Chapter 1 POWER UNIT

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LIST OF ILLUSTRATIONS

Introduction

1. The power unit consists of a single Avon axial flow gas turbine installed centrally within the fuselage with its air intakes in the leading edge of the stub wings and a straight-through jet pipe which exhausts at the tail end of the aircraft structure. Engine starting is effected by means of a triple breech cartridge starter unit mounted on the front of the engine, the firing of the cartridges being initiated electrically from a control switch in the cabin. Fuel flow to the engine burners is controlled by a manually-operated throttle valve. There is no oil tank, all the necessary oil being carried in the engine sump.

DESCRIPTION

Engine bay

2. The engine bay is contained in the centre fuselage, engine removal necessitating withdrawal of the rear fuselage from the remaining structure to gain access. An engine-driven accessories gearbox is also accommodated in the engine bay. In front of the engine are the twin air intake ducts, each of which is fed from an air intake in its respective stub wing. The front and centre fuel tanks are fitted between and around these ducts, and to isolate them from the engine, a fireproof wall is provided at frame 37. Air extractors and cooling ducts are provided to maintain the temperature of the engine bay at a permissible value. Spray rings, encircling the engine compressor outlet casing and turbine nozzle box, are supplied with extinguishant from a fire extinguisher bottle mounted on the rear face of the main spar member. The system is operated manually by cabin control, or automatically by means of inertia switches in the event of a crash landing.

Engine mounting (fig. 1)

3. The engine is provided with four attachment points. These consist of a trunnion on either side of the turbine nozzle box, located on the horizontal centre line of the engine, and front suspension linkages which are located on either side of the engine compressor casing, a little below the engine centre line. The front attachments connect to mountings on frame 34 and incorporate a universal-joint type turnbuckle, which in conjunction with a removable adjustable stop (which raises or lowers the removable centre rail), enables the engine to be correctly positioned. When the engine has been initially centred, the turnbuckles are locked with 20 s.w.g. nickel alloy wire and should not be disturbed subsequently. The rear mounting trunnions, which are provided with spherical bearings, are attached to frame 40A through the medium of split bearing housings. On the port side, the spherical bearing is secured to its trunnion by a pin. On the starboard side, the spherical bearing is free on its trunnion, thus allowing for engine expansion.

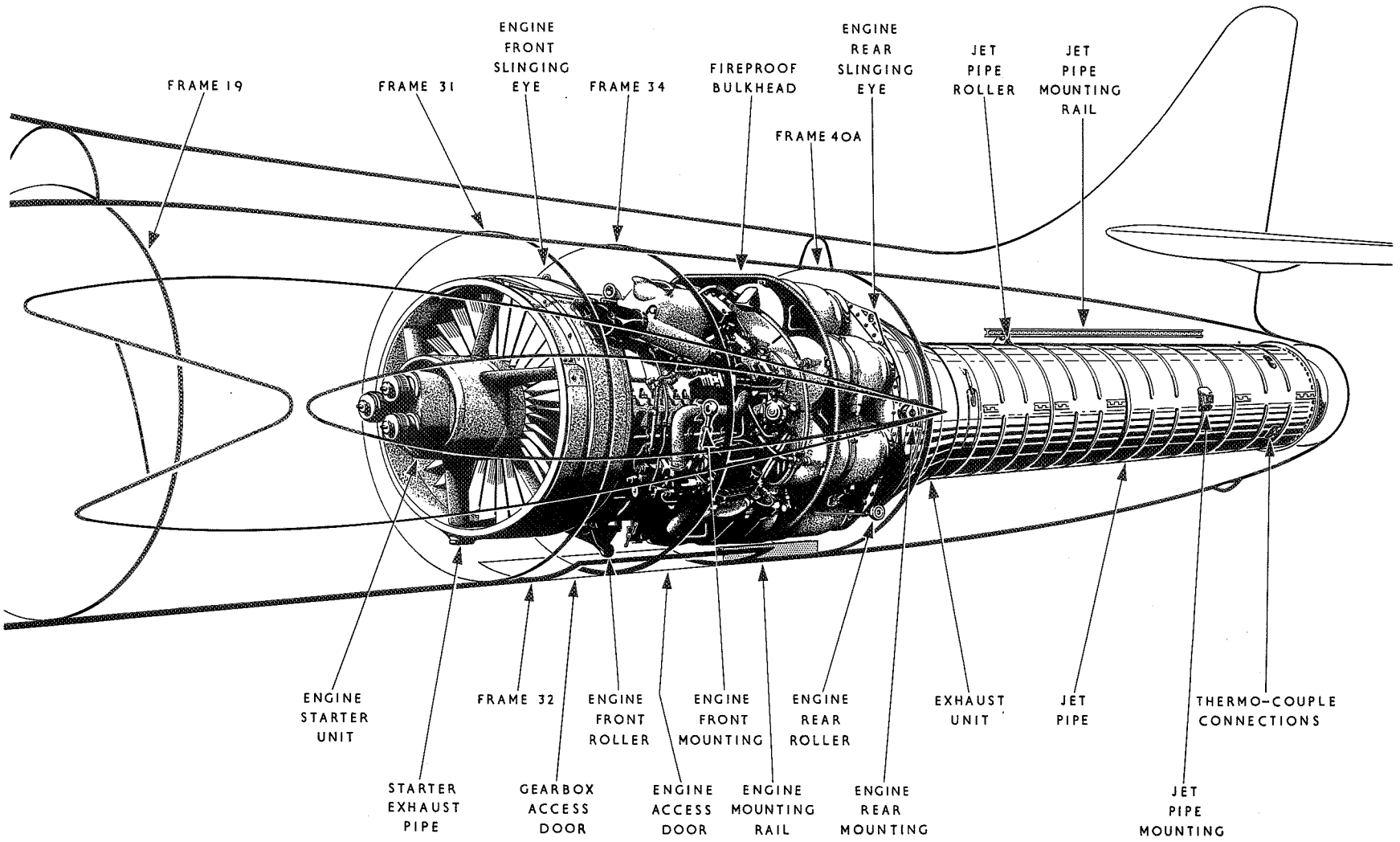

Fig.1. Engine installation

Air intakes

4. 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 for maximum intake of air with the minimum of resistance. Sealing covers are provided for the air intakes to prevent the ingress of dirt or moisture when the aircraft is on the ground, and these must be fitted at all times when the aircraft is parked or in the hangar, except during an engine run or air intake inspection. Safety guards (Sect. 2, Chap. 1), which can be fitted in lieu of the sealing covers, are provided for the protection of personnel during ground running.

