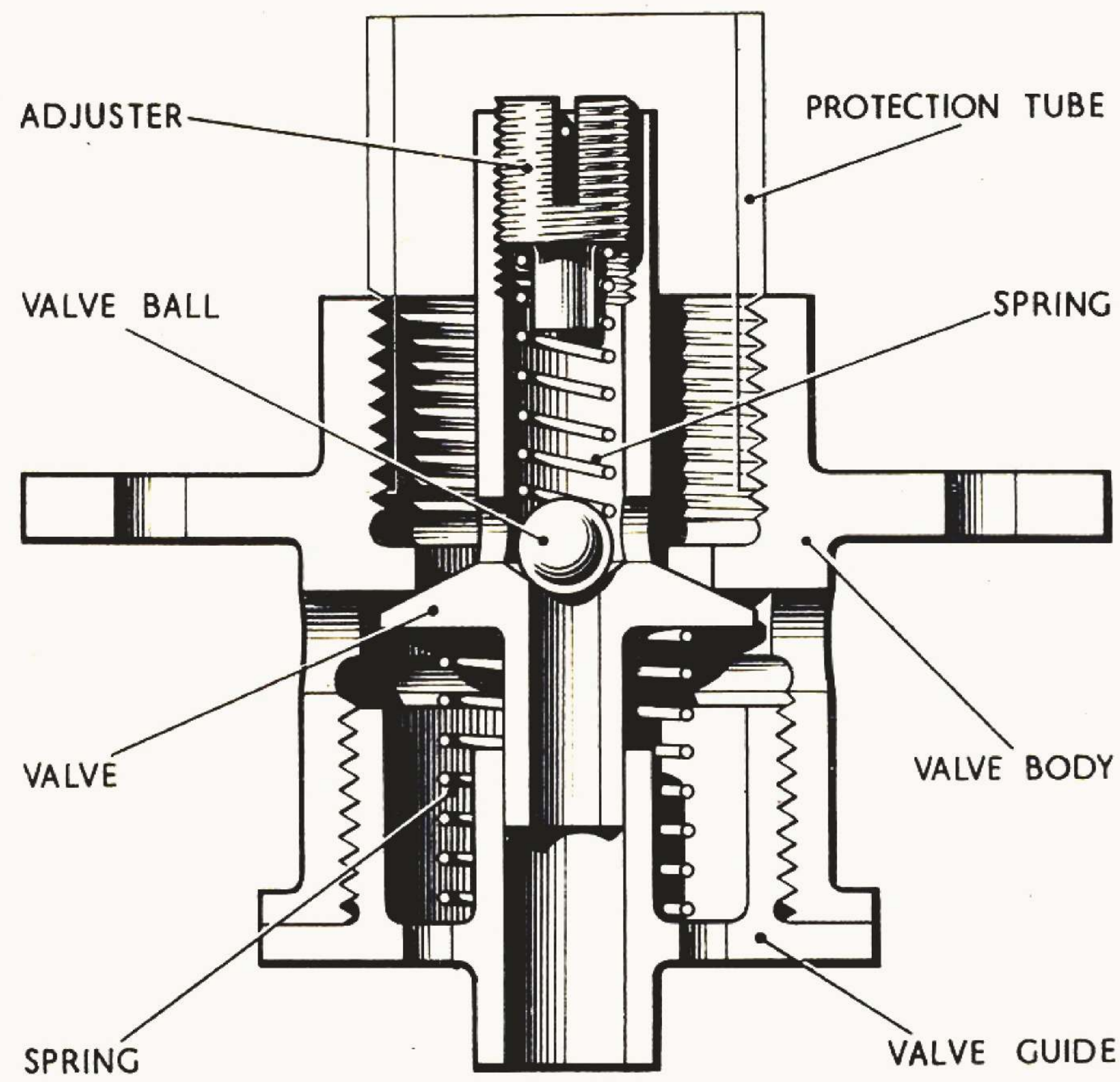


FIG.6. COMBINED PRESSURE RELIEF & SUCTION VALVE
(PRE-MOD 382)

