

## Chapter I POWER UNIT

### LIST OF CONTENTS

	Para.
Introduction ... ..	1
<b>Description</b>	
Engine bay ... ..	2
Engine mounting ... ..	3
Air intakes ... ..	5
Jet pipe ... ..	6
Accessories gearbox and drives ... ..	7
Engine starter ... ..	8
<b>Servicing</b>	
General ... ..	10

	Para.
Precautions ... ..	11
Engine controls ... ..	12
Throttle lever friction damper ... ..	13
Re-light button ... ..	14
Lubrication ... ..	15
Liquid fuel starter—exhaust pipe ... ..	15A
Liquid fuel starter—fuel tank ... ..	15B
<b>Removal and assembly</b>	
General ... ..	16

	Para.
Unpacking and slinging ... ..	19
Removal of accessories gearbox ... ..	20
Removal of engine ... ..	21
Removal of jet pipe... ..	22
<b>Assembly</b>	
General ... ..	23
Accessories gearbox ... ..	24
Accessories gearbox universal drive shaft couplings ... ..	25
Engine controls—Teleflex cables ... ..	26
Liquid fuel starter—fuel tank ... ..	27

### LIST OF ILLUSTRATIONS

	Fig.
Engine installation ... ..	1
Accessories gearbox ... ..	2
Liquid fuel starter installation ... ..	3
Starter tank relief valve ... ..	4
Engine controls (1) ... ..	5
Engine controls (2) ... ..	5(a)
Engine starter bay access door ... ..	6

	Fig.
Gearbox turret access door ... ..	7
Igniter plug access panel—port ... ..	8(a)
Igniter plug access panel—starboard ... ..	8(b)
Engine access door ... ..	9
Gearbox drive access panel ... ..	10
Air supply access panel—port ... ..	11(a)
Air supply access panel—starboard ... ..	11(b)

	Fig.
Front engine mounting access panel ... ..	12
Bleed valve sealing flange ... ..	13
Combustion chamber drain ... ..	14
Engine trolley connection ... ..	15
Rear engine mounting ... ..	16
Securing engine rear roller on trolley ... ..	17
Jet pipe removal ... ..	18

### APPENDIX

◀ I.P.N. (iso-propyl nitrate) starting system ... ..	App. 1 ▶
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#### 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. A liquid fuel starter unit is fitted to the front of the engine, its ancillaries are mounted in the fuselage, adjacent to it. Fuel flow to the engine burners is controlled by a manually-operated throttle valve, the initial opening of which opens the

high-pressure fuel cock. There is no oil tank, all the necessary oil being carried in the engine sump.

#### DESCRIPTION

##### Engine bay

2. The engine is located in the fuselage, aft of the main spar frame. The rear fuselage must be removed before the engine can be withdrawn. *Special equipment is provided to facilitate this work.* The accessories gearbox

is housed in the engine bay, and driven by the engine through two shafts and universal joints and a turret drive arm mounted between them. The twin air intake ducts, in front of the engine, 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, a similar firewall at frame 38, isolates the engine from the rear fuel tanks. Air extractors and cooling ducts are provided to maintain the temperature of the engine bay at a permissible value.

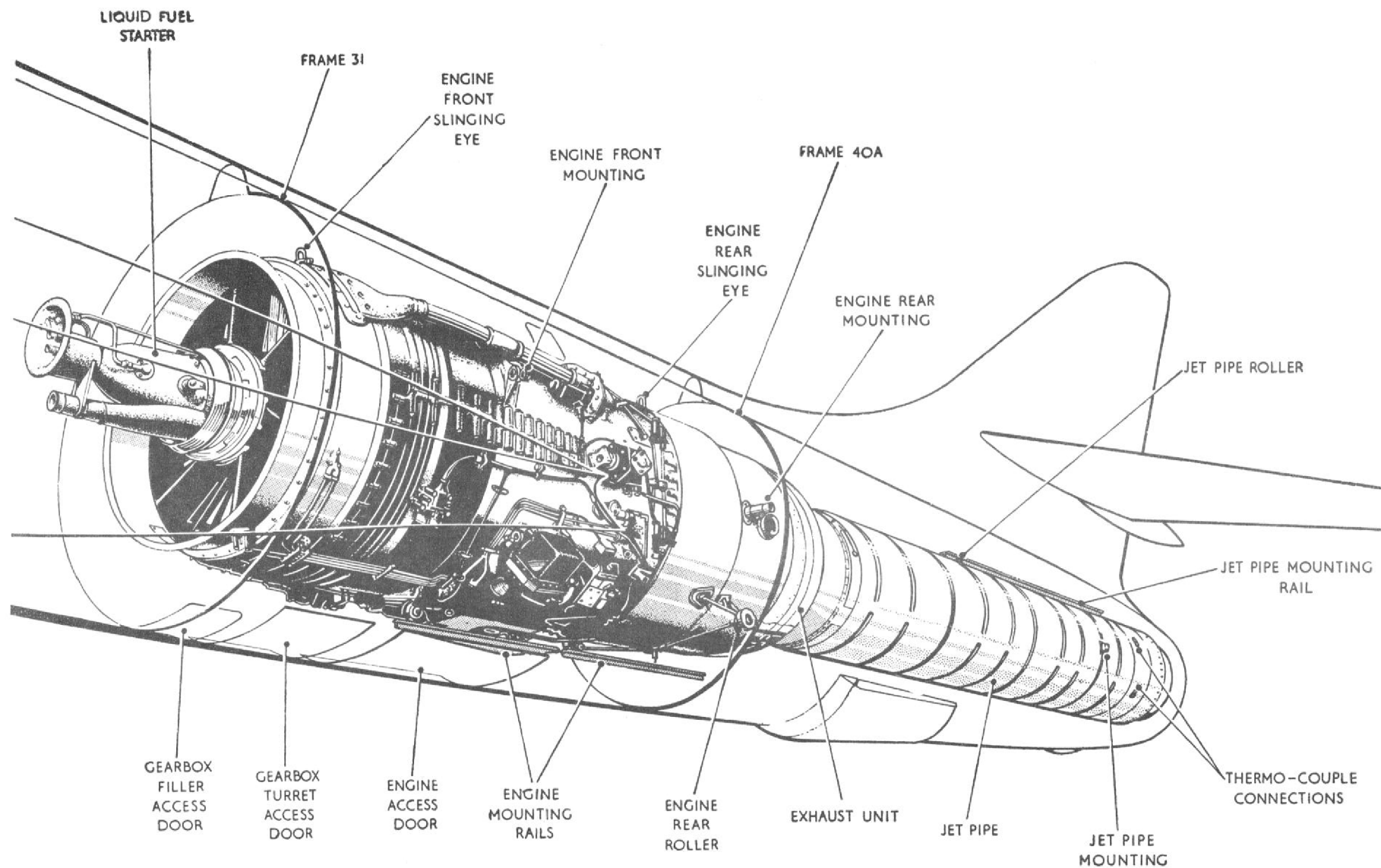


Fig. 1 Engine installation

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**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 universal-joint type turnbuckles. These in conjunction with a special key (*auxiliary lifting key*) which raises or lowers the centre rail, enable 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 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 bolted to thrust members located between frames 38 and 40. The engine is fixed 0.10 in. to port (*when cold*) by the flanged locating trunnion on the port side of the engine. It is free to slide in the starboard trunnion bearing, thus becoming centralised when hot. The split bearing mountings can be swung away from the trunnions when the bearings are dismantled, facilitating engine removal and installation.

**Air intakes**

5. The two air intakes are situated one in each stub wing leading edge, the entry being at the wing roots adjacent to the fuselage. They are shaped for maximum air intake 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 starting the engine. Sealing covers (*Sect. 2, Chap. 1*) are provided for the air intakes to prevent the ingress of dirt and moisture when the aircraft is parked on the ground. These covers must be fitted to the air intakes at all times except during engine running and 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)**

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 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 fitted at the horizontal centre line of the pipe. These blocks are free to move in their mountings on the fuselage, to allow for jet pipe expansion.

The slide and plate of the jet pipe mountings are serrated to allow for vertical adjustment. Access to these mountings is provided by adjacent removable panels. 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 be removed before starting the engine.*

**Accessories gearbox and drives (fig. 2)**

7. The accessories gearbox is located at the bottom of the fuselage between frames 29 and 30, and 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 gearbox is sealed off on the aft face of frame 30 to isolate it from the forward fire zone of the engine bay. The gearbox and turret drive are each provided with an independent oil system, including an oil pump, sump filler orifice and dipstick. Both the gearbox and drive are provided with a breather pipe which vents to atmosphere.