Jet pipe (fig. 1)

5. 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 jet pipe. Each keeper plate is provided with its own access panel. The rear end of the jet pipe is steadied by two universal blocks located at the horizontal centre line. The blocks are free to slide fore-and-aft, and laterally, to allow for jet pipe expansion. An adjacent access panel is provided to permit adjustments to the height of the mounting slide, the slide and its mounting plate are serrated to allow for vertical adjustment. 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 the assembly of the pipe. No weight is exerted on the rail by the rollers once the jet pipe has been secured in position. A sealing cover is provided for fitting over the jet 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 starting the engine.*

Accessories gearbox (fig. 2)

6. The accessories gearbox is mounted in the bottom of the engine bay, just aft of the rear spar on the port side of the aircraft. The gearbox, which is driven from the engine wheelcase by means of a drive shaft, accommodates the hydraulic pump and the two electrical generators which provide all the hydraulic and electrical power for the operation of the aircraft's services. Cooling air for the generators is led to air spouts on the generators from either the inter-cooler duct (Pre. Mod. 250), or from a forward facing air scoop on the engine access door (Post Mod. 250). A description of the accessories gearbox and drive is contained in A.P.2240A, Vol. 1.

Engine starter

7. The cartridge-fired triple-breech engine starter is mounted on the front of the engine. The cartridges are selected, and the time switch which automatically controls the starting cycle, energized by a starter selector switch located in the cabin. Provision for the stowage of three additional cartridges is made in the aerial box lid on the inside of the engine starter access door in the bottom of the fuselage. A supporting stay is provided to retain the access door in the open position.

SERVICING

General

8. The servicing of the engine should be carried out in accordance with the instructions laid down in A.P.4321G & J, Vol. 1. The servicing of the ancillary equipment which forms part of the airframe installation is given in the following paragraphs. The accessories gearbox should be examined for oil level at frequent intervals and topped up with oil as necessary in accordance with the instructions given in Sect. 2, Chap. 2.

Precautions

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

(1) Ensure that the instructions detailed on the LETHAL WARNING marker card at the front of the handbook have been complied with.

(2) If an electrical supply is required during servicing, use an external supply to prevent running down the aircraft batteries.

(3) Ensure that the protective covers are in position over 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) 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) 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 posibility of fire due to shorts. *This should be done irrespective of whether the aircraft batteries have been immobilised or not, as there is always a possibility of the batteries being reconnected before the leads.*

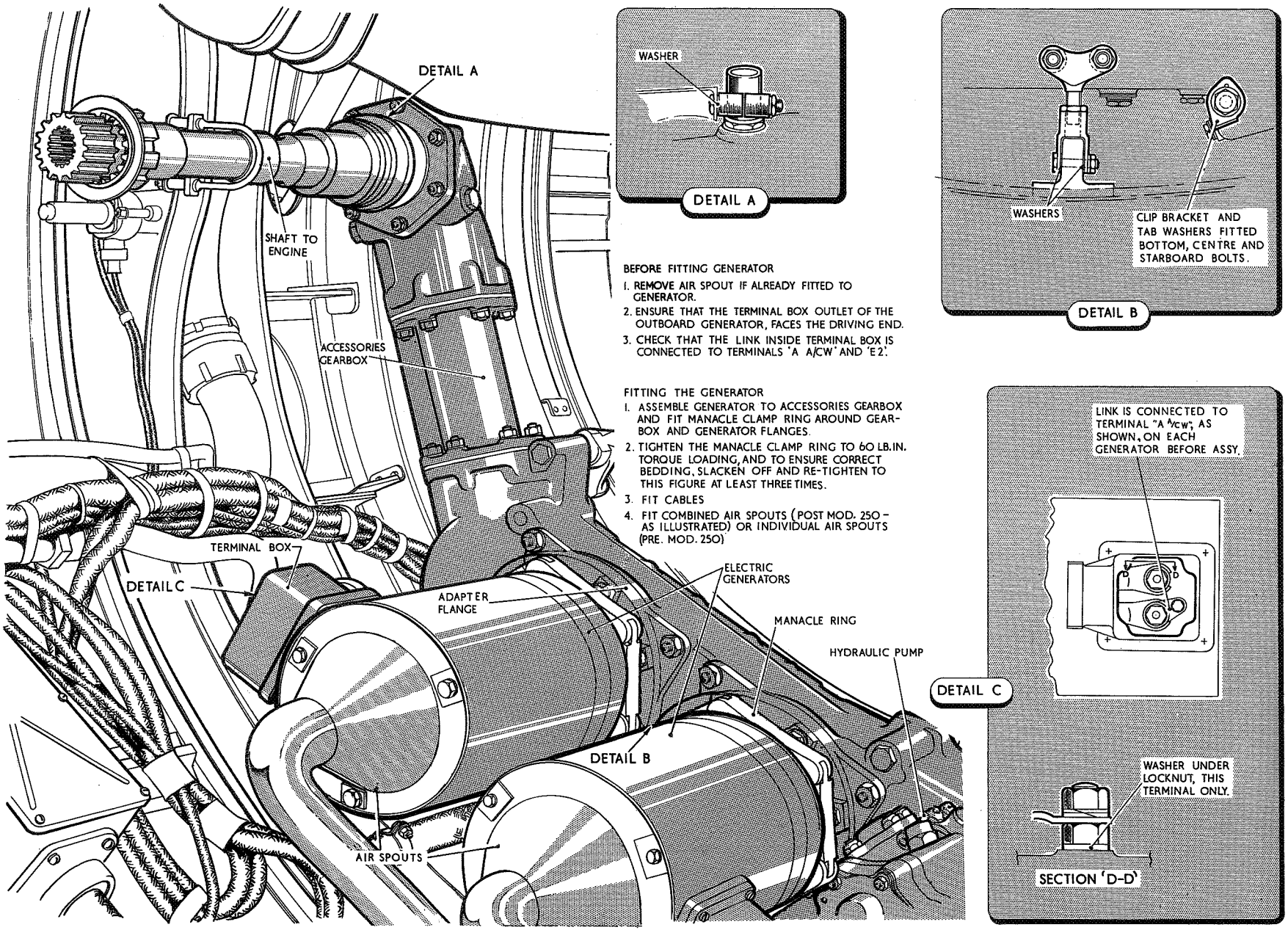

Fig.2 Accessories gearbox

Engine controls (fig. 3 and 3A)

9. The high pressure fuel cock control should be checked to ensure that the range of control lever movement is limited by the stops on the engine and not by those on the cabin quadrant. The throttle control should be checked as in para 10 and 11.

