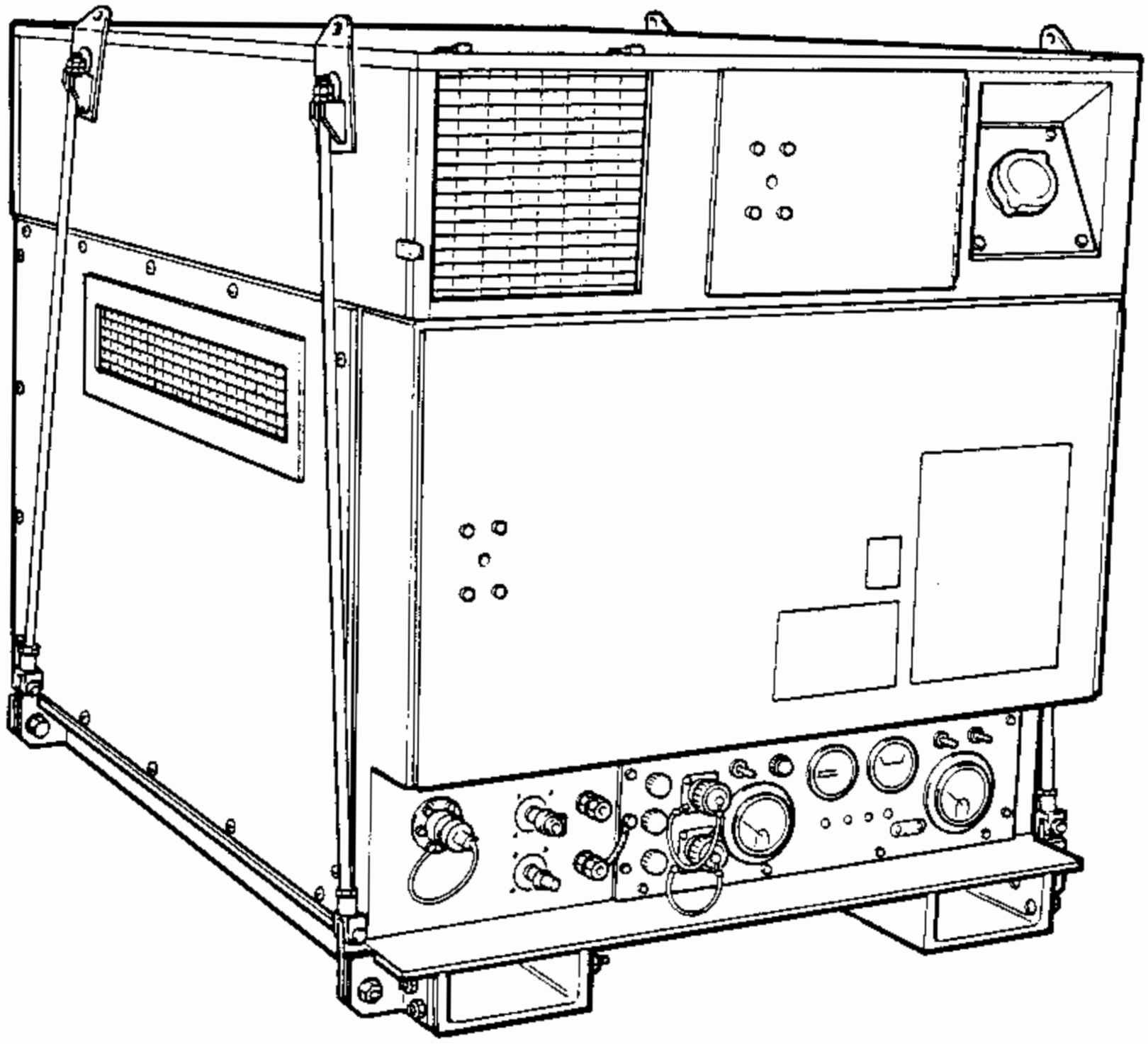

General view of the 4.5 kW engine-driven generator set

ROLE AND PURPOSE

1. The 4.5 kW engine-driven generator set is an independent electrical power supply designed for the SCRA central installation. The installation incorporates two 4.5 kW generator sets, which are arranged in a back-to-back configuration within a vehicle-mounted pallet, together with a set of batteries for starting the generator sets and a set of batteries for supplying power to an adjacent container. The generator sets produce a 28 V D.C. main output for charging the container batteries, and an auxiliary D.C. output for charging the starting batteries. The generator set also produces a 3-phase A.C. output, nominally 115/200 V, 400 Hz, for operating air conditioning equipment within the container.