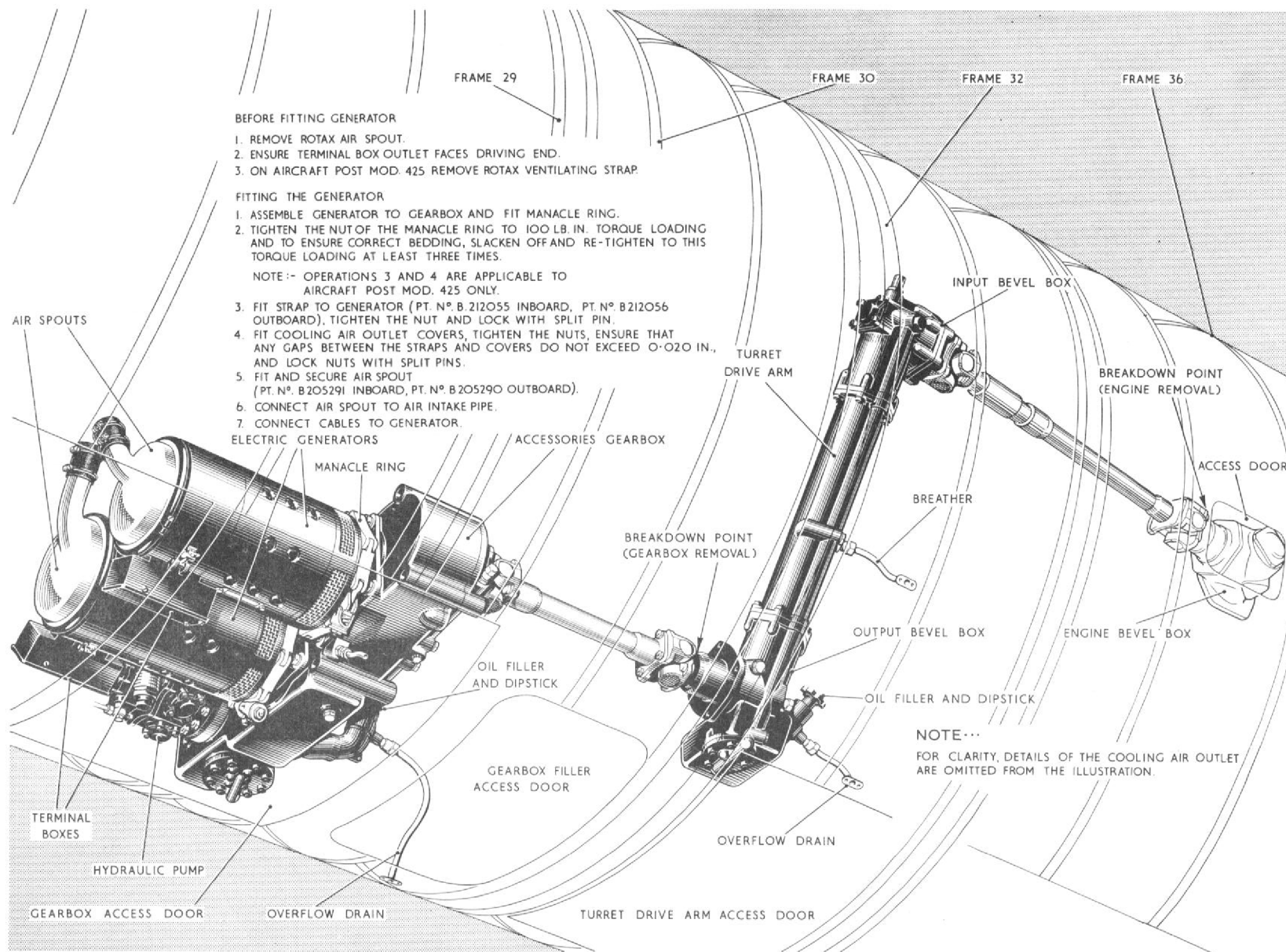


Fig. 2. Accessories gearbox

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**Engine starter (fig. 3)**

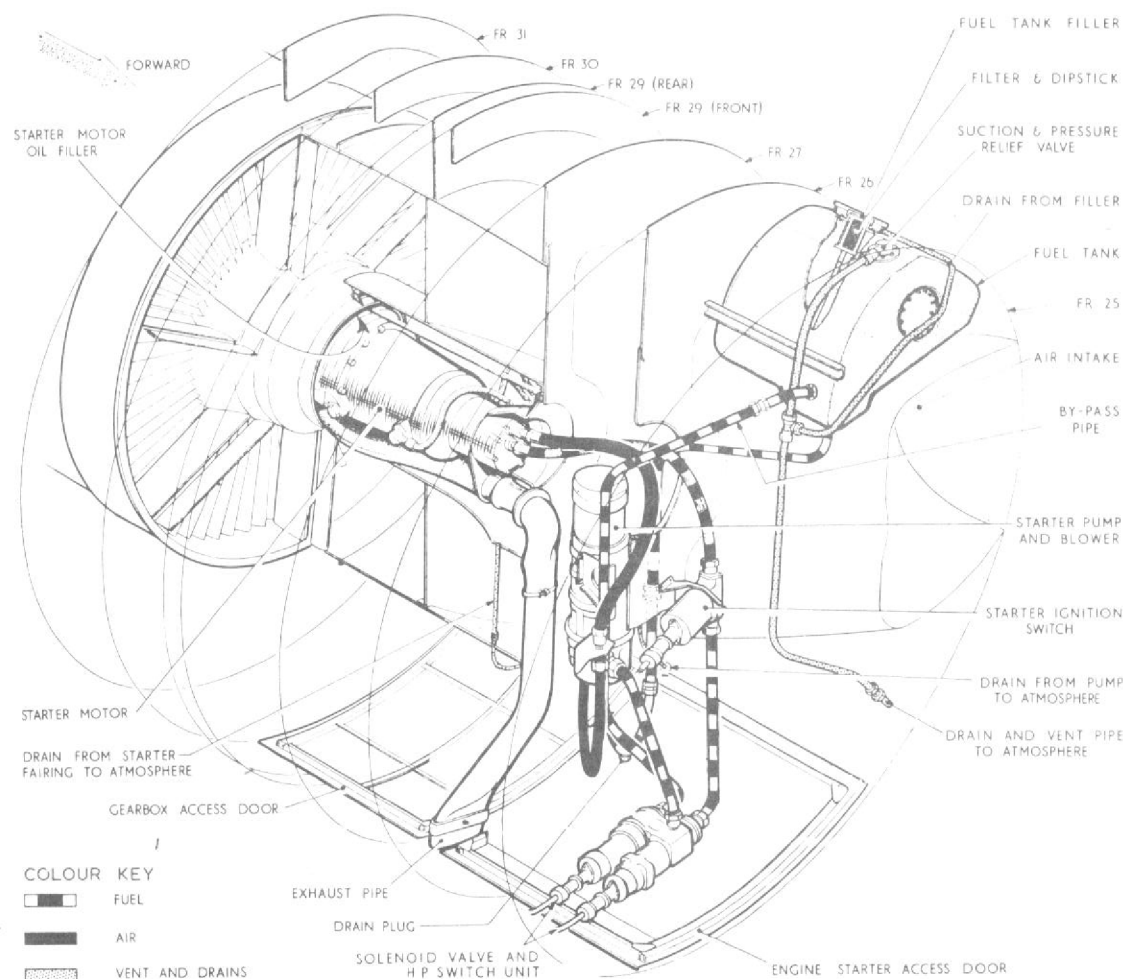
8. The engine is started by a Plessey Iso Propyl Nitrate liquid fuel starter unit. The starter motor consists of a single-stage axial flow turbine, fitted with a reduction gear, it is mounted on the front of the engine with its fuel pump and air blower unit adjacent to it

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. 4).

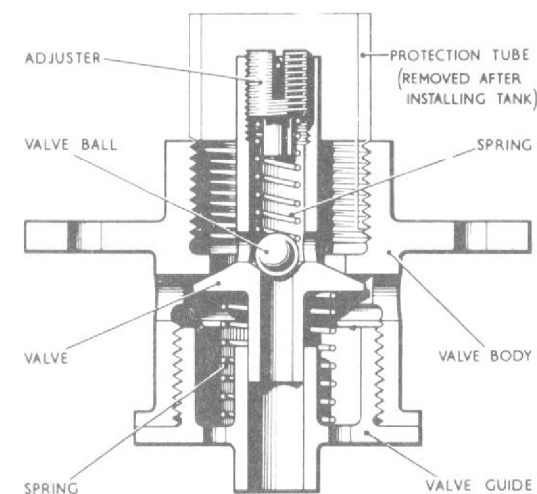
The starting sequence is initiated, by pressing

the starter push-button in the cabin.

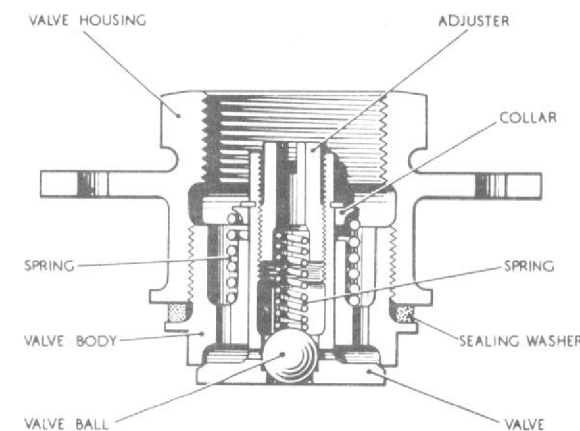
9. The starter is fully described in AP.103D-0208-16. Details of the electrical components used in the system, together with a description of the cycle of operations of the starter electrical circuit, are given in Sect.5, Chap.1, Group C1.



**Fig. 3 Liquid fuel starter installation**



**(Pre-mod 382)**



**(Post-mod 382)**

**Fig. 4 Starter tank relief valve**

## SERVICING

## General

- ◀ 10. The servicing of the engine should be carried out in accordance with the instructions given in AP.102C-<sup>1503</sup><sub>1507</sub>-1. The servicing of the engine ancillary equipment which forms part of the airframe installation, is given in the following paragraphs and servicing the starter motor is given in Appendix 1. ▶

## WARNING

## Precautions

11. 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.

## THIS IS VERY IMPORTANT

- (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) 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 allowed to come into contact with hot pipes, etc. Such leakage must be mopped up immediately and the cause of leakage rectified. Refer to Appendix 1.

- (7) Before removing pipes, care must be taken to ensure that all pressure is released, and that precautions are taken to prevent the spillage of fluid.

- (8) 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 batteries have been immobilised or not, as there is always a possibility of the batteries being reconnected before the leads.*

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

## Engine controls (fig. 5 and 5A)

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. 5 and 5A.

## 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 be serious.

## Re-light button

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

## Lubrication

15. 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. 5. The gearbox universal drive shaft couplings should be lubricated as described in para. 25.

**LUBRICATION**  
TELEFLEX CABLES AND CONTROL BOXES  
WITH GREASE ON ASSEMBLY. GREASE XG-273  
ALL LEVER PIVOTS TO BE OILED WITH OIL OX-14

UNIVERSAL COUPLING ON GEARBOX  
DRIVE SHAFT TO BE GREASED BEFORE  
INSTALLATION OF ENGINE. GREASE XG.271

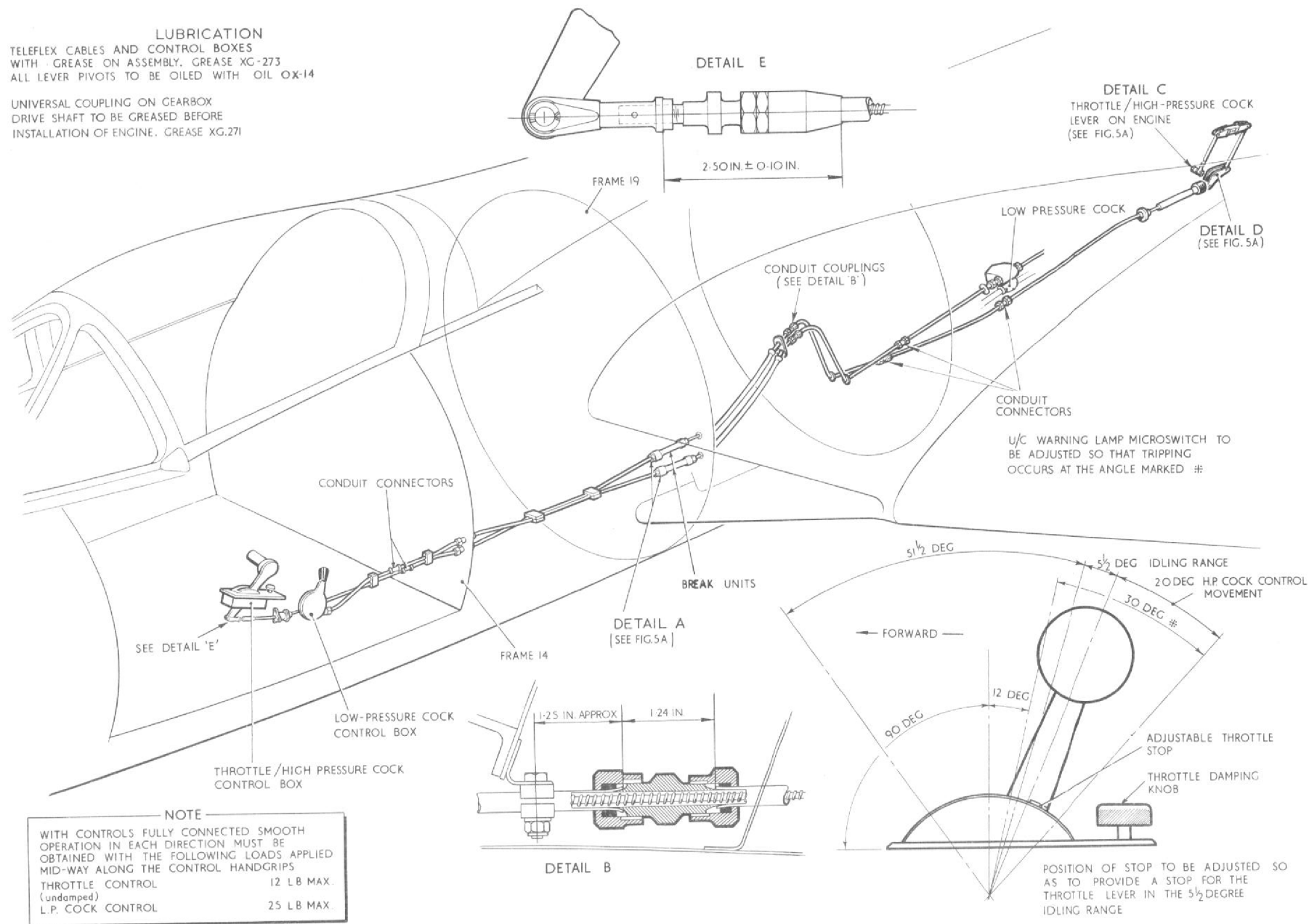


Fig 5 Engine Controls (1)

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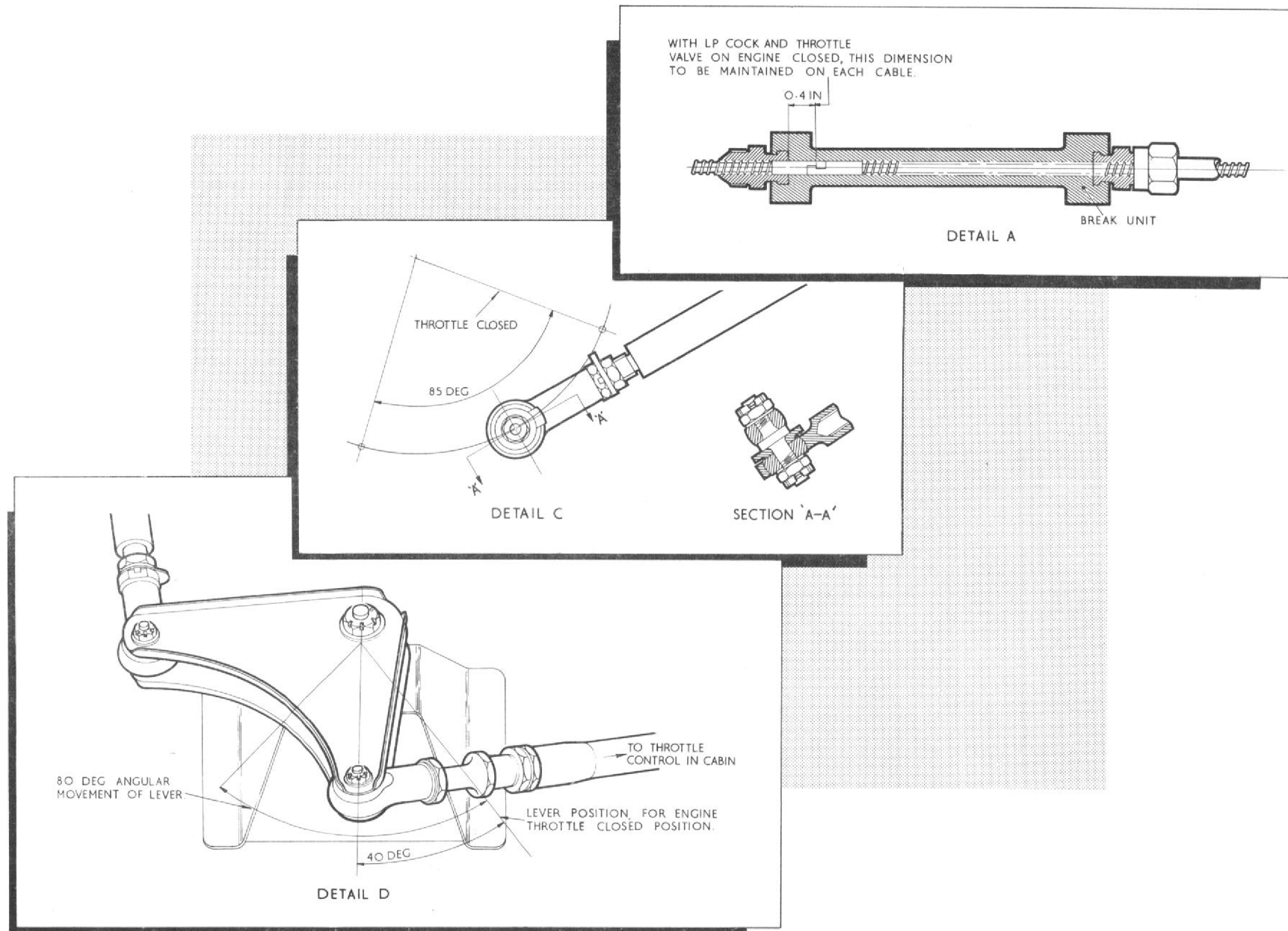


Fig. 5A Engine controls (2)

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## REMOVAL AND ASSEMBLY

## WARNING

The safety precautions in paragraph 11 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.