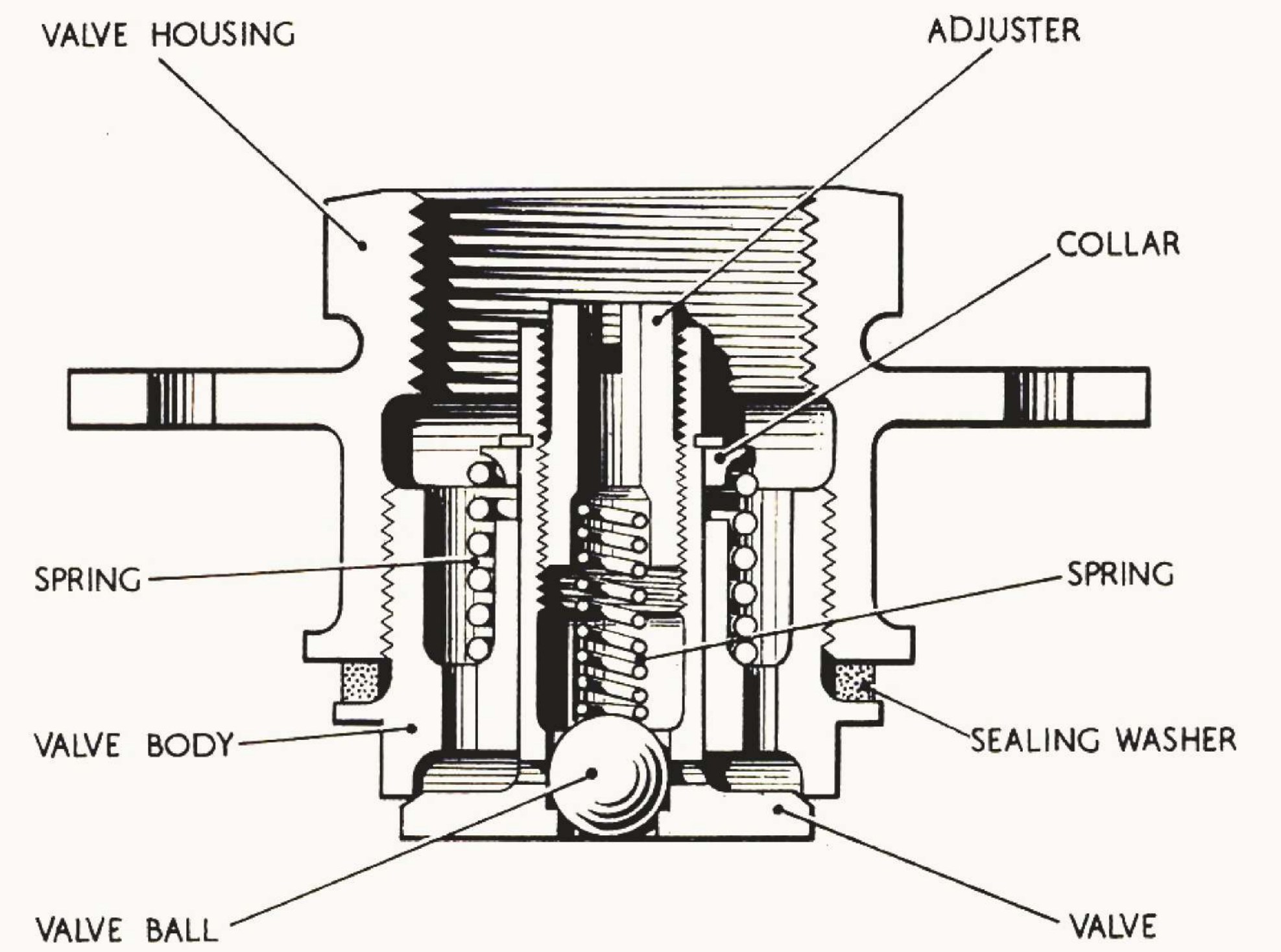


FIG.7. COMBINED PRESSURE RELIEF & SUCTION VALVE
(POST MOD 382)

ENGINE REMOVAL (FIG.8, 9, & 10)

To remove the engine proceed as follows:-

Render the aircraft electrically safe (Sect.5, Chap.1, Group A.1). Move the battery master switch to the OFF position, and as an additional precaution remove the battery leads and stow them on the dummy terminals provided on the battery mounting platform.

Jack up and trestle the aircraft at the specially arranged positions as shown in Sect.2, Chap.4, Fig.4, with the exception of the rear fuselage.

NOTE...

Ensure that the alighting gear is locked down, with the wheels two or three inches off the ground, and that the aircraft is level, fore and aft, and laterally.

Place additional trestles under the centre fuselage as shown in Sect.3, Chap.1, Fig.7.

Ensure that the low pressure fuel cock control in the cockpit is set to OFF.

Remove the rear fuselage (Sect.3, Chap.1, Fig.12).

Remove the following access doors and panels:-

Air supply access panel, starboard.
Front engine mounting access panel, starboard.

NOTE...

Whilst in this vicinity withdraw the bleed valve sealing flange between frames 33 and 34, and lock in the withdrawn position (fig.8, Detail A).

Front engine mounting access panel, port.
Air supply access panel, port.
Igniter plug access panel, port.

Slow running adjustment access panel.
Gearbox drive access panel.
Igniter plug access panel, starboard.
Engine access door.
Gearbox turret access door.
Engine starter bay access door.

BREAKDOWN OF AIRCRAFT SYSTEMS

The following disconnections are given in sequence under their appropriate access doors or panels.

ELECTRICAL

Engine starter bay access door (Fig.8, Detail B)
Disconnect the starter ignition cables, and overspeed relay cable from their respective brackets, on the forward face of frame 26.

Gearbox turret access door (Fig.8, Detail C)
Disconnect and stow the cable assemblies C.3 and C.6.

Igniter plugs access panels.

WARNING...

The electrical energy which may be stored in the condensers of the high energy ignition units is potentially lethal. Therefore at least one minute must be allowed to elapse after disconnecting the L.T. supply, to permit the stored energy to disperse, before the unit or H.T. cable may be safely handled.

Having observed the above warning, and taken the necessary precaution, disconnect the high energy igniter plugs (Fig.8, Detail F, and Fig.9, Detail G).

OTHER SYSTEMS

Engine starter bay access door (Fig.8, Detail B)

Disconnect the starter fuel pipe from the starter igniton switch, and the starter air hose from the bracket on the forward face of frame 26. Tape the fuel pipe and air hose together with the starter electrical cables to facilitate withdrawal.

Gearbox turret access door (Fig.8, Detail C)

Disconnect the fuel delivery pipe between and including, the universal couplings. Remove the pipe from the aircraft. Disconnect the gun heating pipe.

Engine access door (Fig.8, Detail D)

Disconnect the fuel pressure switch pipe from the pressure switch mounted on bottom of the aft face of frame 34. Disconnect the other end of this pipe from the fuel delivery pipe and remove it complete with banjo coupling and bolt.

Disconnect, and remove from the aircraft, the oil cooler drain pipe, and the combined overboard fuel drain pipe. Remove the three bolts securing the zone 1 ventilation duct branch pipe flange to the engine. Push the starboard portion of the branch pipe outboard into the side duct as far as it will go, so that the port branch will clear its corresponding side duct, and remove from the aircraft. Place the removable rail between frames 34 and 37 and lock in the bracket on the forward face of frame 37 by inserting the pip pin. Screw up the adjustment bolt through the bottom of frame 34 to bring the rail into contact with the engine front roller.

Gearbox drive access panel (Fig.8, Detail E)

Pull back the serrated spring loaded locking ring and unscrew the shaft retaining nut to uncouple

the gearbox drive.

Igniter plug access panel, port (Fig.8, Detail F)
Disconnect the throttle control rod from the throttle control lever.

Igniter plug access panel, starboard (Fig.9, Detail G)
Disconnect the centrifugal breather vent and pull outwards to clear the engine.