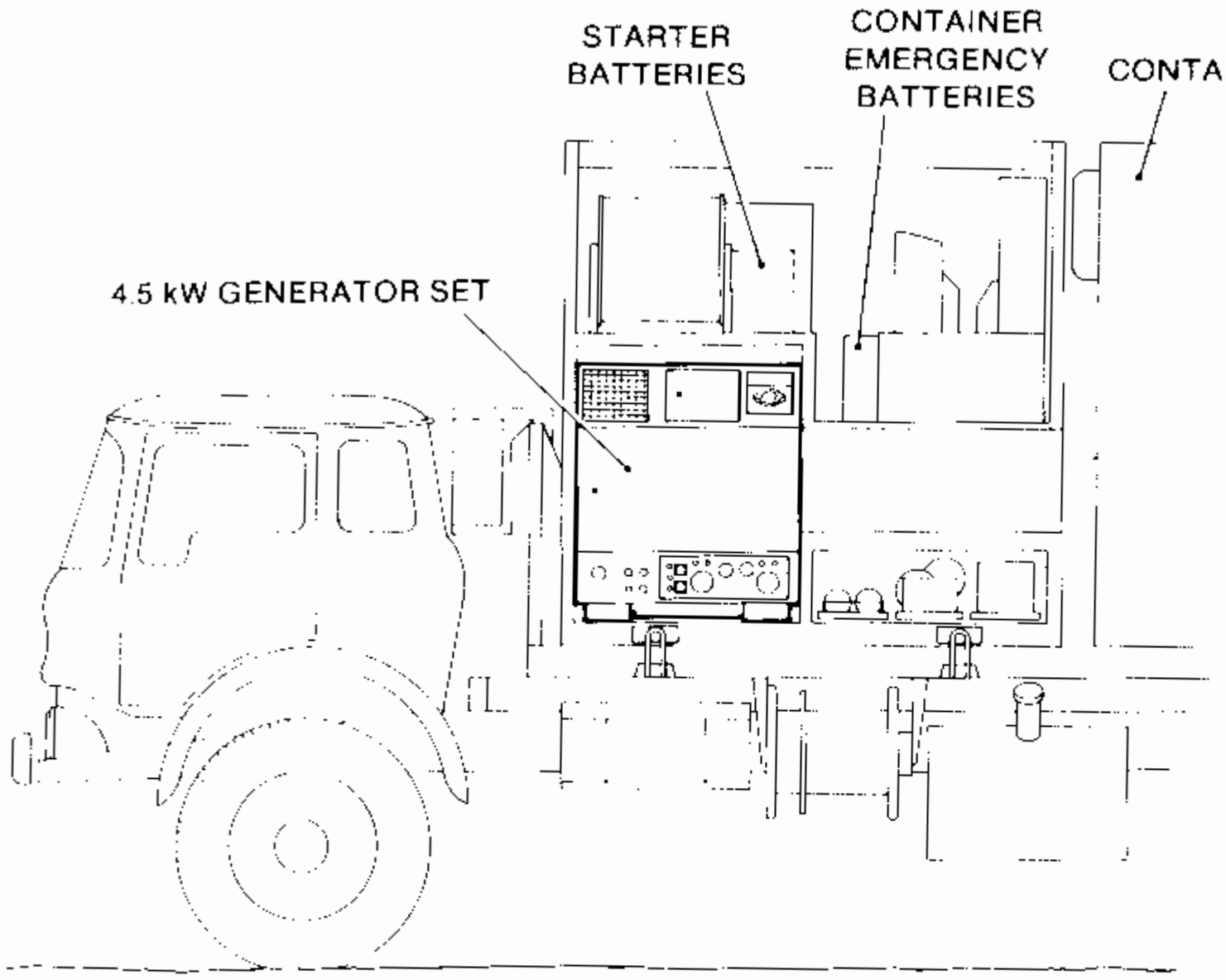

Fig 1 The generator set installed in its role

2. The generator set is automatically controlled and its operation does not require supervision, since built-in sensor circuits initiate any necessary protection action. The control system is linked to the container to enable remote starting and stopping; the remote control link also includes a master warning output and a low fuel warning output. The generator set can also be started and stopped, by both electrical and manual means, using the generator set's integral controls.

TECHNICAL DATA

3. The leading particulars of the generator set and the principal units are as follows:

3.1 Generator set

Manufacturer	Plessey Aerospace Ltd
Part No	503-1-12494-005
Rating	4.5 kW
D.C. output voltage	27.25 V D.C.
A.C. output (3-phase)	
Voltage	115 V L-N, 200 V L-L
Frequency	400 Hz
Fuel tank capacity (approx)	71 litre (16 imp gal)
Weight (wet)	380 kg (838 lb)

3.2 **Engine (Basic)**

Manufacturer	Petters Ltd
Type No	AC2
Type	*2-cylinder, 4-stroke,* air-cooled diesel
Governed speed	3000 *rev/min*
Rating at governed speed	8.2 kW
Fuel consumption (approx)	2.1 litre/h (0.46 gal/h)
Sump capacity	3.6 litre (6.5 pint)
Starting	Electric motor or hand cranking
Direction of rotation	Anti-clockwise viewed on power take off pulley

3.3 **Generator**

Manufacturer	Plessey Aerospace Ltd
Part No	503-1-07620-002
Type	Brushless, air-cooled
Operating speed	4000 rev/min
Rating	5 kW
Outputs	28 V D.C. and 21 V L-L, 400 Hz 3-phase A.C.

Chapter 2

TECHNICAL DESCRIPTION

CONTENTS

Para

DESCRIPTION
1 **External features**
6 **Internal arrangement**
9 **Cooling and exhaust extraction**
10 **Engine assembly**
11 **Basic engine**
12 **Special-to-role equipment**
FUNCTION OF CONTROLS
13 **Engine controls**
14 **Electrical controls**
PRINCIPLES OF OPERATION
15 **Engine starting**
16 **Generator**
19 **Generator excitation and control**