## Unpacking and slinging

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

## Removal of accessories gearbox

20. To remove the accessories gearbox the seal, at frame 30, is first removed, then 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. When the engine is also being removed, the drive is broken down at the splined connection at the engine bevel box. Before removing the gearbox, the hydraulic pump and the two electrical generators must 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 any other pipes in the way may be removed to facilitate the operation. If the engine is to be removed, the difficulty will not arise providing the engine is withdrawn before attempting to remove the gearbox.

## Removal of engine

21. To remove the engine proceed as follows:—

Jack up and trestle the aircraft as described in para. 16.

## 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; these must not be used in the airframe installation.*

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

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

Remove the following access doors and panels and carry out the operations as detailed:—

Engine starter bay access door (*fig. 6*)

- (1) Disconnect the starter ignition cables, and overspeed relay cable from their respective brackets, on the forward face of frame 26. Disconnect the starter fuel pipe from the starter ignition 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. Slacken off the clamp securing the lower end of the starter exhaust pipe at frame 27.

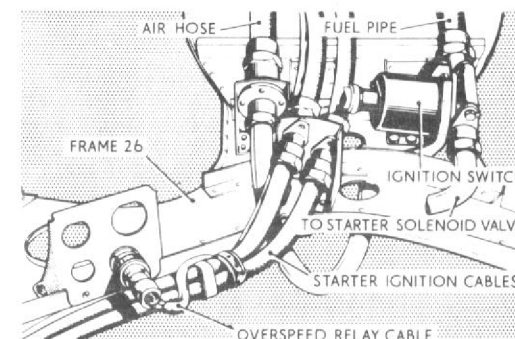
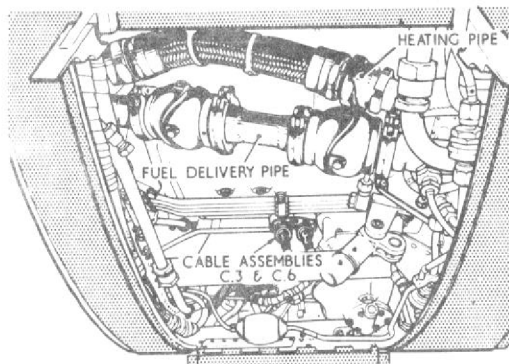


Fig. 6. Engine starter bay access door



**Gearbox turret access door (fig. 7)**

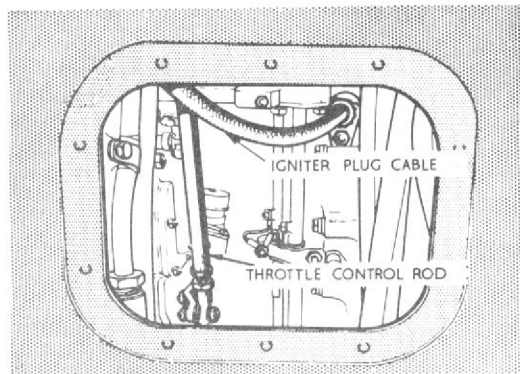
- (2) Disconnect and stow the cable assemblies C.3 and C.6.  
Disconnect the fuel delivery pipe between, and including, the universal couplings. Remove the pipe from the aircraft. Disconnect the heating pipe.



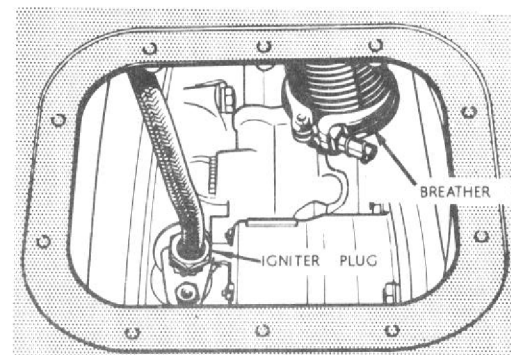
**Fig. 7 Gearbox turret access door**

**Igniter plugs access panels—port and starboard [figs. 8 (a) and 8 (b)]**

- (3) Having taken the precautions set out in the LETHAL WARNING at the front of this handbook, disconnect the high energy igniter plugs. Disconnect the throttle control rod from the throttle control lever on the port side of the fuselage.  
Disconnect the breather pipe from the starboard side and pull outwards to clear the engine.



**Fig. 8(a) Igniter plug access panel—port**

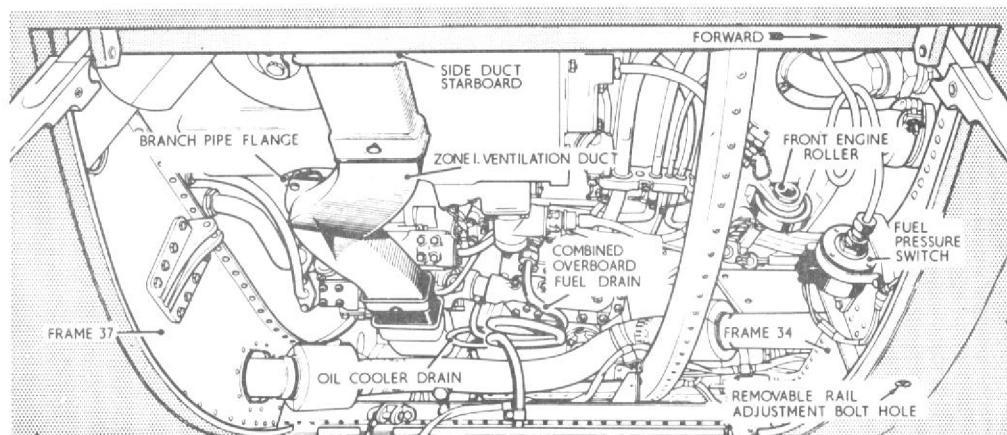


**Fig. 8(b) Igniter plug access panel—starboard**

**Engine access door (fig. 9)**

- (4) Disconnect the fuel pressure switch pipe from the pressure switch mounted on the bottom aft face of frame 34. Disconnect the other end of this pipe from the fuel delivery pipe and remove complete with banjo coupling and bolt. Disconnect and remove 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 and remove the duct. (Duct

*removal is facilitated if the starboard portion of the branch pipe is pushed outboard into the side duct as far as it will go, the port branch will then swing clear.) 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.*

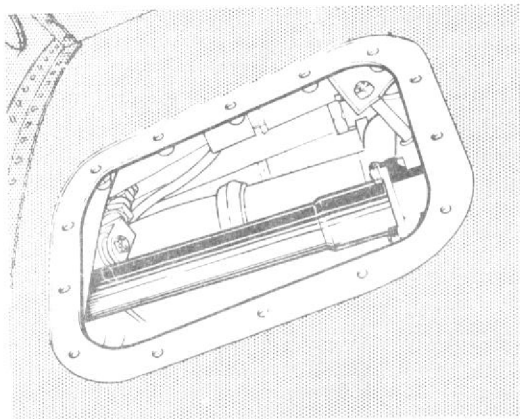


**Fig. 9 Engine access door**



**Gearbox drive access panel (fig. 10)**

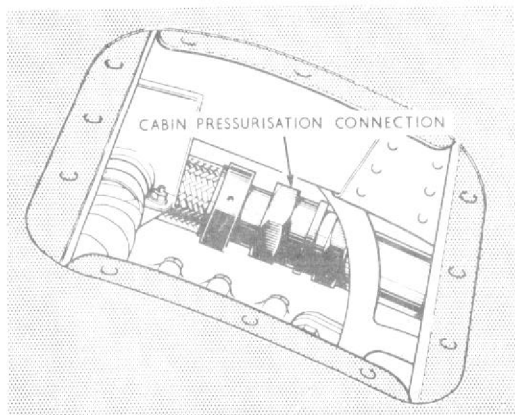
- (5) Disconnect the gearbox drive at the bevel box on the engine and support the shaft to eliminate the possibility of damage.



**Fig. 10. Gearbox drive access panel**

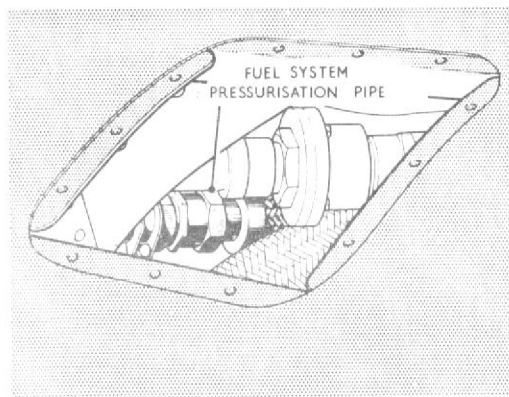
**Air supply access panel, port and starboard [figs. 11 (a) and 11 (b)]**

- (6) Disconnect the cabin pressurisation pipe at the port side of the fuselage.



**Fig. 11(a). Air supply access panel—port**

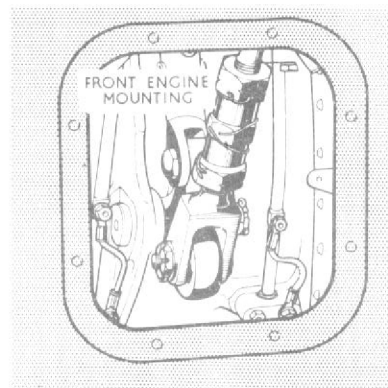
Disconnect the fuel system pressurisation pipe from the starboard side.



**Fig. 11(b). Air supply access panel—starboard**

**Front engine mounting access panels, port and starboard (fig. 12)**

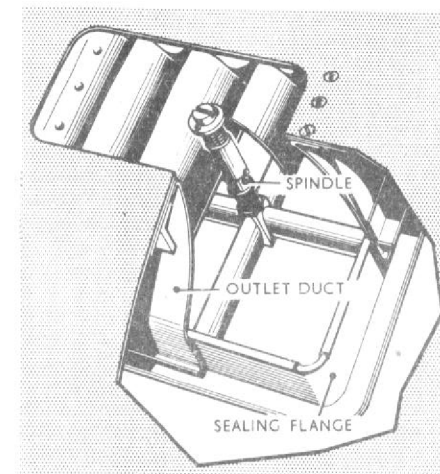
- (7) Remove the split-pinned nut and bolt from the engine mounting turnbuckle fork end and swing the turnbuckle clear of the engine.



**Fig. 12. Front engine mounting access panels—port and starboard**

**Bleed valve sealing flange (fig. 13)**

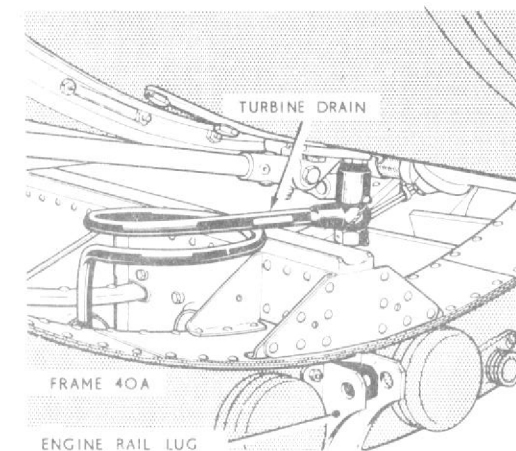
- (8) Withdraw the bleed valve sealing flange between frames 33 and 34 and lock in the withdrawn position.



**Fig. 13. Bleed valve sealing flange**

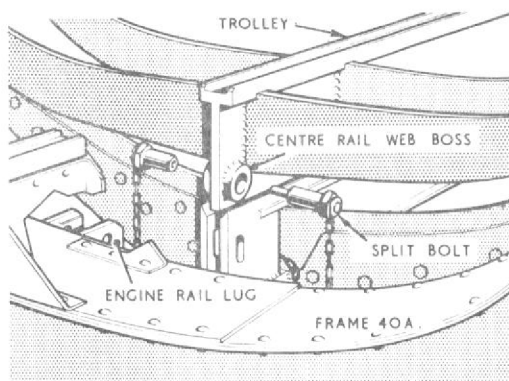
**Frame 40A (fig. 14)**

- (9) Disconnect and remove the turbine drain pipe from the combustion chamber.