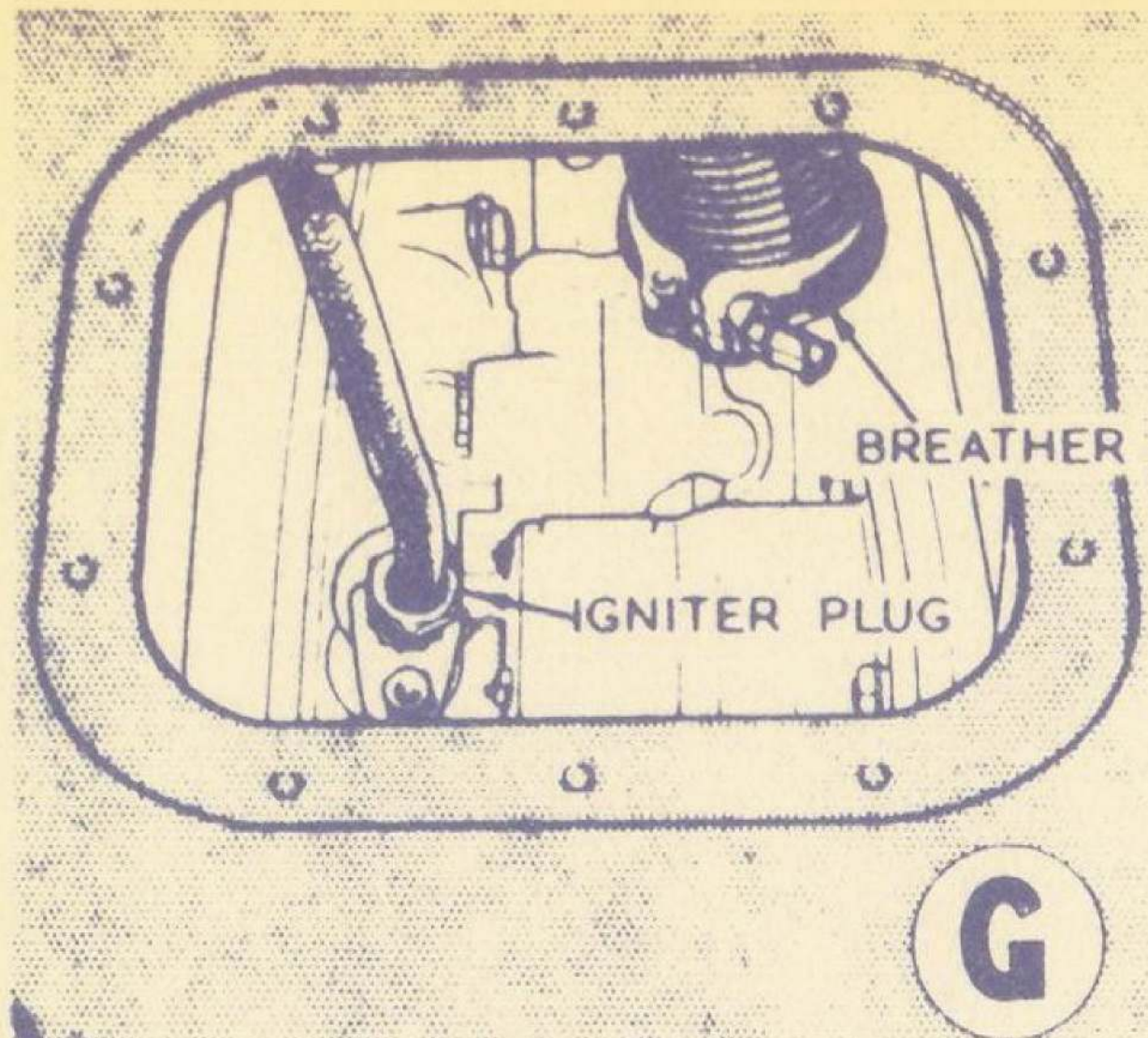
Air supply access panel, starboard (Fig.9, Detail H)
Disconnect the fuel system pressurisation pipe.

Front engine mounting access panels, port and starboard (Fig.9, Detail K)
Remove the split-pinned nut and bolt from the engine mounting turnbuckle fork end, and swing the turnbuckle clear of the engine.

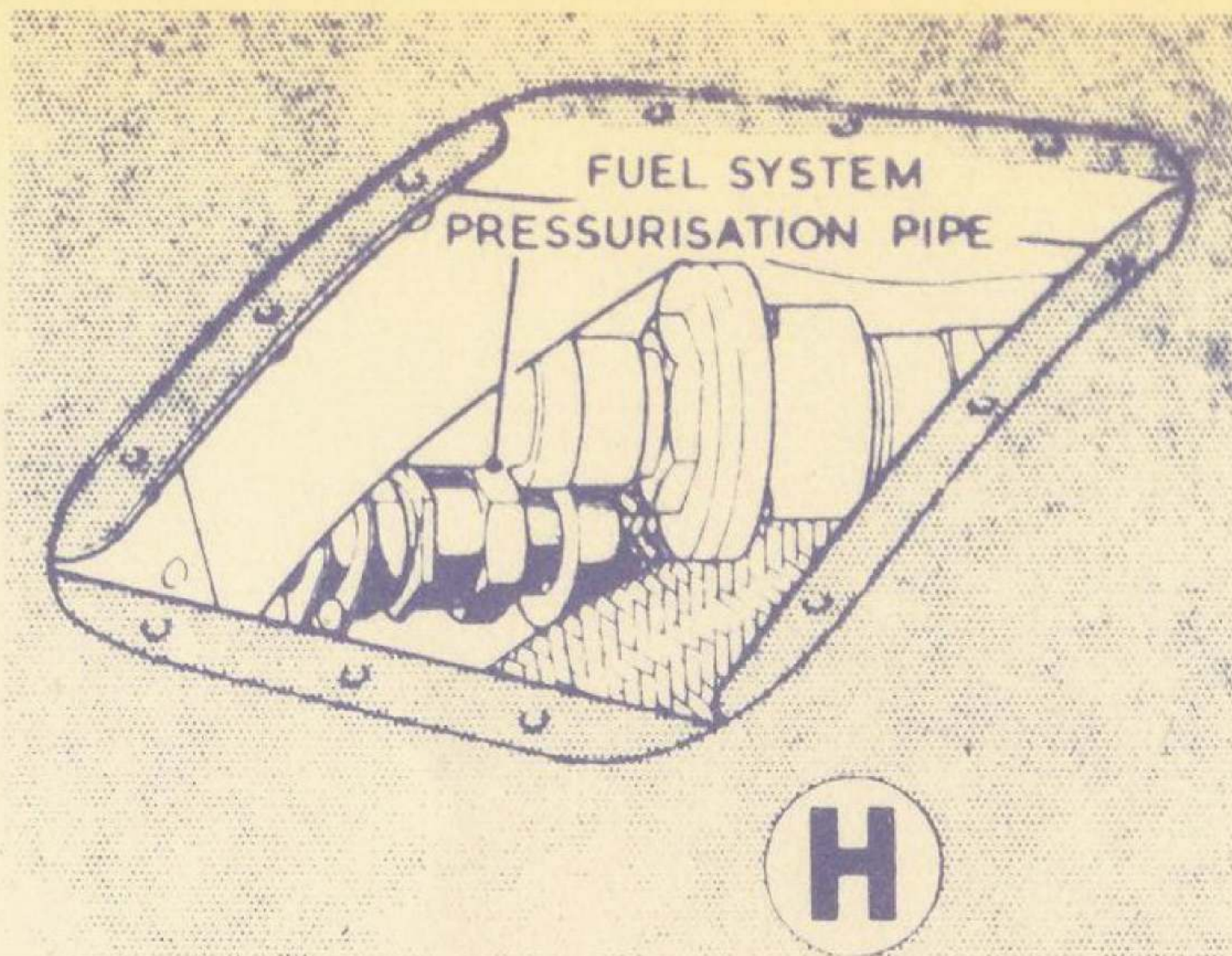
Air supply access panel, port (Fig.9, Detail J)
Disconnect the cabin pressurisation pipe.