Avon 113 engines

10. The throttle lever in the cabin must have a spring of about $\frac{1}{16}$ in. to $\frac{1}{8}$ in. each end of the quadrant when the lever on the engine is against the 'open' or 'closed' stop.

Avon 115—122 series engines

11. In the 'closed' position the control lever in the cabin must have a spring of about $\frac{1}{16}$ in. to $\frac{1}{8}$ in. at the quadrant when the lever on the engine is against the closed stop. In the 'open' position the lever in the cabin must contact the stop on the quadrant when the engine lever is 0·005 in. to 0·010 in. off the 'open' stop (this ensures that movement of the control rod from the top temperature control actuator is immediately transmitted to the engine throttle lever). A recommended procedure for this adjustment is to set the controls with the cabin lever against the open stop on the quadrant and adjust the control rod so that a 0·010 in. feeler guage is nipped between the stop plate on the engine and its open stop adjusting screw, remove this feeler guage and check that a 0·006 in. feeler guage can be freely inserted in its place. The throttle or high pressure fuel cock stops on the engine should not be interfered with in any way as these have been set in the correct position by the engine manufacturers, the control levers on the engine may, however, require repositioning when being coupled to the aircraft linkage to ensure full control travel. It may also be found necessary to adjust the control rod between the actuating lever of the top temperature control actuator and the bell crank lever but it is important, after such adjustment, that a check be made to ensure that a clearance of 0·125 in. is present in the recess between the bell crank lever and the throttle lever arm when the throttle is fully closed. On completion of the adjustments ensure that all controls are in safety, correctly locked and that they are free from fouling throughout their full range of movement. Lubrication details and control lever settings are given in fig. 3 and 3A.

Throttle lever friction damper

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

Accessories gearbox universal drive couplings

13. The universal couplings in the drive between the engine and the accessories gearbox must be lubricated by means of the grease nipples with grease to Specification XG-271 before assembly, and thereafter on every occasion that the engine is removed.

Re-light switch

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

Lubrication

15. Oil specifications and capacities for the engine and accessories gearbox 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 and gearbox universal shaft couplings are detailed in fig. 3, additional information on the gearbox drive universal couplings being given in para. 13.

REMOVAL AND ASSEMBLY

WARNING

The safety precautions in paragraph 8 must be complied with.

General

16. The removal of the engine entails jacking up the aircraft at the specially prepared positions as shown in Sect. 2, Chap. 4 *(with the exception of the rear fuselage)*. When jacked up, the alighting gear should be in the fully extended position with the wheels two or three inches off the ground; the aircraft must be level fore-and-aft and laterally.

17. 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 operation, a rear fuselage removal trolley is provided and another trolley is provided to accommodate the engine. These and other special equipment referred to in this chapter are listed in Sect. 2, Chap. 4.

18. 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 bolt should be screwed into frame 52, beneath the fuselage. The engine trolley is fitted with rails which, in conjunction with rails provided in and for fitment to the centre fuselage, facilitate withdrawal and installation of the engine.

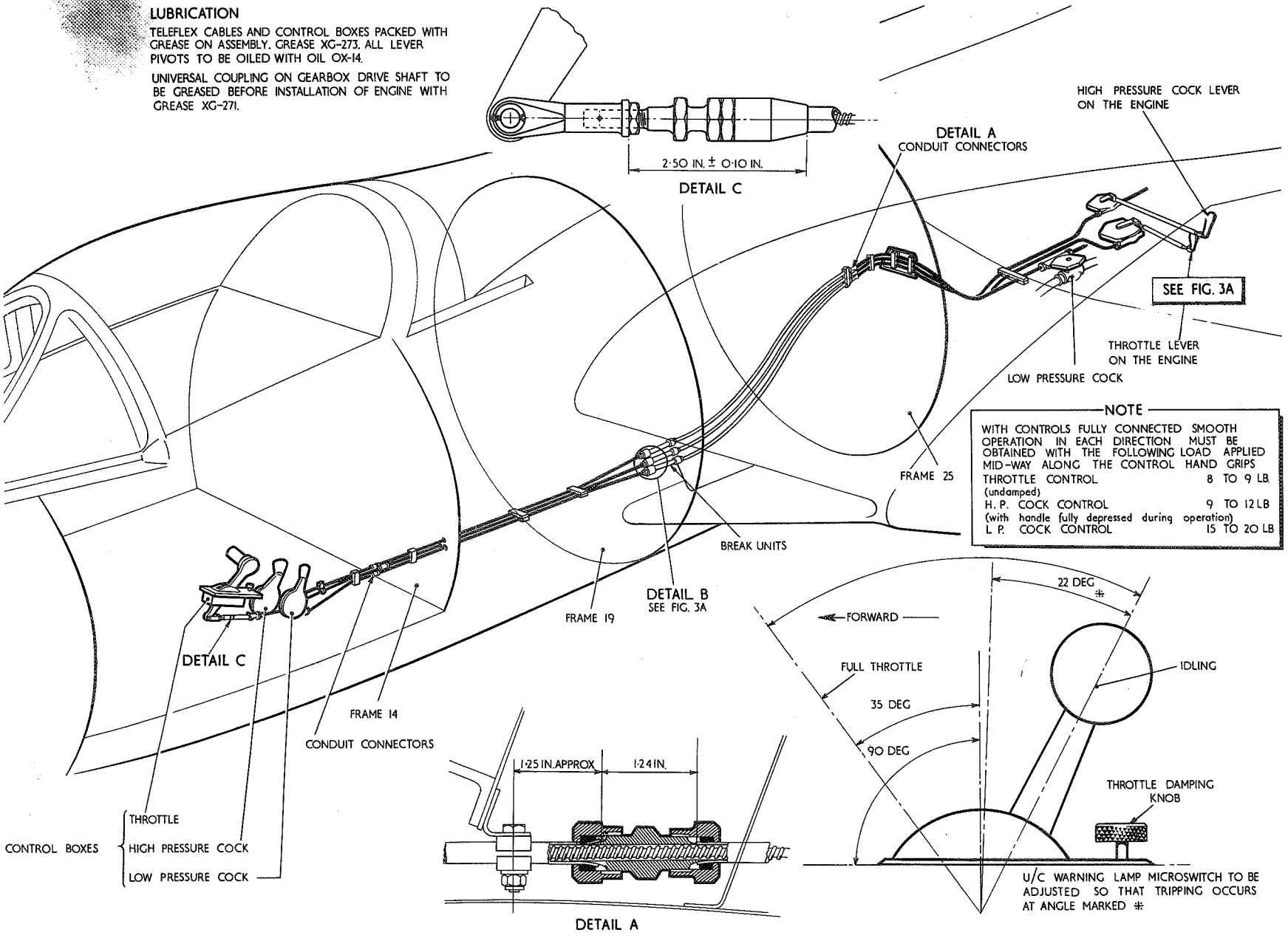

Fig. 3 Engine controls (1)