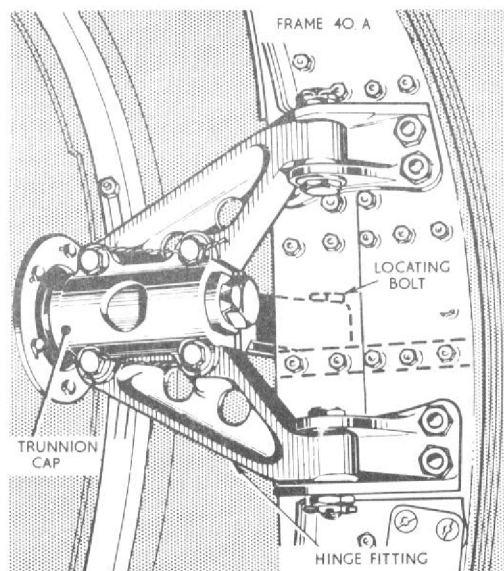
**Fig. 14. Combustion chamber drain**

- (10) After disconnecting the items detailed in sub-paras. (1) to (9), 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. 15*).



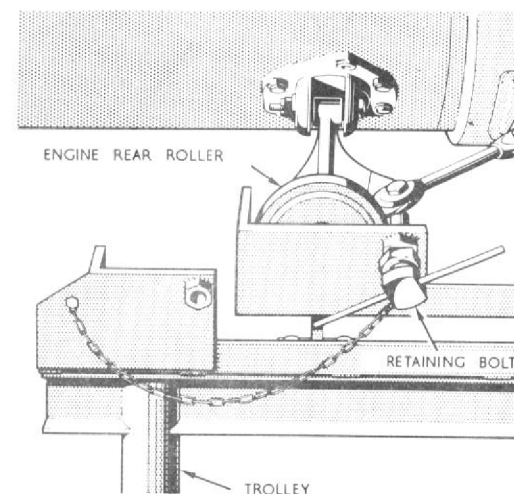
**Fig. 15. Engine trolley connection**

- (11) Lower the trolley on to 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 the engine rail lug. Unlock and remove the four bolts securing the engine mounting trunnion caps. Remove the trunnion caps and the locating nuts and bolts (*fig. 16*), enabling the hinge fittings to swing clear as the engine is withdrawn.



**Fig. 16. Rear Engine Mounting**

- (12) Withdraw the engine from the aircraft on to the trolley, and secure by placing the retaining bolts in front of the engine rear rollers at the end of the roller rails (*fig. 17*). Withdraw the split bolt to disengage the trolley from frame 40A. Lower the trolley on to its wheels and tow away.

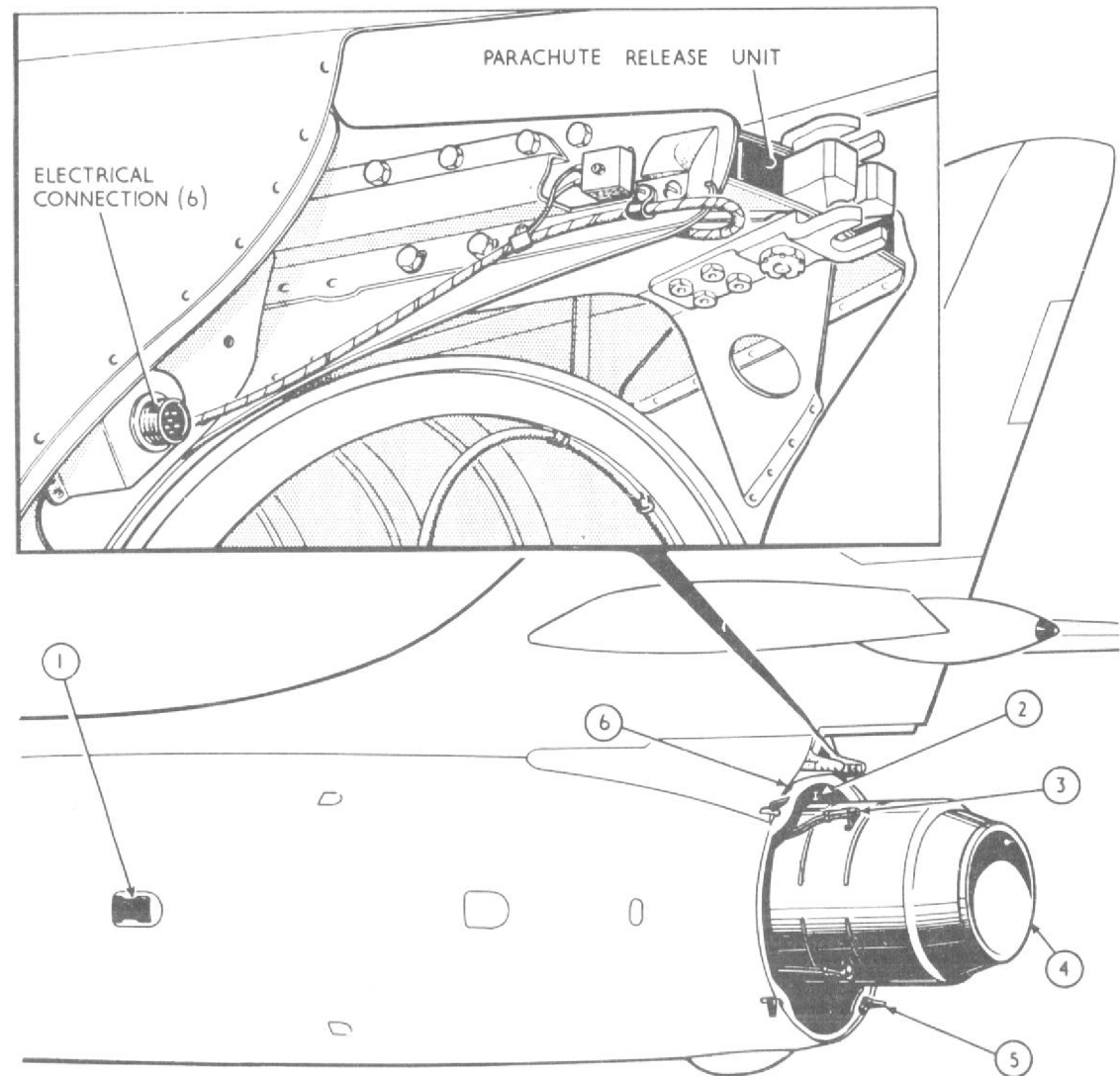


**Fig. 17. Securing engine rear roller on trolley**

**Jet pipe removal (fig. 18)**

**22.** 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) Remove the braking parachute (*detailed in Sect. 3*).
- (3) Render the aircraft electrically safe (*Sect. 5, Chap. 1*).
- (4) Remove the access door on the port side of the tail cone and unscrew the electrical connection (6).
- (5) Take the weight of the tail cone, release the four toggle fasteners (5) and remove the tail cone.
- (6) Remove the jet pipe access panels (1) port and starboard in the rear fuselage.
- (7) Dismantle the jet pipe coupling through the access doors in the engine casing (*as detailed in Sect. 3*).
- (8) Uncouple the eight thermocouple connections (3) at rear of jet pipe.
- (9) 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. 18 Jet pipe removal**

## ASSEMBLY

### General

**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 pressurisation system and the air pressure pipes of the fuel system, must be examined to ensure that they are free from foreign matter.
- (2) Before installing the engine examine the port and starboard side ventilating ducts, Pt. No. D.202818-9. Only ducts with the perforated end caps flanged over the sides of the ducts are to be fitted. Examine the rivets securing the attachment bracket, if the rivets are found to be loose a replacement duct must be fitted.
- (3) The clamp on the lower end of the engine starter exhaust pipe at frame 27 (*fig. 3*), must be slackened off when the engine is being installed in order to enable the upper end of the pipe to be aligned with the starter exhaust. A sighting door in the port side of the air intake inner skin, is provided to facilitate the alignment of the pipe with the starter exhaust connection.
- ◀ (4) It is essential that "Priming the fuel system" and "Fuel drainage check" (*fail-safe*) checks described in Appendix 1, be carried out after each engine removal, whenever the starter is changed, or where there has been any disturbance of the components of the starter fuel system. ▶
- (5) Before attempting to start the engine, check that the following pipe connections are tight:—
  - (a) Two connections on the starter ignition switch.

- (b) Three connections on the combined solenoid valve and H.P. switch unit.

- (c) The lower connection on the pump.

Ensure that the above connections are securely wire-locked, using 22 s.w.g. locking wire.

### Accessories gearbox

**24.** If the engine is already out of the airframe, the accessories gearbox should be installed first. Prior to, or immediately after installation, the drive arm and gearbox should be filled with oil up to the full mark on the dipstick. After the initial engine run, the oil level should be checked and, if necessary, the level topped up. The oil level should also be periodically checked in accordance with maintenance instructions. When installing the gearbox and drive shafts, care must be taken to ensure that the splines on the drive shafts are lightly smeared with grease to specification XG-271 and that the upper (*forward*) shaft is assembled with the master spline at both ends of the shaft correctly mated. A thin red line is painted on the master splines to facilitate this operation. When the gearbox is installed, a check should be made to ensure that the seal at frame 30 is correctly fitted. When new generators are to be fitted, reference should be made to the assembly Note contained in *fig. 2*.

### Accessories gearbox universal drive shaft couplings

**25.** The universal drive couplings in the drives between the engine and gearbox must be lubricated, through the grease nipples provided, and in addition, the internal spaces in the joints, including the holes through the spider arms, should be filled with grease, leaving no air pockets. The grease to be used for both operations must be to specification XG-271, and greasing is to be effected prior to assembly and thereafter on every occasion when the engine is removed.

### Engine controls—Teleflex cables and conduits

**26.** 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. A.P.1464D, Vol. 1 describes the Teleflex components.

### Liquid starter fuel tank (*fig. 3*)

**27.** The procedure for the removal of the tank is as follows:—

- (1) Defuel the aircraft (*Sect. 2, Chap. 2*).
- (2) Render the aircraft electrically safe (*Sect. 5, Chap. 1*).
- (3) Drain the tank via the drain plug.
- (4) Gaining access through the fuel tank vent connection access panels on the top of the fuselage in addition to the starter bay access panel from between frames 25 and 26 remove the following:—

Fuel tank vents.  
Fuel pipes.  
Liquid starter fuel and drain pipes.  
Ignition switch and bracket.  
Fire extinguishers and pipes.  
Junction box No. 1.

- (5) Free and stow clear any electrical cables.
- (6) Remove the bolts etc., securing the tank beam to frames 25 and 26, remove the nuts etc. securing the beam to the tank and remove the tank.

The assembly of the tank is the reverse of operations (1) to (6). Prior to assembly fit two new rubber washers (*Part No. F.202606*) on the tank support spigots. As assembly proceeds, the systems disturbed during removal must be tested for serviceability.

## APPENDIX 1

## I.P.N. (ISO-PROPYL NITRATE) STARTING SYSTEM

## LIST OF CONTENTS

	Para.		Para.		Para.
Introduction ... ..	1	Removal and installation		Starter motor	
Modification standard ... ..	6	General ... ..	18	Removal ... ..	29
<b>Servicing</b>		Fuel pump air blower and motor unit		Installation ... ..	30
General ... ..	7	Removal ... ..	19	<b>Safety discs</b>	
Examination for damage and security ... ..	8	Installation ... ..	20	Removal ... ..	31
Priming the fuel system ... ..	9	H.p. switch and solenoid valve assembly		Installation ... ..	32
Fuel drainage check ... ..	10	Removal ... ..	21	<b>Igniter cables</b>	
Fuel consumption check ... ..	11	Installation ... ..	22	Removal ... ..	33
Electrical checks ... ..	12	Ignition switch		Installation ... ..	34
Examine/clear combustion chamber		Removal ... ..	23	<b>Igniter plugs</b>	
nozzle plate drain hole ... ..	13	Installation ... ..	24	Removal ... ..	35
Flushing the atomizer air valve... ..	14	Ignition unit		Installation ... ..	36
Clean and examine the atomizer		Removal ... ..	25	<b>Atomizer</b>	
air valve ... ..	15	Installation ... ..	26	Removal ... ..	37
Clean and examine the air blower		Control unit		Installation ... ..	38
filter ... ..	16	Removal ... ..	27	<b>Fault diagnosis and rectification</b>	
Renew the air dump valve		Installation ... ..	28	General ... ..	39
seals ... ..	17				

## LIST OF TABLES

	Table.
Special tools, test equipment and materials ... ..	1
Torque loadings ... ..	2
Fuel consumption acceptance limits ... ..	3
Fault diagnosis and rectification ... ..	4

## LIST OF ILLUSTRATIONS

	Fig.		Fig.
Liquid fuel starter installation ... ..	1	Motor, air blower and fuel pump assembly mounting brackets ... ..	4
Removal/installation of atomizer, hoses and air valve ... ..	2	L.p. ignition switch installation ... ..	5
Motor, air blower and fuel pump ... ..	3	Sectional view of sheared safety disc ... ..	6
		Orientation of igniter plug ... ..	7



### Introduction

1. The IPN (iso-propyl nitrate) starting system consists of an engine mounted turbine (rotor) driven starter motor and aircraft mounted fuel and electrical components. The starter motor rotor is driven by the gas generated by the controlled ignition of IPN fuel (AVPIN) in the starter motor combustion chamber. The resultant drive is transmitted, via an epicyclic reduction gear, to the engine.