Disconnect and remove the turbine drain from the combustion chamber, (Fig.9, Detail L).

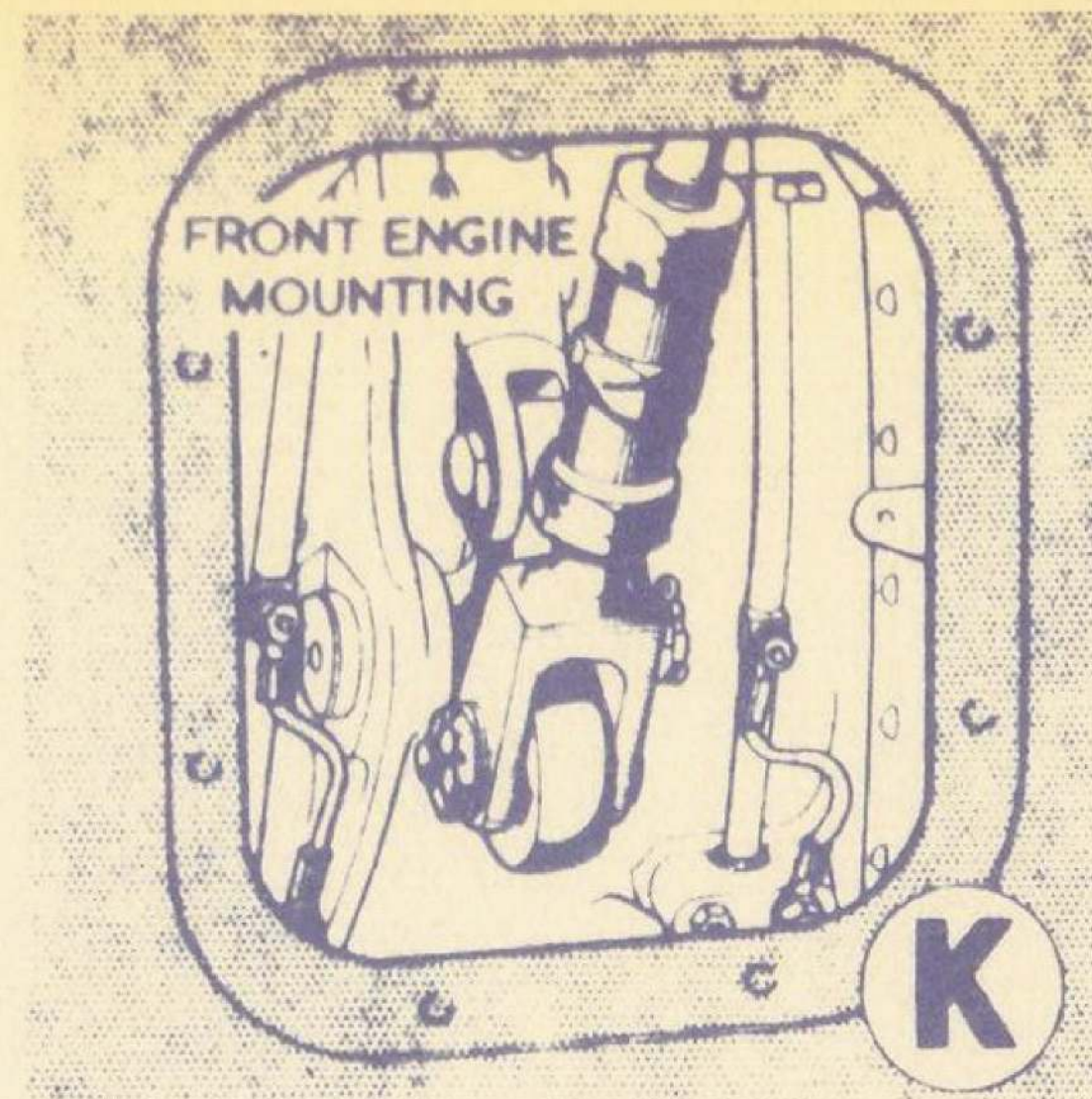
After disconnecting the above items, centralise the lateral adjustment handles on the cross members above the axles of the engine removal trolley. Wheel the trolley up to the aircraft so that the boss on the centre rail web is adjacent to the engine rail lug on the rear face of frame 40A. Screw down the built-in jack at each corner of the trolley and using the lateral adjustment, line up the centre rail web boss on the trolley with the engine rail lug on the aircraft (Fig.10, Detail A). Lower the trolley onto its wheels, roll it forward, and jack it again, so that the centre rail web boss engages with the engine rail lug on the aircraft. Align the engine rear roller rails with the engine rear rollers, ensuring that the trolley is level fore and aft. Lock the trolley to frame 40A by inserting the split bolt in