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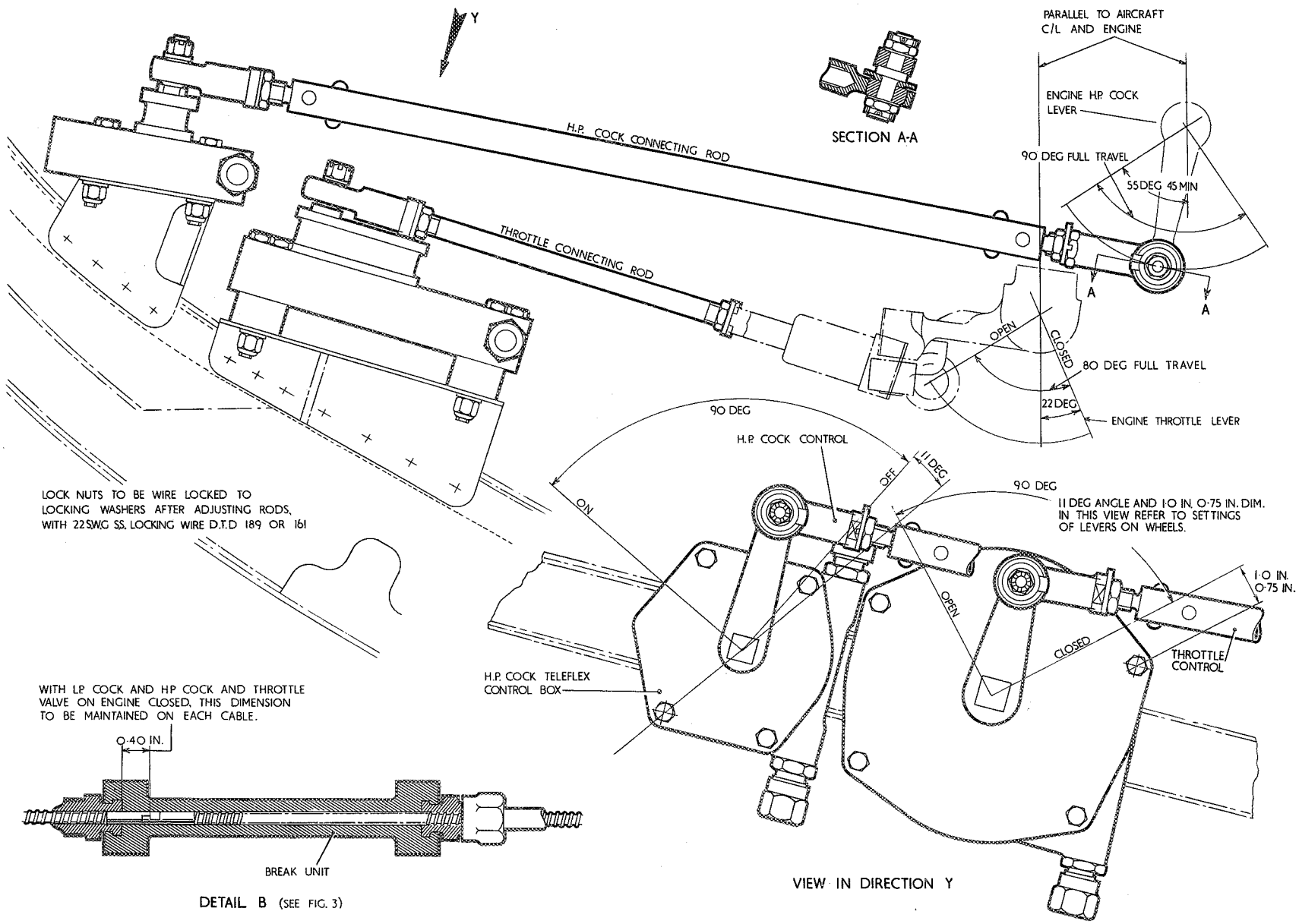

Fig. 3A Engine controls (2)