2. A full description and operating details of the system are given in AP.103D-0208-16A. The system operating cycle, once initiated by the engine starter button, is fully automatic. A control unit, containing a timing motor, energized via a speed control switch in the starter motor gearbox, determines the sequence of operation and will shut down the system in the event of component failure or malfunction. The operating cycle is terminated, at a pre-determined output shaft speed, by the speed control switch, or by a time switch in the control box.

3. The starter motor relies on the mono-fuel properties of the AVPIN fuel for its operation. This fuel contains sufficient oxygen to support combustion and will decompose under high pressure and temperature conditions, such as are created in the starter combustion chamber. At normal temperature and pressures the fuel burns readily when mixed with air.

4. The airframe mounted equipment controls the delivery of fuel to the starter motor combustion chamber and provides a supply of air, at the commencement of the operating cycle, for scavenging purposes. An ignition unit, energized via a fuel pressure operated ignition switch and connected to the starter motor igniters, provides initial combustion of the fuel.

5. Pressure fuel and air for the starter motor are provided by a combined fuel pump, air blower and motor unit. The pump is supplied with fuel from a special tank in the aircraft and delivers the fuel to the starter motor via a high pressure (h.p.) switch and solenoid valve assembly, and the ignition switch. Blower delivery air is piped direct to the starter motor.

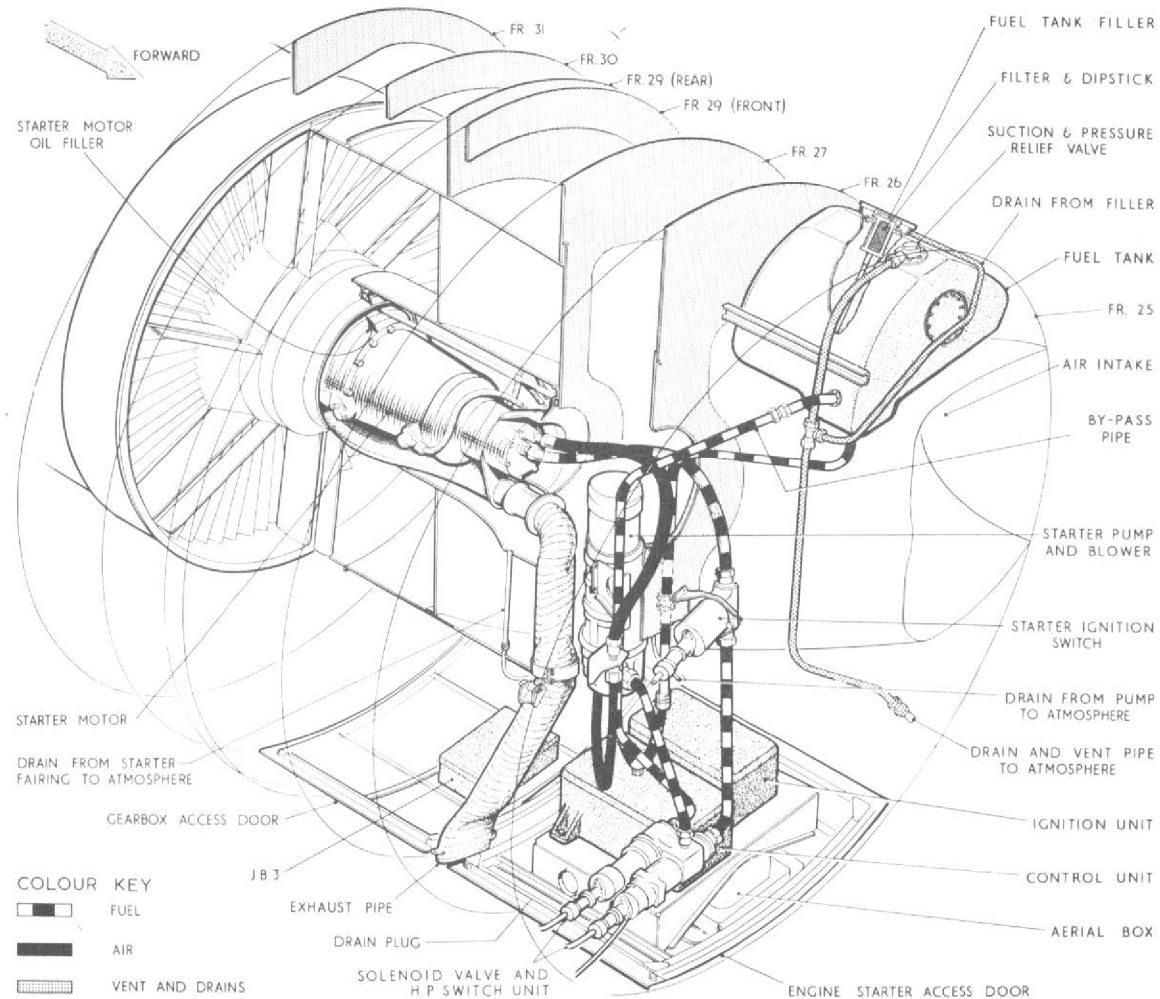


Fig.1 Liquid fuel starter installation



## Modification standard

6. This appendix is technically up-to-date in respect of the following modifications. Information on modification titles, classification categories and mark applicabilities can be obtained by reference to the engine/ECU/type Modification Lists.

130	160	196	S.229	S.306	S.808
131	162	198	S.235	S.311	S.816
136	163	203	S.238	S.312	S.817
137	166	204	S.243	S.314	S.840(0)
138	169	205	S.250	S.317	S.849
142	171	S.206	S.259	S.327	S.858(0)
145	172	S.207	S.260	S.329	S.862(0)
147	173	S.210	S.261	S.334	S.866(0)
148	176	S.211	S.277	S.371	S.880
149	186	S.212	S.278	S.464	S.883
151	187	S.215	S.279	S.634	S.889
152	190	S.223	S.281	S.646	S.913
153	192	S.224	S.285	S.647	S.938
154	193	S.225	S.288	S.670	S.954
155	194	S.227	S.291	S.671	S.963
158	195	S.228	S.305	S.714	S.967

## SERVICING

## General

7. (1) Reference in the text to special tools, test fixtures and materials is made by 'item' number details of which are given in Table 1.
- (2) Discard all tabwashers, 'O' ring seals, gaskets and locking wire on removal.
- (3) 'O' ring seals should be fitted in the dry condition and the exposed surfaces lubricated with grease, Table 1 item 4.
- (4) During assembly lubricate all threads with grease, Table 1 item 3.

TABLE 1

## Special tools, test equipment and materials

Item	Ref.No.	Part No.	Description
1	5G/1621	-	Insulation resistance tester
2	-	558-2-01663	Special spanner - air valve sleeve
3	34B/9100528	-	Grease ZX-13 (NATO code S-720)
4	33H/9424829	-	Grease XG-250 (NATO code S-736)
5	34A/9423147	-	AVPIN fuel
6	30A/9437135	-	Locking wire DTD189 (22 S.W.G.)
7	33D/2201949	-	Trichloroethane
8	34A/9100591	-	Oil OX 38 (NATO code 0-149)
9	34A/9100552	-	Oil OM 170 (NATO code 0-115)
10	-	-	Acetone
11	33E/1322	-	Cleaning fluid - Methyl-ethyl-ketone

## Examination for Damage and Security

8 Examine and rectify as follows:-

- (1) Remove light corrosion
- (2) Reprotect exposed surfaces
- (3) Tighten loose nuts, bolts and screws
- (4) Renew damaged pipes
- (5) Renew faulty locking devices

TABLE 2

## Torque loadings

Item	Torque load
Safety disc holder	384 lb.f.in.
Atomizer securing bolts	180 lb.f.in.
Igniter securing bolts	32 to 35 lb.f.in.
Combustion chamber securing nuts/bolts	216 lb.f.in.
Fuel-pipe-to-atomizer bolts	100 lb.f.in.
Air pipe securing bolts	180 lb.f.in.

## Priming the fuel system

9. (1) Top up the fuel tank, to the upper mark on the dipstick, through the filter in the filler neck, with clean fuel, Table 1 item 5.
- (2) Disconnect the 2-pin plug from the ignition unit (located on the starter access door), then connect a 24V lamp to the plug; this will render the ignition system inoperative and provide an indication of the fuel pressure in the pipe line to the atomizer.
- (3) Connect an electrical supply to the aircraft and adjust the input to between 23 and 26V d.c. on load.

## Note . . .

Ensure that the input voltage is maintained within the specified limits during operation of the starting system. High or low input will give incorrect fuel drainage.

- (4) Position a clean container under the exhaust outlet.

(5) Depress the starter button to effect a simulated start; observe the lamp and check that:—

- (a) A full airflow is evident at the starter exhaust for approximately three seconds.

Note . . .

*Negligible airflow and audible indication that the air motor is labouring indicates a sticking atomizer air valve. The valve should be removed and cleaned as detailed in para.15.*

#### WARNING

Under no circumstances must the air valve be flushed out in-situ at this stage.

- (b) The fuel pump air blower and motor unit shuts down at the end of the three second air cycle.

(c) Pre-mod S647: The control box timer stops approximately 18 seconds after operation of the starter button.

- (d) When the lamp is illuminated, fuel drains from the starter exhaust.

Note . . .

*Where fuel drains from the starter exhaust but the lamp does not light up, a faulty l.p. switch and/or associated wiring is indicated.*

#### WARNING

Where the lamp is illuminated but no fuel drains from the starter exhaust, the nozzle plate drain hole must be examined and cleared as detailed in Para.13.

- (6) Repeat (5) as necessary, at one minute intervals until fuel drains from the exhaust; check the system for fuel leakage.

#### WARNING

Where more than four simulated starts are required before fuel drains from the starter exhaust, the nozzle plate drain hole must be examined and cleared as detailed in Para.13.

- (7) Effect a fuel drainage check as detailed in para.10.

#### Fuel Drainage Check

##### 10.

#### WARNINGS . . .

(1) This check must not be effected until a minimum cooling period of one hour has elapsed since an attempted start during which combustion occurred.

(2) An observer must not be positioned in the engine air intake or in the vicinity of the starter until two drainage checks (sub-para.3) have been effected satisfactorily. The third check must be carried out within thirty minutes of second satisfactory fuel drainage check.

- (1) Top up, connect the 24V lamp and the ground electrical supply as detailed in para.9, sub-para. (1) to (3).

(2) Position a clean container (calibrated in cubic centimetres) under the exhaust outlet.

(3) Effect a simulated start and check as detailed in para.9, sub-para. (5). Measure and record the quantity of fuel drained and check that approximately three quarters of the total fuel drainage occurs in the first 10 to 30 seconds, the remainder, other than odd drops, during the next minute. The total fuel drained should be between 80 and 110 cm<sup>3</sup>.

Note . . .

*Where the fuel drainage does not follow the correct pattern, in that the drainage stops early or continues to drip steadily, or, is less than the specified minimum, a blocked nozzle plate drain hole is indicated.*

#### WARNING

A blocked nozzle plate drain hole constitutes a serious hazard. Under no circumstances must a start be attempted until the drain hole has been cleared as detailed in para.13.

- (4) Repeat (3) twice. During the last check, which must be effected within thirty minutes of the second satisfactory check, an observer must be positioned in the engine air intake. The observer is to visually check for fuel leaks during this check paying particular attention to fuel pipe/atomizer and exhaust muff coupling joints for leaks. Any fuel leakage detected is to be rectified.

Note . . .

*Check that the quantity of fuel drained, on each of the three runs, does not vary by more than 20 cm<sup>3</sup>.*

#### WARNING

Under no circumstances must a start be attempted if the quantity of fuel drained, or the drainage pattern is other than specified.

- (5) Remove all traces of fuel from the starter exhaust, then remove the container.

(6) Disconnect the lamp, then connect the 2-pin plug to the ignition unit.

#### Fuel Consumption Check

11. This check provides a guide to the overall efficiency of the system and the results obtained should be recorded.

- (1) Top up the fuel tank, through the filter in the filler neck, with clean fuel, Table 1 item 5, to the upper mark on the dipstick. Note contents accurately.

(2) Connect a suitable voltmeter across the fuel pump, air blower and motor unit supply leads at a convenient position as near the motor as possible.

(3) Effect a start; note the duration, in seconds, of starter combustion and the voltmeter reading during combustion.

(4) Measure the quantity of fuel, in  $\text{cm}^3$ , required to replenish the tank to the original level [sub-para. (1) ].

(5) Calculate the fuel consumption per second and compare the figure obtained with the value given in Table 3.

$$\text{Consumption per sec (cm}^3/\text{S)} = \frac{\text{Fuel required to replenish tank}}{\text{Duration of combustion}}$$

TABLE 3

## Fuel consumption acceptance limits

Electrical input on load V d.c.	Fuel consumption rate	
	Min.	Max.
	$\text{CM}^3/\text{S}$	$\text{CM}^3/\text{S}$
16	285	365
20	330	410
26	370	420

## Electrical Checks

12. Whenever the IPN electrical system has been disturbed, check the relevant circuits for continuity and, using tester, Table 1 item 1 check that the insulation resistance is not less than 5 megohm. Refer to wiring diagram (Sect. 5, Chap.1, Group C1).