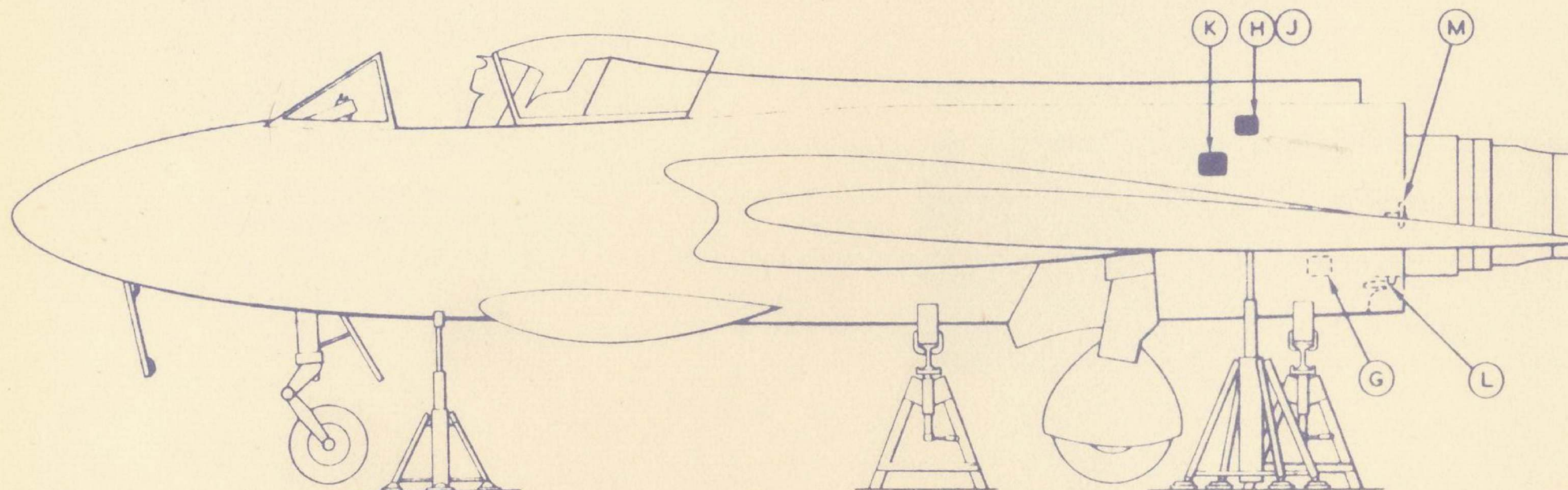
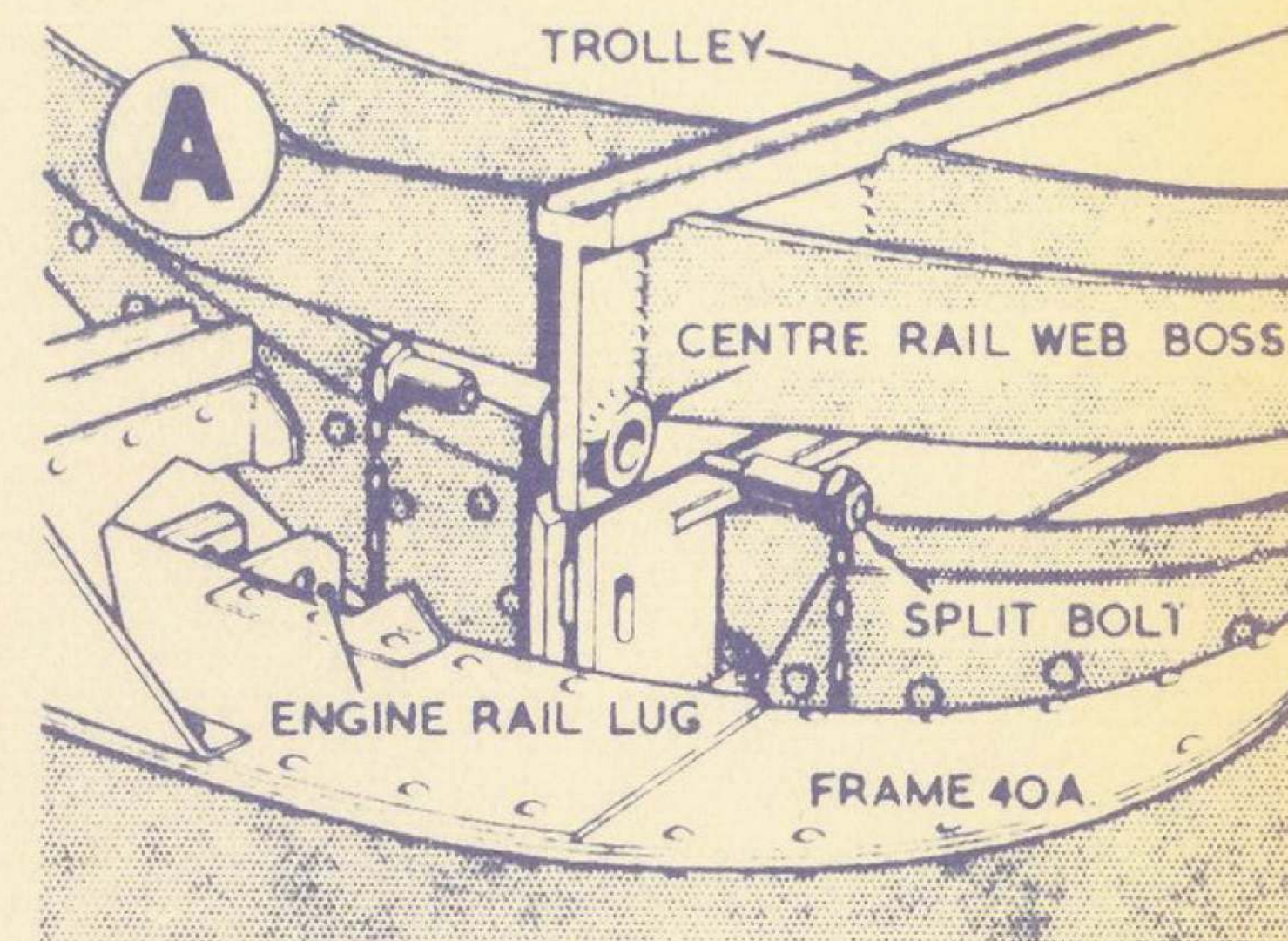
IGNITER PLUG ACCESS PANEL. — STBD.