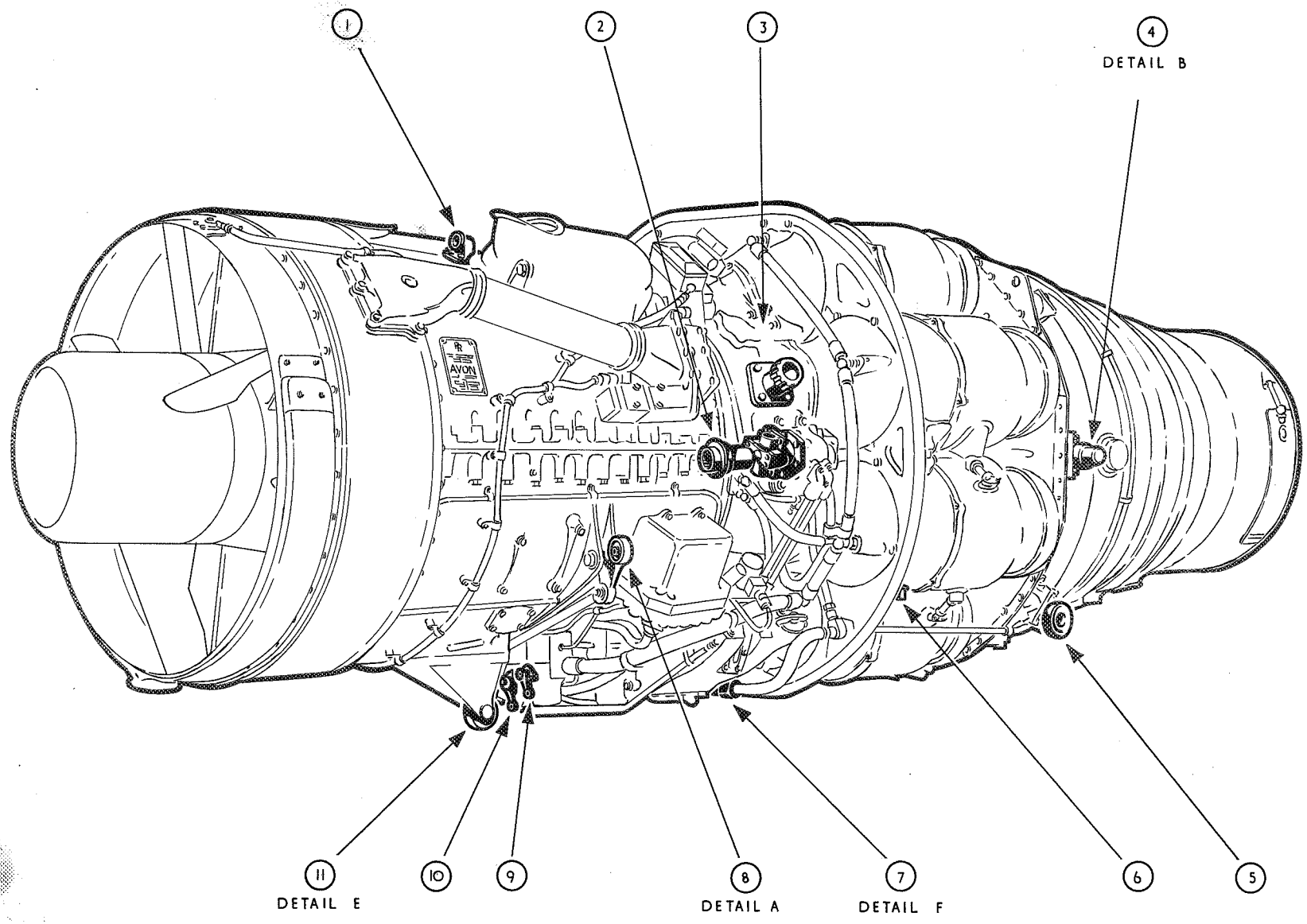

Fig. 4. Engine removal (1)

19. If the batteries are not to be removed prior to engine removal, ensure that the battery master switch in the cabin is put to the OFF position. As an additional precaution, remove the leads from the batteries, insulate the Cannon plugs on the ends of the battery leads and place them in such a position that there is no possibility of them shorting on the aircraft structure.

20. Ensure that the breech of the engine starter is unloaded, i.e. no cartridges fitted.

Unpacking and slinging

21. The procedure for unpacking, slinging and the use of the transit stand is described in A.P.4321G & J, Vol. 1.

Engine removal (fig. 4, 5 and 6)

22. To remove the engine proceed as follows :—

(1) Ensure that the safety precautions laid down in the LETHAL WARNING notice at the beginning of this volume have been complied with.

(2) Render the aircraft electrically safe (*Sect. 5, Chap. 1*)

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

(4) Remove the following access doors and panels, the location of which are given in *Sect. 2, Chap. 4* :—
Engine starter access door.
Gearbox access door.
Engine access door.
Access panels in stub wings.
Engine front mounting access panels.
Engine oil sump filler access panel, starboard only.
Igniter plug access panels.
Cold air unit panels.
Engine bleed valve duct panels.

(5) Remove the wheelcase breather (*item 17, fig. 5*).

(6) The following disconnections are given in sequence under their appropriate access door or panel:—

(*a*) *Engine starter access door.* Immobilise the engine starter by removing the cartridges (A.P.1181D). Pull out the starter exhaust pipe and lock in the 'down' position by inserting the pip pin through the attachment bracket on frame 31.

(*b*) *Gearbox access door.* Disconnect and stow the cable assemblies C.3 and C.6 (*fig. 5 items 13 and 14*).

(*c*) *Engine access door.* Disconnect and remove the drain pipe from the oil filler (*item 18, fig. 5*). Disconnect the overboard drain pipe (*detail D, fig. 5 and 6*) from the engine access door landing aft of frame 34 by removing the anchorage clip from the drain connection and from the spill connection (15) at the bottom of the fuel units and fuel pressure warning light switch. Remove the drain pipe from the aircraft. Disconnect the two connecting rods from the high pressure cock and throttle levers (*item 9 and 10, fig. 4*) and from their respective Teleflex wrapped box units on frame 34. Disconnect the fire extinguisher hose (*detail F, fig. 4 and 6*) from the rigid metal pipe (*item 7, fig. 4*) on the engine. Tuck back the hose behind frame 37. Unscrew the six bolts from the fire sealing plate (*detail F, fig. 4 and 6*) on the forward face of frame 37. Remove the plate from the aircraft. Unscrew the four nuts and disconnect the fuel inlet pipe from the fuel units (*item 16, fig. 5*) and from the connection behind the nearest flexible coupling. Remove the pipe and coupling from the aircraft. Place the removable rail (*detail E, fig. 6*) between frames 34 and 37 and lock in the bracket on the forward face frame 37 by inserting the pip pin. By screwing up the adjustment bolt through the bottom of frame 34 bring the rail into contact with the engine front roller (11) (*detail E, fig. 6*).

(*d*) *Engine front mounting access panels.* Disconnect the engine front mountings (*detail A, fig. 4 and 6*) and pull the fork ends flush to frame 34 in order to clear the engine front mounting eyes (*item 8, fig. 4*) and avoid fouling the engine on removal. Prise back the serrated, spring loaded locking ring and unscrew the shaft retaining nut to break down the gearbox drive shaft (*item 2, fig. 4*).

(*e*) *Igniter plug access panels.*

WARNING

The electrical energy which may be stored in the condensers of the high energy ignition units is potentially lethal; to allow the stored energy to disperse, at least one minute must elapse after disconnecting the L.T. supply, before handling the H.E.I. units or the H.T. cable.

Disconnect the high energy igniter plugs (*item 6, fig. 4 and 5*) from the combustion chambers numbers 3 and 6.