## Examine/clear combustion chamber nozzle plate drain hole

13. (1) Remove both safety discs from the combustion chamber as detailed in para.31, sub-para. (1) (2) and (3), then using a suitable probe torch examine the combustion chamber for fuel.

(2) Where fuel is present, using a suitable wire, clear the nozzle plate drain hole.

(3) Ensure that all fuel is drained from the combustion chamber, then install the safety discs as detailed in para.32.

(4) Carry out a fuel drainage check as detailed in para.10.

## Flushing the atomizer air valve.

14. Where a sticking atomizer air valve has been diagnosed as a cause of failure to start the following method may be used to free the valve.

## Note . . .

*This method must not be used when the fault is diagnosed during, and as a result of, priming the fuel system.*

(1) Disconnect the atomizer air supply pipe from its connection at the bracket adjacent to the motor mounting.

(2) Using suitable equipment, apply an air pressure of  $10 \text{ lb/in}^2$  to the atomizer air supply pipe.

(3) Gradually increase the pressure until the air valve opens; release the pressure.

(4) Disconnect air supply, raise the atomizer air supply pipe end up to the starboard wing tank relief valve access panel (second panel from the cabin) and using a funnel prime the pipe with  $50 \text{ cm}^3$  of boiling water. Reconnect the air supply.

## Note . . .

*Accurate measurement of the water is essential. Use of an excessive volume of water will increase the risk of a blocked nozzle plate drain hole due to dislodged carbon.*

(5) Momentarily pressurize the air supply pipe to ensure that the water reaches the air valve, then allow to soak for 15 minutes.

(6) Apply a pressure of  $30 \text{ lbf/in}^2$  to the air supply pipe for one minute to expel the water through the starter motor.

(7) Disconnect the air supply and reconnect the atomizer air supply pipe; lock with locking wire.

(8) Carry out a fuel drainage check once only as detailed in para.10 sub-para. (1), (2), (3), (5) and (6); the quantity of fuel drained must not be less than  $40 \text{ cm}^3$ .

(9) Where the fuel drainage is less than  $40 \text{ cm}^3$  repeat (8) only once.

## CAUTION . . .

*If the fuel drainage is not satisfactory at this stage a blocked nozzle plate drain hole is indicated; the drain hole must be examined/cleared as detailed in para.13.*

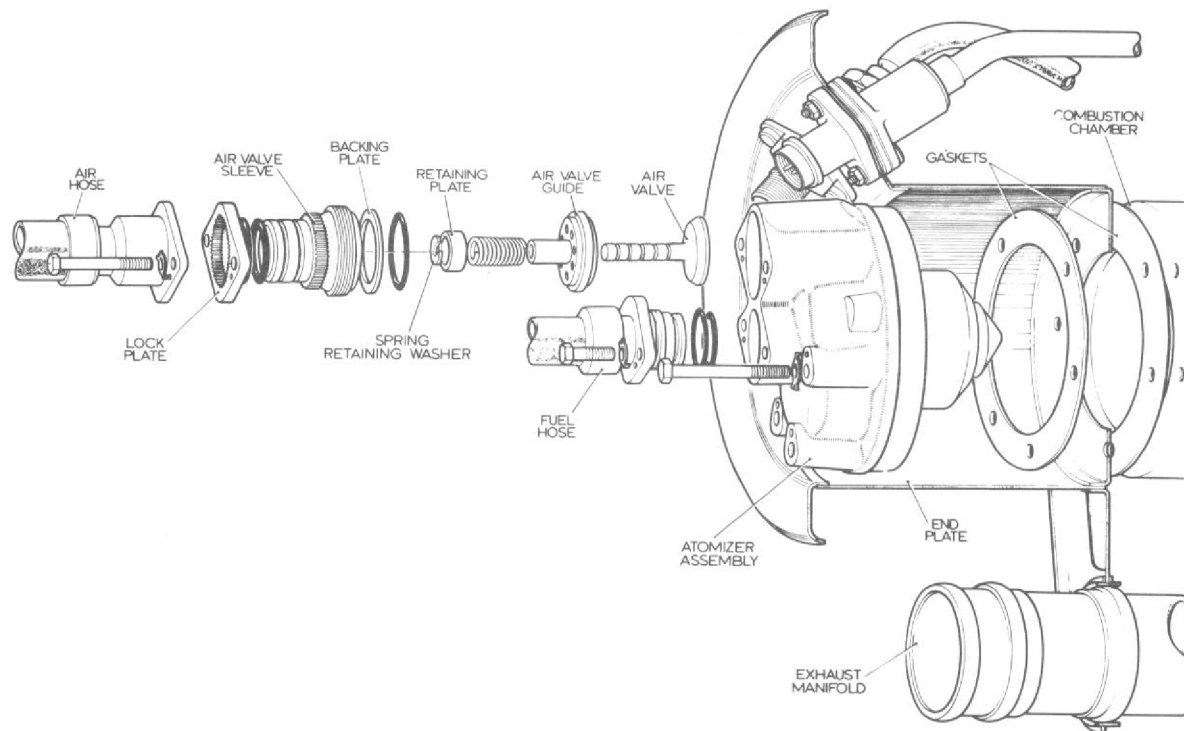


Fig.2 Removal/installation of atomizer, hoses and air valve.

**Clean and examine the atomizer air valve.**

15. Where a sticking atomizer air valve has been diagnosed during priming, or where persistent valve sticking occurs, the following method should be used to free the valve.

(1) Remove the engine as detailed in Sect.4, Chap.1.

(2) Unlock and remove the bolts securing the air hose to the atomizer, then remove the hose; remove the air valve lock plate.

(3) Remove and discard the 'O' ring seals from the air valve sleeve then, using special spanner, Table 1 item 2, remove the sleeve.

(4) Remove the backing plate then remove and discard the 'O' ring seal.

(5) Remove the air valve assembly.

(6) Depress the air valve spring and remove the retaining washer; remove the retaining plate and separate the air valve, guide and spring.

(7) Immerse the air valve, guide and spring in boiling water and wash off the fuel deposits; dry with clean dry compressed air.

(8) Examine the air valve; flaking of the PTFE coating or damage to the valve seat

will entail rejection of the valve and the guide.

(9) Examine the spring. Damage or distortion will entail rejection.

(10) Position the air valve in the guide, then locate the spring, over the stem, in the guide.

(11) Position the retaining plate, flange first, on the spring, then depress the plate and fit the retaining washer to the groove in the valve stem.

(12) Release the retaining plate ensuring that the washer locates in the bore of the plate.

(13) Position the air valve assembly, seat first in the atomizer air inlet port, then locate the 'O' ring seal in the recess formed round the valve guide.

(14) Position the backing washer on the seal and secure with the valve sleeve.

(15) Using special spanner, Table 1 item 2, fully tighten the sleeve, then locate the lock plate, spigot first and bolt holes aligned, on the valve sleeve splines.

(16) Fit the two 'O' ring seals to the air valve sleeve, then assemble the air hose to the sleeve and fit the bolts and new tab-washers.

(17) Torque tighten the bolts to the specified figure (Table 2) then lock by bending up the tabwashers.

(18) Install the engine as described in Sect.4, Chap.1.

#### Clean and examine the air blower filter (fig.3)

16. (1) Remove the fuel pump air blower motor unit as detailed in para.19.

(2) Remove the screws and washers securing the frame, then remove the frame, cover and filter gauze.

(3) Clean the filter gauze in cleaning fluid, Table 1 item 11, then dry with clean dry compressed air.

(4) Examine the filter gauze; damage and/or corrosion will entail rejection.

(5) Position the cover and the filter gauze in the frame, then locate the frame on the air blower inlet port.

(6) Secure the frame with the screws and spring washers; fully tighten the screws.

(7) Install the fuel pump, air blower motor unit as detailed in para.20.

#### Renew the air dump valve seals (fig.3)

17. (1) Remove fuel pump air blower motor unit as detailed in para.19.

(2) Unlock and remove the screws securing the valve cap to the fuel pump housing, then remove the valve cap, guide spring and dump valve; remove the 'O' ring seal from the valve.

(3) Remove the valve seat, then remove the 'O' ring seal from the seat.

(4) Using a clean, non-fluffy cloth moistened with trichloroethane Table 1 item 7, clean the components.

#### Note...

*Care must be exercised to avoid damaging the rubber seat in the air dump valve during this operation.*

(5) Examine the components for damage and corrosion; either of these faults will entail rejection.

(6) Fit the 'O' ring seals to the valve seat and the stem of the valve.

(7) Position the valve seat, spigot first, in the pump housing then locate the valve, stem first, in the pump housing.

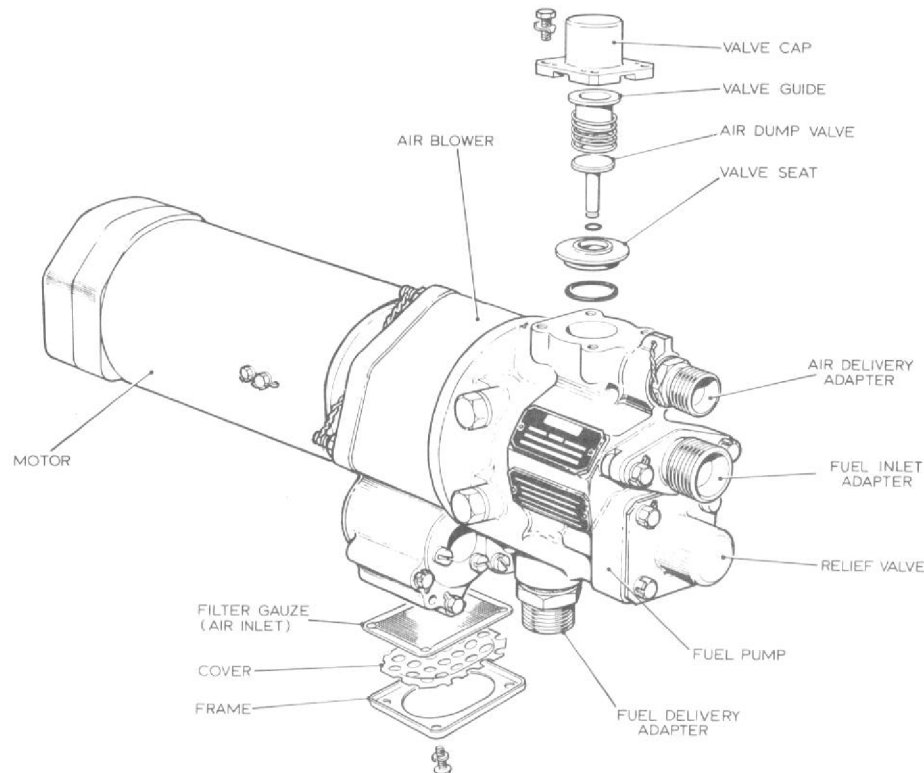


Fig.3 Motor, air blower and fuel pump

(8) Position the valve guide, flange first, in the valve cap, then locate the spring on the guide.

(9) Assemble the valve cap, complete with guide and spring, to the pump housing, fit the screws and tabwashers and finger tighten screws.

(10) Ensure the gap between the valve cap flange and the pump body is equal at all four screw positions.

(11) Fully tighten the screws progressively and in diametrically opposed sequence, ensuring that the flange gap is maintained and equal. Bend up the lock tabs.

(12) Install the fuel pump air blower unit as detailed in para.20.

#### REMOVAL AND INSTALLATION

##### General.

18. Prior to disconnecting or connecting electrical cables the aircraft must be rendered electrically safe (Sect.5, Chap.1, Group A1). On disconnecting electrical cables ensure that the cable ends and component terminals are suitably protected by fitting approved caps or polythene bags (Ref.No. 32B/1135-1138). Before disconnecting fuel pipes drain the starter fuel tank via the drain plug in the fuel pipe adjacent to the bottom of the fuel pump air blower and motor unit. After draining fit, tighten and wire-lock drain plug. Open ends of pipes and component open connections must be blanked off with approved caps or blanks.

##### Fuel pump air blower and motor unit

##### Removal

19. (1) Disconnect electrical cables from fuel pump motor, mounted on the front face of frame 27, and tie clear.

(2) Remove the locking wires and disconnect the fuel and air pipes from the unit. Slacken other ends of pipes and move clear.

(3) Remove the locking wire and disconnect the drain pipe from the unit. Move pipe clear.