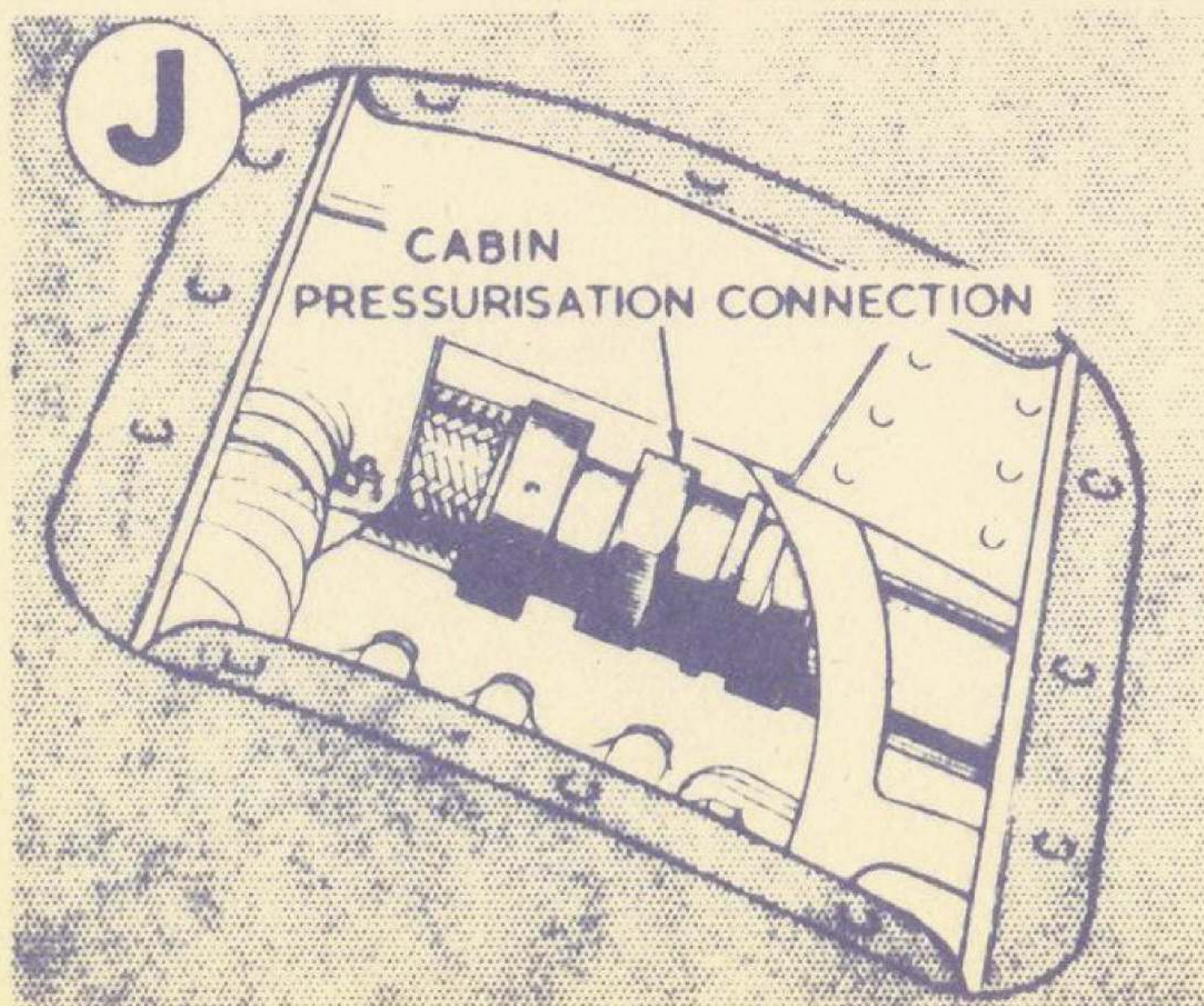
AIR SUPPLY ACCESS PANEL STARBOARD



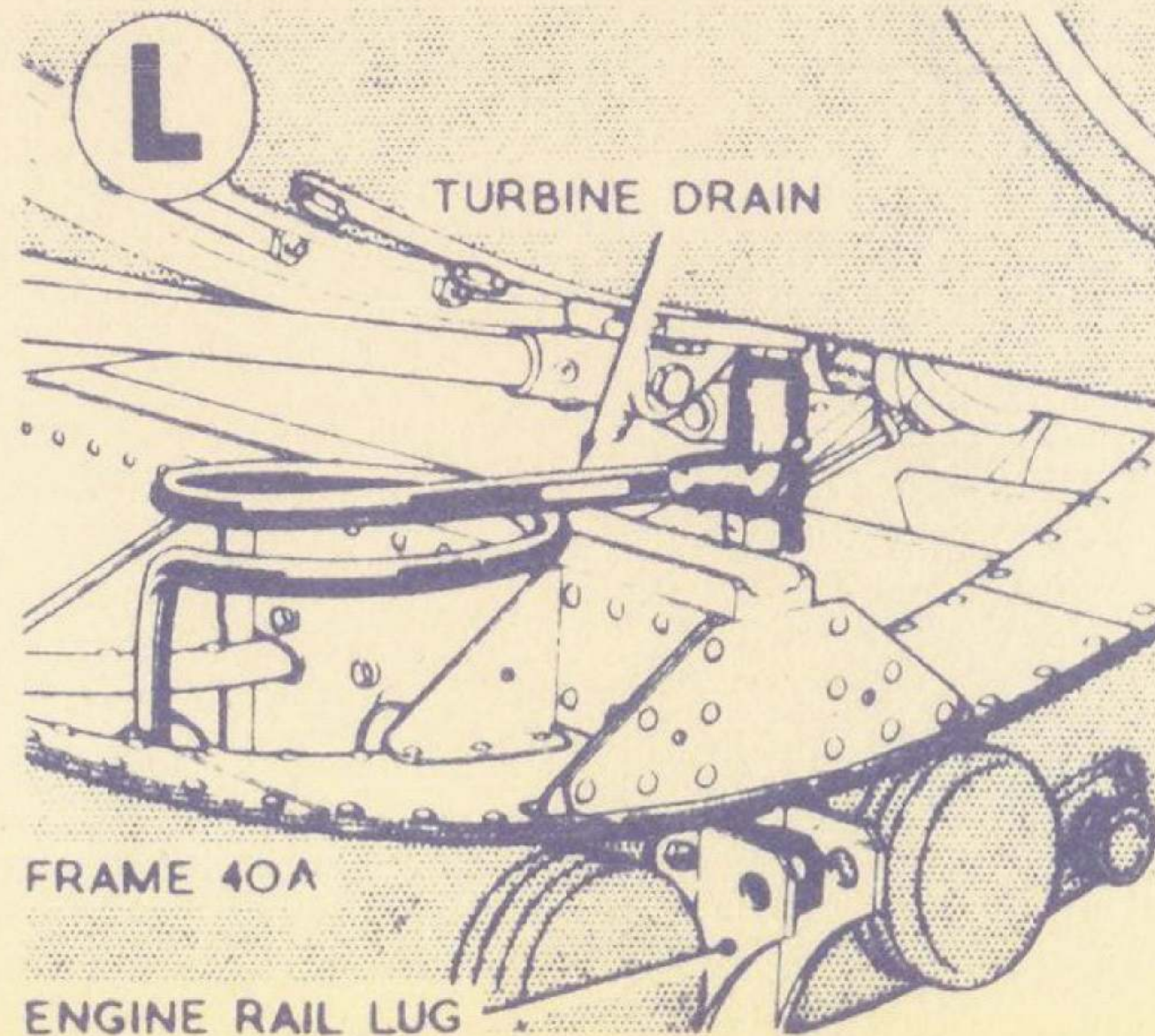
FRONT ENGINE MOUNTING ACCESS PANELS. PORT & STARBOARD.