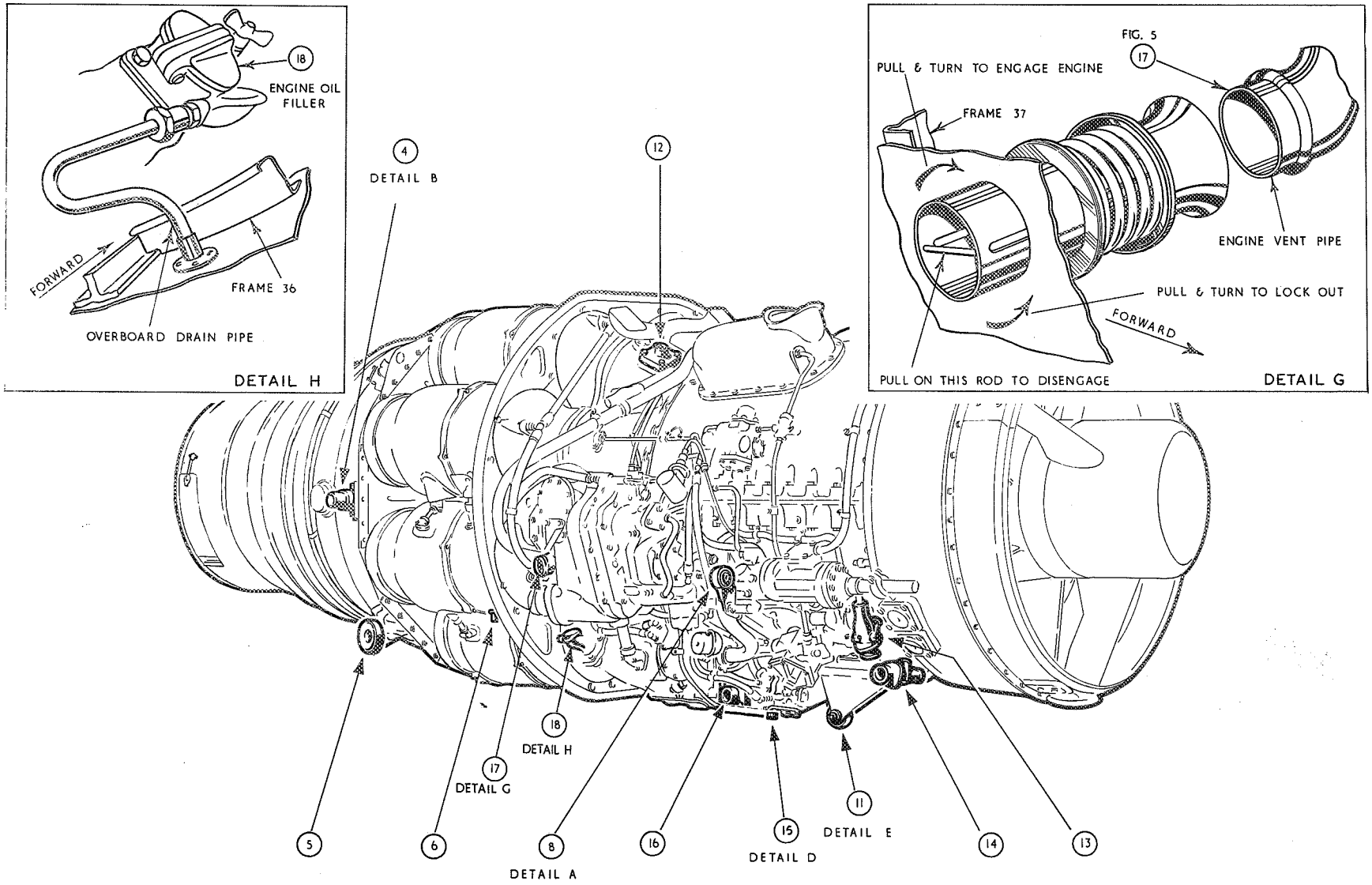

Fig.5 Engine removal (2)

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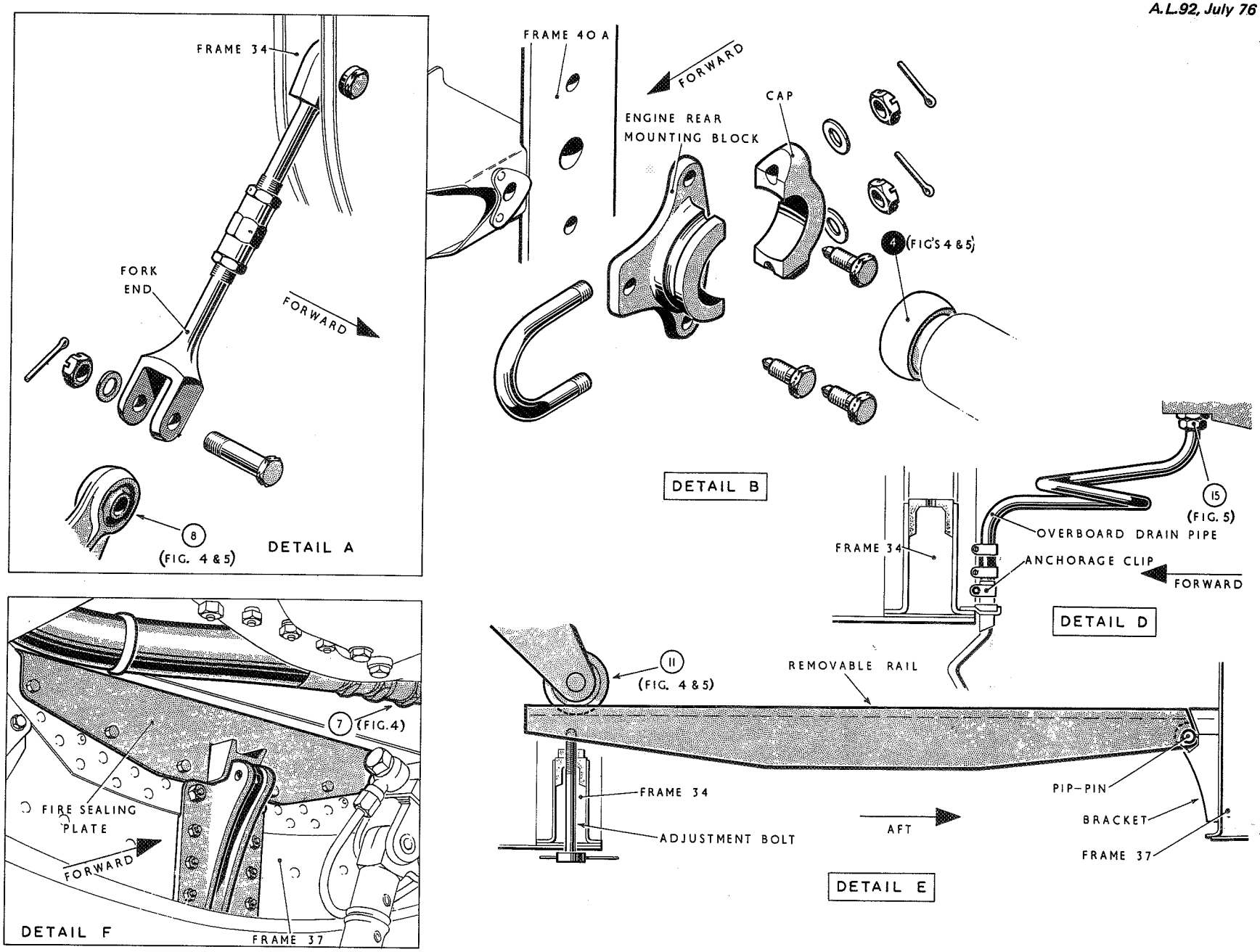

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Fig.6 Engine removal (3)

(f) Cold air unit access panels. Disconnect the flexible metallic fuel-tank pressurizing pipe from the engine *(item 3, fig. 4)* and from the non-return valve aft of frame 36. Remove the pipe from the aircraft. Disconnect the flexible air conditioning pipe from the engine *(item 12, fig. 5)* and from the connection behind the flexible coupling. Remove the pipe and coupling from the aircraft.