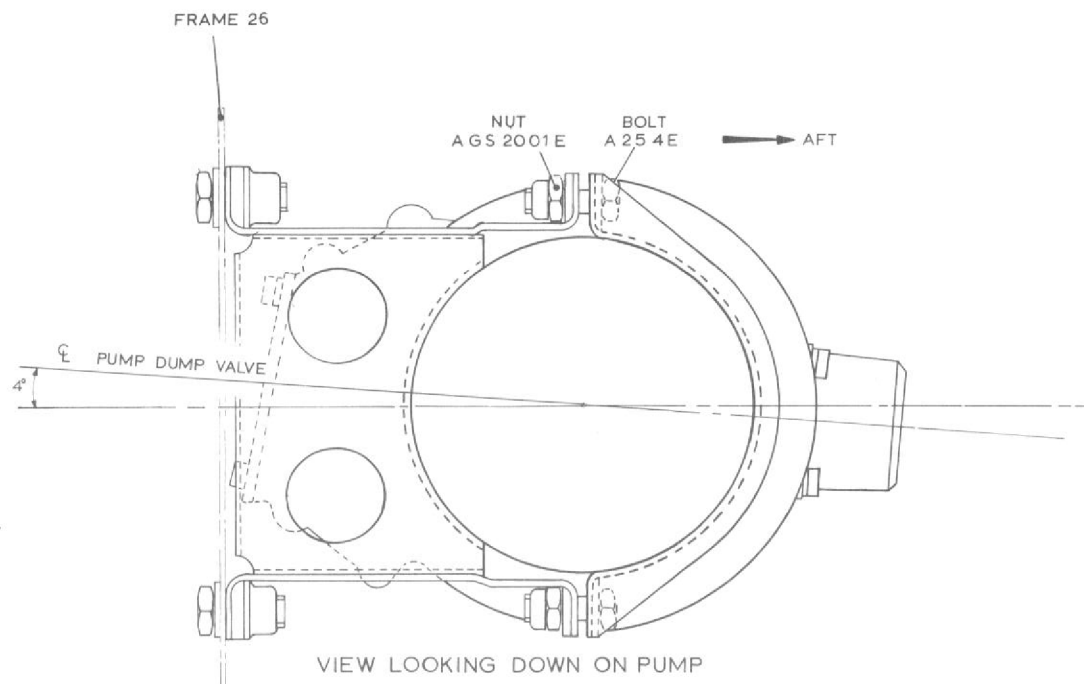


Fig.4 Motor, air blower and fuel pump assembly mounting brackets.

##### Installation

20. (1) Remove the bolts securing the terminal cover, then remove the cover.

(2) Using insulation tester, Table 1 item 1, check that the resistance between the motor terminals and the casing is not less than 0.5 megohms.

##### CAUTION...

*On no account should the unit be run prior to installation as this may damage the fuel pump.*

(3) Ensure that banjo body, banjo bolt and washer are fitted to the drain connection.

(4) Offer unit to mounting bracket, ensuring that the fuel pump dump valve

cap faces aft and is clear of the exhaust pipe i.e. offset to port as shown in fig.4. Fit clips and secure with nuts and bolts.

(5) Re-connect fuel, air and drain pipes. Tighten and re-lock connections using stainless steel locking wire.

(6) Ensure that redundant connections are blanked off.

(7) Re-connect electrical cables to pump motor terminals.

(8) Restore electrical services to normal.

(9) Effect a fuel drainage check as detailed in para.10, sub-para. (1), (2) and (3) and check for leaks.



**H.p. switch and solenoid valve assembly.****Removal**

21. (1) Disconnect electrical cables from h.p. switch and solenoid valve assembly, mounted on the aft face of frame 25, and tie clear.

(2) Disconnect all pipes from the assembly, slacken other ends of pipes and move clear.

(3) Remove the two bolts securing the assembly to the mounting.

**Installation**

22. (1) Remove the dust caps from electrical connections

(2) Using insulation tester, Table I item 1, check that the resistance between each plug pin and the frame and between pins A and C of the h.p. switch connection is not less than 5 megohms.

(3) Remove the dust caps from the inlet and outlet connections.

(4) Attach to mounting on frame 25 with bolts and washers. Ensure that a locking lug is fitted to the upper bolt.

(5) Re-connect all pipes, tighten and re-lock connections with stainless steel wire.

(6) Re-connect electrical cables to the assembly.

(7) Restore the electrical services to normal.

(8) Prime the fuel system as described in para.9 and check for leaks.

**Ignition switch****Removal**

23. (1) Disconnect electrical cable from l.p. ignition switch, mounted on a bracket on the front face of frame 26 and tie clear.

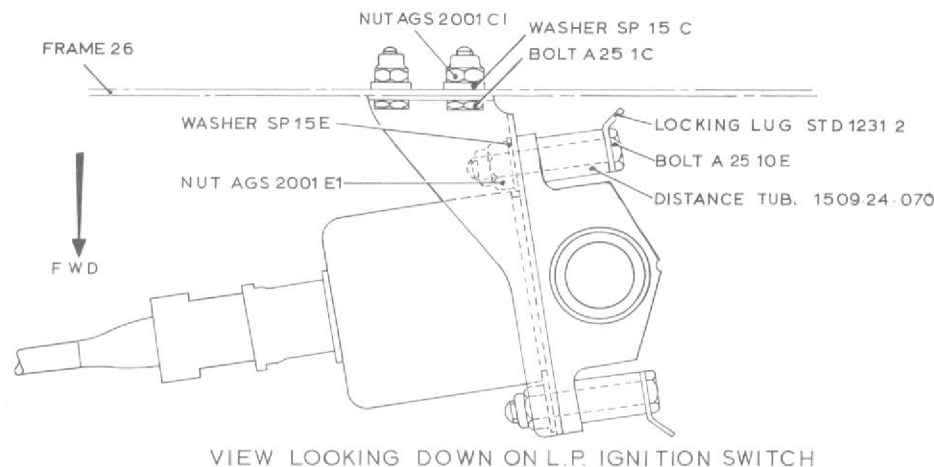


Fig.5 L.p. ignition switch installation

(2) Remove the locking wires and disconnect the fuel pipes from the switch. Slacken other ends of pipes and move clear.

(3) Remove two bolts, etc. securing the switch to the mounting bracket.

(4) Apply an air pressure of 70 lbf/in<sup>2</sup>, then release the pressure.

(5) Repeat (4) four times.

(6) Apply a gradually increasing air pressure and check that the circuit is broken between pins A and B and made between pins A and C, at between 40 and 45 lbf/in<sup>2</sup>.

(7) Decrease the pressure to 20 lbf/in<sup>2</sup>; check that continuity is restored between pins A and B, then release the pressure and remove the test equipment.

(8) Fit the switch to the mounting bracket as shown on fig.5.

(9) Re-connect fuel pipes, tighten and wire-lock connections with stainless steel locking wire.

(10) Re-connect electrical cable.

(11) Prime the system as detailed in para. 9 and check for leaks.

**Installation**

24. (1) Remove the dust cap from the electrical connection then, using insulation tester, Table I item 1, check that the resistance between each plug pin and the frame and between pins A and C is not less than 5 megohms.

(2) Remove the dust caps from the inlet and outlet connections, then suitably blank the outlet connection and connect the inlet to a low pressure air supply.

(3) With no air pressure applied check for continuity between pins A and B.

**Ignition unit  
Removal**

**WARNING ...**

Between switching off and commencing work on the unit, a minimum period of two minutes must elapse to allow the capacitors to discharge.

25. (1) Disconnect the electrical cables from the ignition unit mounted on the inside of the starter access door.
- (2) Remove the three bolts securing the unit to the door, remove unit and ensure washers between unit and door are retained for subsequent installation.

**Installation**

26. (1) Fit the unit on the inside of the starter access panel using bolts (Pt. No. A. 25 3E), ensure that washers (Pt. No. SP. 16 E) are fitted between unit and door.
- (2) Remove protective covers from the electrical connections and cables. Re-connect cables to unit.

**WARNING ...**

Under no circumstances must the unit be energized without the igniters connected.

**Control unit  
Removal**

27. (1) Disconnect the electrical cables from the control unit mounted on the inside of the starter access door.
- (2) Remove the four bolts securing the unit to the door, remove unit and ensure washers between unit and door are retained for subsequent installation.

**Installation**

28. (1) Remove the dust caps from the electrical connections.

- (2) Pre-mod S647 units only; carry out the following check.

- (a) Connect pin A of the 2-pin plug, via a suitable 'normally open' switch, to pin A of the red 4-pin plug.
- (b) Connect a 24V d.c. electrical supply, positive to pin A, to the 2-pin plug.
- (c) Momentarily close the switch; check that the time switch motor runs for approximately 18 seconds, then stops.
- (d) Remove the test equipment.

- (3) Fit the unit on the inside of the starter access panel using bolts (Pt. No. A. 25 3E), ensure that washers (Pt. No. SP. 16 E) are fitted between unit and door.
- (4) Effect a fuel drainage check as detailed in para.10.

**Starter motor  
Removal**

29. (1) Remove or roll out the engine as detailed in Sect.4, Chap.1.
- (2) While supporting the starter motor remove the bolts securing the motor to the engine and remove the starter motor.
- (3) Remove the drive coupling from the motor (if necessary) and refit to engine.
- (4) Remove the air hose from the atomizer by unlocking and removing the bolts securing the hose to the atomizer.
- (5) Remove the fuel hose from the atomizer by unlocking and removing the bolts securing the hose to the atomizer.
- (6) Fit protective covers and blanks to the mounting flange, fuel inlet, air inlet,

exhaust, igniter cable and speed probe cable connections.

**Installation**

30. (1) Remove the dust caps.
- (2) Check the output shaft for freedom of rotation.
- (3) Using tester, Table 1 item 1, check that the insulation resistance between the speed control plug pins and the frame is not less than 5 megohms at 500V d.c.
- (4) Disconnect the cables from the igniter plugs then, using tester, Table 1 item 1, check that the insulation resistance between the conductor and braiding is not less than 5 megohms at 500V d.c. reconnect the cables then using locking wire, Table 1 item 6, lock the cable connectors to the plugs.
- (5) Check for continuity between the control plug pins.
- (6) Unlock and remove the oil filler plug and drain the starter motor of inhibiting oil; discard the tabwasher and temporarily refit the plug.
- (7) Check that the oil feed hole in the mounting flange is clear.
- (8) Prior to fitting fuel and air hoses suitably blank one end of each hose.
- (9) Connect each hose, in turn, to a suitable rig filled with oil, Table 1 item 9, and pressurize as follows:

(a) Air hose	200 lbf/in <sup>2</sup>
(b) Fuel hose	1 250 lbf/in <sup>2</sup>
- (10) Check hoses for leakage over a period of two minutes; no leakage is permissible.
- (11) Release the pressure then disconnect the hose from the pump.

(12) Flush the hoses with acetone, Table 1 item 10; then fit them to the starter motor Para.15, sub-para. (16) and (17) detail the procedure for fitting the air hose.

(13) Remove the drive coupling from the engine, fit on to the starter motor output shaft. Fit the starter motor on to the engine whilst engaging the drive coupling with the engine, lubricate bolt threads with oil OX-38, then fit and tighten to a torque load of 235 lb.f.in.

**Note...**

*Ensure that the oil feed hole aligns with the corresponding hole in the engine and gasket.*

(14) Prime the oil system

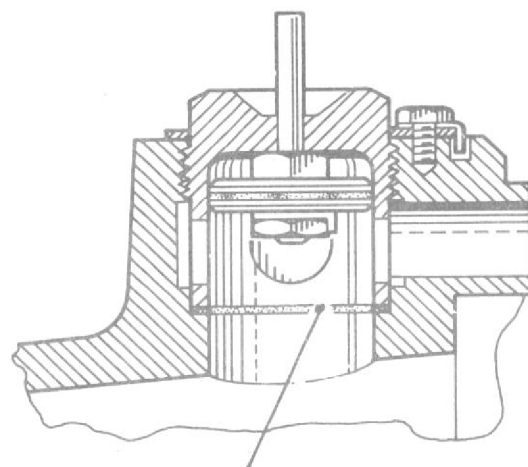
(a) Remove the oil filler plug, then using a suitable syringe inject 100 cm<sup>3</sup> of oil, Table 1 item 8 into the starter gearbox.

(b) Fit a new 'O' ring seal to the oil filler plug, then fit the plug and a new tabwasher.

(c) Fully tighten the filler plug, then lock by bending up the tabwasher.

(15) Install the engine as described in Sect.4, Chap.1.

(16) Prime the fuel system as detailed in para.9.



SHEARED PORTION OF DISC

2231

Fig.6 Sectional view of sheared safety disc

**Safety discs (fig.6)**

**Removal**

**CAUTION...**

*Safeguard all tools and parts removed to prevent them falling into the engine.*

31. (1) Enter the air intakes and remove access panels from air intake inner skins.

(2) Unlock and remove the safety disc locking screws.

(3) Remove the star locking washers, then remove the disc holders.

(4) Remove the sheared outer edge of the discs from the seatings in the combustion chamber, then remove any carbon deposits from the seatings.

**Note...**

*Care must be exercised to avoid damaging the seatings during this operation.*

(5) Take the disc holders to the bench.

(6) Remove and discard the discs from the holders.

**Installation**

**Note...**

*On completion, an independent check should be carried out to ensure that no foreign objects have been left in the air intakes or have dropped into the engine.*

32. (1) Position the safety disc, stem first in the holder.

(2) Apply an even coating of grease, Table 1 item 3, to the threads of the holder.

(3) Then enter the air intakes and install the holders in the combustion chamber and torque tighten to the specified figure (Table 2).

(4) Position the star locking washer, aligning the locking screw hole, on the holder and secure with the locking screw and tabwasher.

(5) Fully tighten the screw and lock.

(6) Refit access panels on inner skins of air intake.

(7) Thoroughly examine the engine to ensure that nothing has dropped into the engine. Then remove all tools etc. from the air intakes.