AIR SUPPLY ACCESS PANEL. PORT



COMBUSTION CHAMBER DRAIN



REAR ENGINE MOUNTING

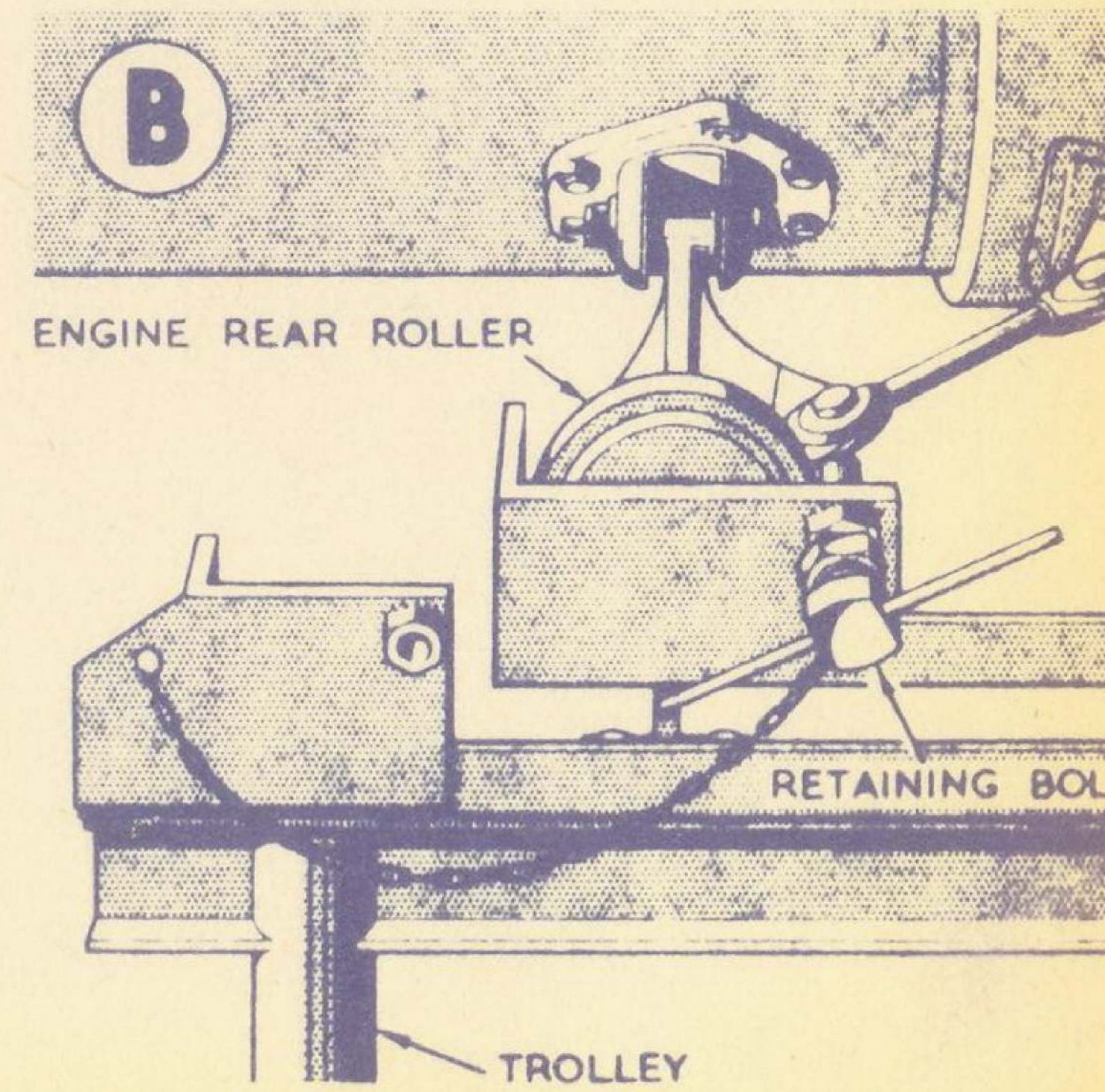
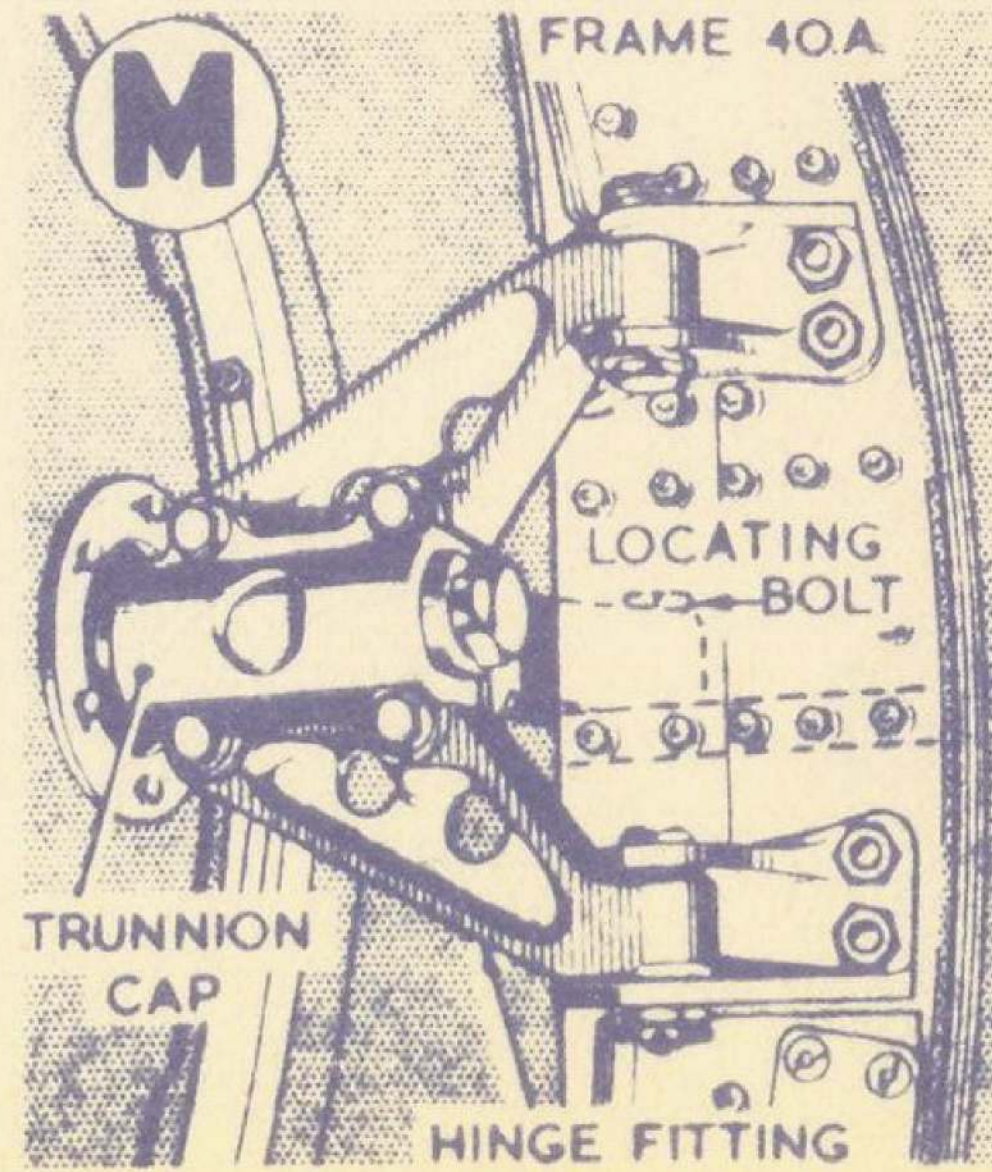