(g) Engine bleed valve duct panel. Pre-mod. H.1009 – PR Mk.11 aircraft only.
Disconnect the flexible metal-braided gun heating pipe from the elbow on the engine *(item 1, fig. 4)* and tie back to the aircraft structure.

(h) Engine bleed valve duct panel. Post-mod. H.1009 – G.A. Mk.11 aircraft only.
Ensure that Blank Part No.F. 239636 and Clamp Part No.A. 186450 are fitted to gun heating bleed elbow Part No.A.192131 on E.C.U.

(7) Having disconnected the above items, align the engine removal trolley with the engine rail lug on the rear face of frame 40A. Screw down the built in jacks at each corner of the trolley and raise it to the required height. Bring the engine rear roller channels of the trolley into alignment with the engine rear rollers *(item 5, fig. 4 and 5)* by turning the lateral adjustment handles on the cross members above the trolley axles. Lock the trolley to frame 40A by inserting the pip pin in the connecting link of the trolley. Dismantle the engine rear mountings *(detail B, fig. 6)* by removing the split pins, slotted nuts and washers from the 'U' bolts. Withdraw the caps off the 'U' bolts. Pull the engine rearward about six inches in order to free the special bolts securing the rear mounting blocks *(item 4, fig. 4 and 5).* Break the wire locking and unscrew the three special bolts securing the engine rear mounting blocks to frame 40A. Remove the blocks from the aircraft. Transfer the engine from the aircraft to the trolley and secure by replacing the retaining bolts in front of the engine rear rollers at the ends of the roller channels. If the engine is not to be re-installed remove the pin and bearing from the port rear engine mounting and the bearing from the starboard rear engine mounting and retain with the mounting blocks. Withdraw the pip pin to disengage the trolley from frame 40A. Lower the trolley on to its wheels and tow away.

Note . . .
Under no circumstances may the engine–airframe joint pins or bolts be used to mount the engine on the stand. Special bolts are provided for this purpose which must not be used in the airframe installation.

Engine installation

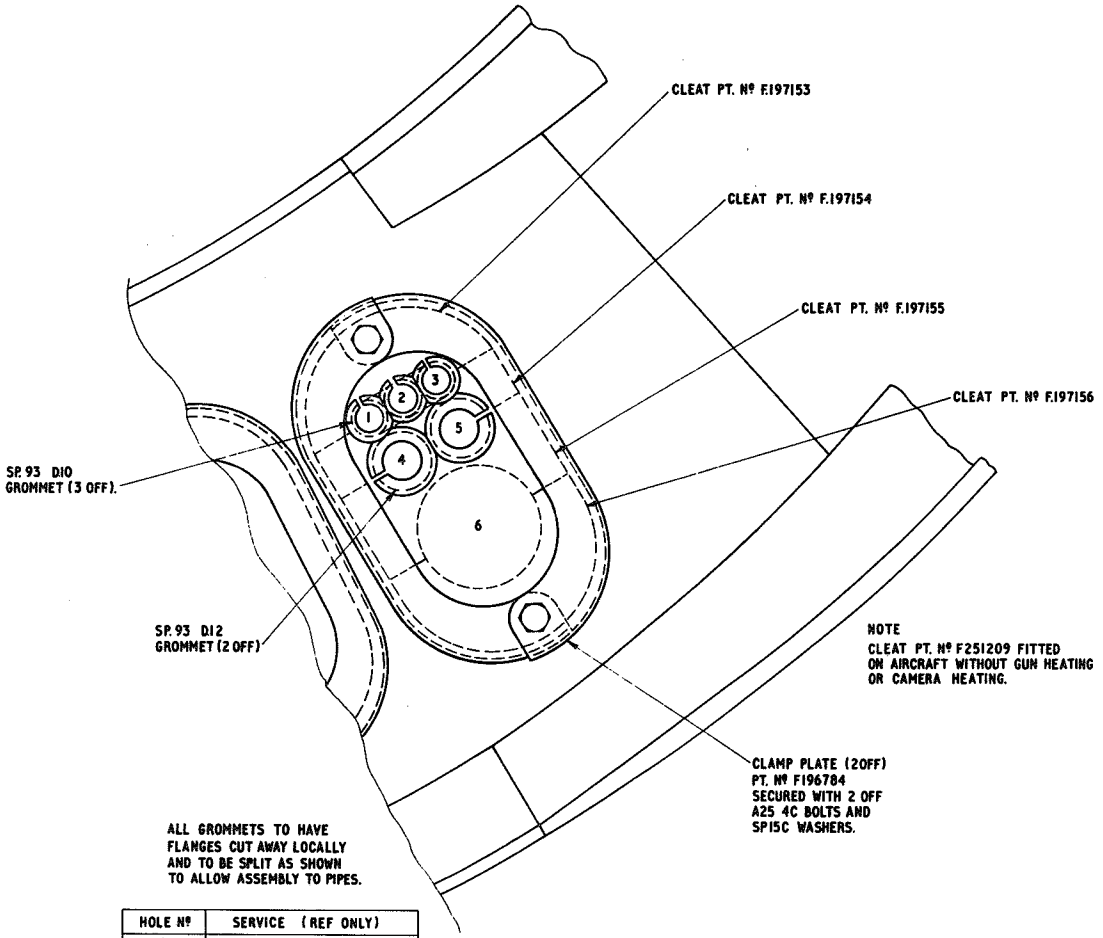
23. In general, the re-installation of the engine and its ancillaries is a reversal of the removal procedure, but the following precautions must be taken :—

(1) If a new engine is being installed as a result of compressor failure, or engine seizure, the pipe lines of the cabin pressurization system and the air pipes of the fuel system, *must* be examined to ensure that they are free from foreign matter.

(2) The accessories gearbox drive shaft universal couplings must be lubricated in accordance with the instructions given in para. 12 before the engine is installed.

(3) When checking the security of the accessories gearbox drive coupling, ensure that the locking sleeve teeth are in positive engagement with those of the coupling locknut.