**Igniter cable(s)****Removal**

33. After removing the engine (Sect.4, Chap. 1) proceed as follows:—

- (1) Cut the locking wire and remove the cable(s) from the end plate connector.
- (2) Cut the locking wire and remove the cable(s) from the igniter plug(s).

**Installation**

34. The cables should be installed prior to engine installation as follows:—

- (1) Assemble the cable(s) to the end plate connector(s) and fully tighten.
- (2) Using wire, Table 1 item 6, wirelock the cables to each other.
- (3) Assemble the cable(s) to the igniter plugs and fully tighten.
- (4) Using wire, Table 1 item 6, wirelock the cable(s) to the lug(s) provided on the igniter plug(s).

**Igniter plug(s)****Removal****Note . . .**

*Safeguard all tools and parts removed to prevent them falling into the engine.*

35. (1) Enter air intakes and remove access panels from inner skins of air intake.
- (2) Unlock and remove the cable connector from the igniter plug.
- (3) Note the angular relationship of the igniter cap to the combustion chamber, then unlock and remove the securing bolts.

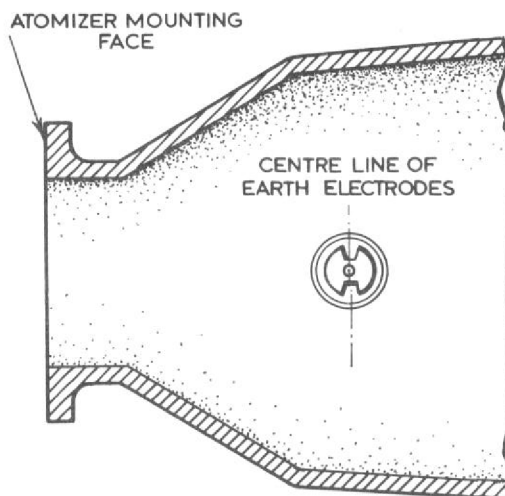


Fig.7 Orientation of igniter plug.

- (4) Remove the igniter plug, then remove the gasket.

**Note . . .**

*Two 2BA tapped holes are provided in the body flange for extraction purposes.*

- (5) Secure the plug body to the plug cap with the transportation nuts and bolts.

**Installation****Note . . .**

*On completion an independent check should be carried out to ensure that nothing has been left in the air intakes or dropped into the engine.*

36. (1) Remove the transportation nuts and bolts, then separate the plug cap from the plug body.

- (2) Position the gasket on the plug body, then insert the body with the earth electrodes positioned at right-angles to the starter axis as shown in fig.7.

- (3) Position the plug cap, orientated as noted in para. 35 (3), on the body and secure with the bolts and tabwashers.

- (4) Torque tighten the bolts to the specified figure (Table 2) and lock by bending up the tabwashers.

- (5) Assemble the cable connector to the igniter plug and fully tighten.

- (6) Using wire, Table 1 item 6, lock the cable connector to the plug.

- (7) Refit access panels on inner skin of air intakes.

- (8) Thoroughly examine the engine to ensure that nothing has dropped into the engine and remove all tools, etc. from the air intakes.

**Atomizer (Fig.2)****Removal**

37. After removing the engine (Sect.4, Chap. 1) the atomizer is removed as follows:—

- (1) Unlock and remove the bolts securing the air hose to the atomizer, then remove the hose.

- (2) Unlock and remove the bolts securing the fuel hose to the atomizer, then remove the hose.

- (3) Unlock and remove the bolts securing the atomizer, then withdraw the atomizer from the combustion chamber.

(4) Remove and discard the atomizer gasket.

(5) Fit the fuel port, air valve and atomizer dust covers and secure with the nuts, bolts and packing pieces.

#### Installation

38. The atomizer should be installed prior to engine installation as follows:—

(1) Check that the nozzle plate drain hole in the combustion chamber is completely clear, then using a suitable suction type cleaner remove any loose carbon from the chamber.

(2) Remove the nuts, bolts and packing pieces securing the dust covers, then remove the covers.

(3) Assemble the atomizer, interposing the gasket to the end plate, and secure with the bolts and tabwashers.

#### Note ...

*The air valve is located adjacent to the speed control cable plug.*

(4) Ensure that the 'O' ring seals are located in their recesses provided and the locking plate is located on the air valve sleeve and aligned with the bolt holes, then assemble the air hose to the sleeve and secure with the bolts and tabwashers.

(5) Torque tighten the atomizer and air hose retaining bolts to the specified figure (Table 2).

#### Note ...

*The bolts must be tightened evenly, in turn, to avoid distortion of the atomizer.*

(6) Fit the 'O' ring seals to the fuel hose, then assemble the hose to the atomizer and secure with the bolts and tabwashers; torque tighten the bolts to the specified figure (Table 2).

#### FAULT DIAGNOSIS AND RECTIFICATION

##### General

39. Faults which may be encountered during service are listed in Table 4 together with their possible causes and the appropriate remedial action to be effected. In the Table no account is taken of incorrect supply voltage, faulty installation or obvious defects.

*(Continued overleaf)*

**TABLE 4**  
**Fault diagnosis and rectification**

Fault	Cause	Remedy
Starting system fails to operate on selection.	No supply to control unit.	Check 10 amp. fuse; renew if necessary. If fuse blows on subsequent start, refer to '10 amp fuse blows during starting cycle'. Refer to the aircraft wiring diagram (Sect.5, Chap.1, Group C1) and check the supply to the control unit and the start button circuit. Rectify if necessary.
	Speed control switch open circuit	Disconnect the lead from the control unit blue four pole plug, then check for continuity between the lead sockets A and D. If satisfactory reconnect socket. If an open circuit is indicated, check the wiring between the socket and the speed control switch; rectify as necessary. If the wiring is satisfactory, reject the starter motor for a faulty speed control switch.
	Faulty control unit	Disconnect the LT supply lead at the ignition unit, then select a start and check that the control unit time switch motor can be heard running. If faulty, reject the control unit. Connect a suitable circuit tester across the motor contactor LT terminals then select a start. A live circuit should be indicated during the control unit cycle.  If a dead circuit is indicated, check the wiring to the contactor rectify as necessary. If the wiring is serviceable, reject the control unit.
	No supply to fuel pump, air blower and motor unit.	Refer to the aircraft wiring diagram (Sect.5, Chap.1, Group C1). Check the power supply to the contactor and the motor terminal, rectify as necessary.
	Faulty motor contactor	Refer to A.P.4343D, Vol.1, Book 2, Sect.10. Function check the contactor, reject if faulty.
	Faulty fuel pump, air blower and motor unit.	Reject fuel pump, air blower and motor unit.
10 amp. fuse blows during starting cycle	Short circuit	Refer to the aircraft wiring diagram (Sect.5, Chap.1, Group C1). Disconnect as necessary and check the aircraft wiring for a short to earth. Rectify as necessary.
	Faulty h.p. switch or solenoid valve.	Check the insulation resistance between pins A and C on the h.p. switch. Check the solenoid valve insulation resistance. If faulty reject h.p. switch and solenoid valve assembly.
	Faulty H.T. lead/igniter	Disconnect as necessary and check leads and igniters for a short to earth. Reject faulty components.
	Faulty control unit	Substitute the control unit for one of known serviceability, then attempt a start. If satisfactory, reject original control unit.
	Faulty ignition unit.	Reject.



## RESTRICTED

TABLE 4 (Contd).

Fault	Cause	Remedy
Starting system shuts down on release of start button.	Faulty aircraft wiring	Refer to the aircraft wiring diagram (Sect.5, Chap.1, Group C1). Check the wiring between the motor contactor positive terminal and the h.p. switch lead socket A; h.p. switch lead socket B and the ignition switch lead socket A; the ignition switch lead socket B; and the control unit red lead socket D. Renew faulty wiring as necessary.
	Faulty h.p. switch	Using a 500V megger, check that the insulation resistance between each plug pin and the frame and between pins A and C is not less than 5 megohms. Check for continuity between pins A and B. If faulty reject the h.p. switch and solenoid valve assembly.
	Faulty ignition switch	Using a 500V megger, check that the insulation resistance between each plug pin and the frame and between pins A and C is not less than 5 megohms. Check for continuity between pins A and B. If faulty, reject the ignition switch.
	Control unit	Reject control unit.
Starter motor fails to light up (systems shut down after 3 seconds).	Low aircraft supply voltage	Rectify as necessary.
	Empty fuel tank	Check fuel contents; top up, if necessary.
	Leaking fuel system	Carry out a fuel drainage check. Record the amount of fuel drained from the starter motor exhaust and check the system for leaks; rectify leaks as necessary. If the fuel drainage is less than the specified minimum and no leaks are found, refer to 'Fuel drainage less than specified minimum'.
	Sticking atomizer air valve.	Disconnect the L.T. supply at the ignition unit, then select a start. Check that the motor unit runs normally with no audible indication of labouring and that air flows from the exhaust pipe. If the motor labours a sticking air valve is indicated. Flush the air valve as detailed in para.14.

TABLE 4 (Contd)

Fault	Cause	Remedy
Starter motor fails to light up (systems shut down after 3 seconds) (Contd).	Faulty ignition switch	Connect a suitable circuit tester across the ignition unit L.T. supply lead socket, then select a start. Check that a live circuit is indicated momentarily (0.2 seconds) before the system shuts down. If a faulty circuit is indicated check the wiring between the ignition switch and the ignition unit; rectify as necessary.  If the wiring is satisfactory, remove the ignition switch, check the insulation resistance and effect a functional check; reject switch if faulty.
	Negative pressure inside ignition unit (Aircraft last flight at or above 40,000 ft).	Release the red painted screw in the ignition unit cover (Pre-mod S889) or press the plunger in the ignition unit body (Mod.S889).  Allow one minute for the air pressure to return to ambient, then tighten the screw or release the plunger. Attempt a start.
	Faulty ignition system.	Disconnect the HT ignition leads and check for continuity and, using a 500V megger, that the insulation resistance is not less than 5 megohms. Renew faulty lead. Remove the igniter and carry out a function check using an ignition unit of known serviceability; renew faulty igniters. If the igniters and HT leads prove to be serviceable, reject the ignition unit.
	Air blower inlet filter obstructed	Examine; rectify as necessary.
Combustion not sustained (Starter motor shuts down before reaching cut-out speed)	Blown safety disc	Check, renew, if necessary. <b>Note . . .</b> <i>Where repeated safety disc failures occur, the starter motor should be rejected for overhaul.</i>
	Empty fuel tank.	Check. Top up as necessary.
	Restriction in supply to fuel pump	Check the fuel tank and pipes for obstruction and the tank inward vent valve for damage. Rectify as necessary.
	Loss of fuel pressure (leakage)	Check the system for leaks and effect a fuel drainage check (para.10). Rectify any external leaks as necessary. If no external leaks are found and the fuel drainage is not satisfactory refer to 'Fuel drainage less than specified minimum'.
	Faulty speed control switch or h.p. switch and solenoid valve.	Refer to the aircraft wiring diagram (Sect.5, Chap.1, Group C1) and check the wiring to the speed control switch. Rectify as necessary. If the wiring is satisfactory, reject the H.p. switch and solenoid valve. If the fault persists, reject the starter motor for a faulty speed control switch.

TABLE 4 (Contd)

Fault	Cause	Remedy
'Popping' in starter motor during air cycle when starter is hot.	Failure of air dump valve 'O' ring seal	Disconnect the air pipe from the fuel pump then, with the ignition unit 2-pin plug and solenoid valve plug disconnected, initiate a start. Check the air port in the fuel pump for fuel; any leakage will entail renewal of the air dump valve 'O' ring seal.
	Faulty h.p. switch and solenoid valve.	Reject
Low engine cranking speed	Partially seized starter motor	Reject
	Faulty air motor blower and pump unit.	Reject
	Faulty h.p. switch and solenoid valve.	Reject
Starter motor fails to turn	Faulty engine	Refer to A.P.102C- <sup>1503</sup> <sub>1507</sub> -1. Check the engine for freedom.
	Seized starter motor	Reject
Fuel drainage less than specified minimum and/or low fuel consumption	Faulty control unit	Effect a fuel drainage check (para.10) using a control box of known serviceability. If fuel drainage is acceptable, reject the original control unit.
	Faulty fuel pump or motor unit	Reject fuel pump, air blower and motor unit.
	Solenoid valve sticking	Disconnect the lead from the solenoid valve, then using a suitable supply, exercise the valve six times. Failure to operate or sluggish response will entail rejection of the h.p. switch and solenoid valve assembly.

**RESTRICTED**

TABLE 4 (Contd)

Fault	Cause	Remedy
Fuel drainage excessive	Short circuit ignition switch	Check aircraft wiring to ignition switch. Rectify as necessary. If wiring is serviceable function test ignition switch. Reject if faulty.
	Faulty control unit.	Carry out a fuel drainage check (para.10) using a control unit of known serviceability. If the fuel drainage is acceptable reject the original control unit.
	Failure of air dump valve 'O' ring seal or faulty h.p. switch.	Refer to 'popping' in starter motor during air cycle when starter is hot.
Incorrect fuel drainage pattern.	Blocked nozzle plate drain hole	Clear as detailed in para.13.
	Leaking atomizer	Roll out engine. Remove, dismantle and clean the atomizer. Check the fuel valve for leaks.

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