FIG. 9 ENGINE REMOVAL (2)

FIG. 10 ENGINE REMOVAL (3)

the engine rail lug.

Unlock and remove the four bolts securing the trunnion caps. Remove the trunnion caps and the locating nuts and bolts, enabling the hinge fittings to swing clear as the engine is withdrawn (fig.9 detail M).

Withdraw the engine from the aircraft and onto the trolley, and secure by placing the retaining bolts in front of the engine rear rollers at the ends of the roller rails (Fig.10, Detail B). Withdraw the

split bolt to disengage the trolley from frame 40A. Lower the trolley onto its wheels and tow away.

On aircraft in which Mod.480 is incorporated, an access door in the inner skin of the air intakes is provided to facilitate the renewal of the safety disc of the engine starter motor: a sighting door, fitted adjacent to, and to port of the safety disc access door, is provided to ensure correct alignment of the starter exhaust on engine replacement.

JET PIPE REMOVAL (FIG.11)

Render the aircraft electrically safe (Sect.5, Chap.1, Group A.1).

Ensure that the aircraft is chocked fore and aft and that the undercarriage safety stops are fitted (Sect.2, Chap.1, Fig.6).

Remove the tail cone by releasing the four toggle fasteners (5).

Remove the jet pipe access panels (1), port and starboard in the rear fuselage.

Break down the jet pipe coupling through the access doors in the engine casing (Sect.3, Chap.1, Fig.12. Detail of jet pipe coupling).

Uncouple the eight thermocouple connections (3) at the rear of the jet pipe.

Pull the jet pipe (4) rearward until it is out of the rear mountings. Carefully manhandle the pipe (approximately 196 lb. in weight) until it is clear of the jet pipe mounting rail (2) and the aircraft and place on a felt padded surface.

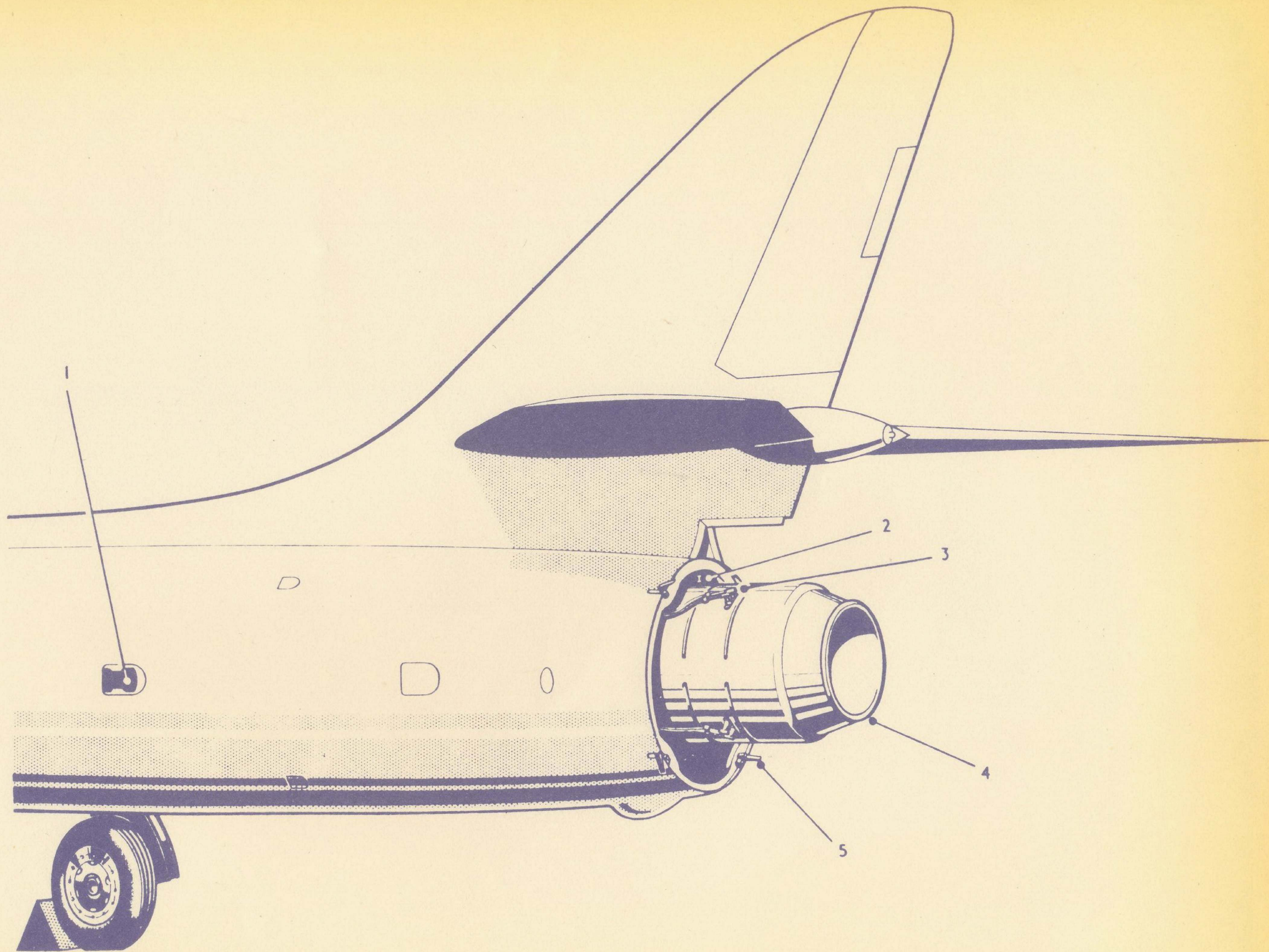


FIG. II JET PIPE REMOVAL



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