◀ (4) Before engine installation, examine the pipes and clamp assembly located at the starboard lower aft face of frame 32 *(fig.6A)* for signs of pipe chafing, possibly caused by deterioration of the grommets or fracture of the pipe cleats. Renew any unserviceable pipes, cracked cleats or deteriorated grommets. Replacement grommets are to be Part No.SP 93, as specified in fig.6A, prepared by cutting away the flanges locally and splitting *(as shown)*. After reassembling the grommets and cleats, check that adequate clearance exists between the pipes and controls (STI/Hunter/395 refers). ▶



HOLE Nº	SERVICE (REF ONLY)
1	ENGINE CONTROLS
2	ENGINE CONTROLS
3	ENGINE CONTROLS
4	HYDRAULIC (RETURN)
5	HYDRAULIC (PRESSURE)
6	GUN HEATING

VIEW ON AFT FACE OF FRAME 32 STARBOARD SIDE
LOOKING FORWARD.

Fig.6A Assembly of clamp plates and cleats frame 32 (STI/Hunter/395)

Accessories gearbox

24. If the engine is already out of the airframe, the accessories gearbox should be installed first. Prior to installation, the gearbox should be filled with oil *(Sect. 2, Chap. 2)* and, after the initial engine run, the oil level should be checked and if necessary topped up. When installing the gearbox fit the six bolts securing the gearbox to the rear spar taking care to fit the distance piece Part No. F.209992 to the top bolt on the starboard side between the gearbox and the rear spar. Tighten the six bolts evenly and when tight lock with the tab washers. Then fit the mounting block *(detail A, fig. 2)* on the mounting trunnion at the top of the gearbox casing and the eye and fork end assembly *(detail B, fig. 2)* to the bottom of the gearbox and the fuselage stringer. The clearances between the components at these top and bottom attachments are taken up by fitting the washers shown in fig. 2 details A and B. Prior to connecting the drive shaft coupling lightly grease the splines with grease XG-271. Before fitting an accessory, examine the quill drive for general condition and that it is an easy sliding fit on the accessory serrations. Immerse the quill in gearbox oil prior to refitting to the gearbox. Lubricate the serrated shaft of the accessory with gearbox oil. When new generators are to be fitted reference must be made to the assembly note contained in fig.2.

Jet pipe removal (fig. 7)

25. To remove the jet pipe proceed as follows :—

(1) Ensure that the aircraft is chocked fore and aft and that the undercarriage safety locks are fitted.

(2) *Render the aircraft electrically safe (Sect. 5, Chap. 1).*

(3) Take the weight of the tail cone, release the four toggle fasteners (5) and remove the tail cone.

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

(5) Dismantle the jet pipe coupling through the access doors in the engine casing *(as detailed in Sect. 3).*

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

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

Jet pipe installation

26. The jet pipe guide rails are described in para. 5. The installation procedure is a reversal of the operations given in para. 25. Immediately before installing the jet pipe, examine all electrical cables and connectors in the rear fuselage jet pipe bay for general condition and serviceability.

Engine controls—Teleflex cables and conduits

27. The control conduits should be formed to the same shape and cut to the same length as the items being replaced, and the Teleflex cables cut to the same length as the items being replaced.

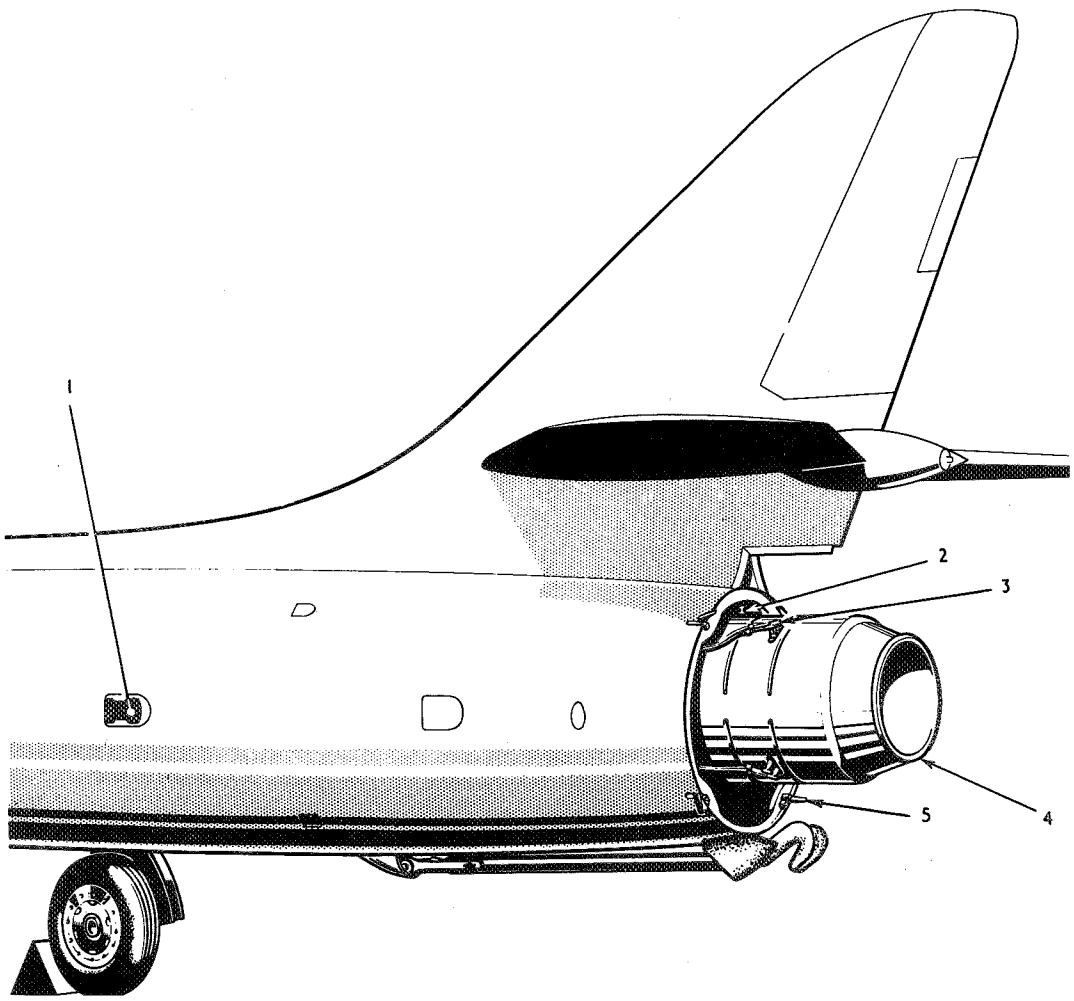


Fig. 7 Jet pipe removal