23 **Fault protection**
25 **Shutting down**
26 **A.C. power supply**

Table *Page*

1 **Control panel details** 7

Fig *Page*

1 **Principal external features** 2
2 **Internal arrangement (RHS)** 3
3 **Internal arrangement (LHS)** 4
4 **Location of components (front)** 6
5 **Generator set control panel** 7
6 **Simplified circuit diagram of generator set** 11

DESCRIPTION

EXTERNAL FEATURES (Fig 1)

1. The generator set is mounted on a steel baseframe, which incorporates fork lift shoes to facilitate mechanical handling. The main components of the set are mounted on the baseframe and enclosed within a box-shaped acoustic cover assembly, which attenuates the operating noise.

2. The acoustic cover consists of a top cover assembly bolted to a support frame, together with detachable side and rear panels, and a large front door for access to the engine. To facilitate vertical lifting of the generator set, four anchor plates are fitted to the top cover. The plates are connected to lugs on the baseframe by adjustable tie bars. A small door for access to the top of the engine is installed in the top cover. The top cover also incorporates a fan-assisted extraction system (see Fig 2) for the engine cooling and exhaust systems. Air inlet apertures are provided in each of the side covers. An exhaust extension assembly (separately stowed) is provided for venting the exhaust fumes to atmosphere, when operating the generator set in confined spaces.

3. All switches, instruments and indicators are contained on a control panel, which is the front panel of a control box installed in an aperture between the engine main access door and the baseframe. The control box contains all the control and protection circuitry for the generator set. The control panel also incorporates an output connector for the A.C. power supply and a connector for a remote control facility.

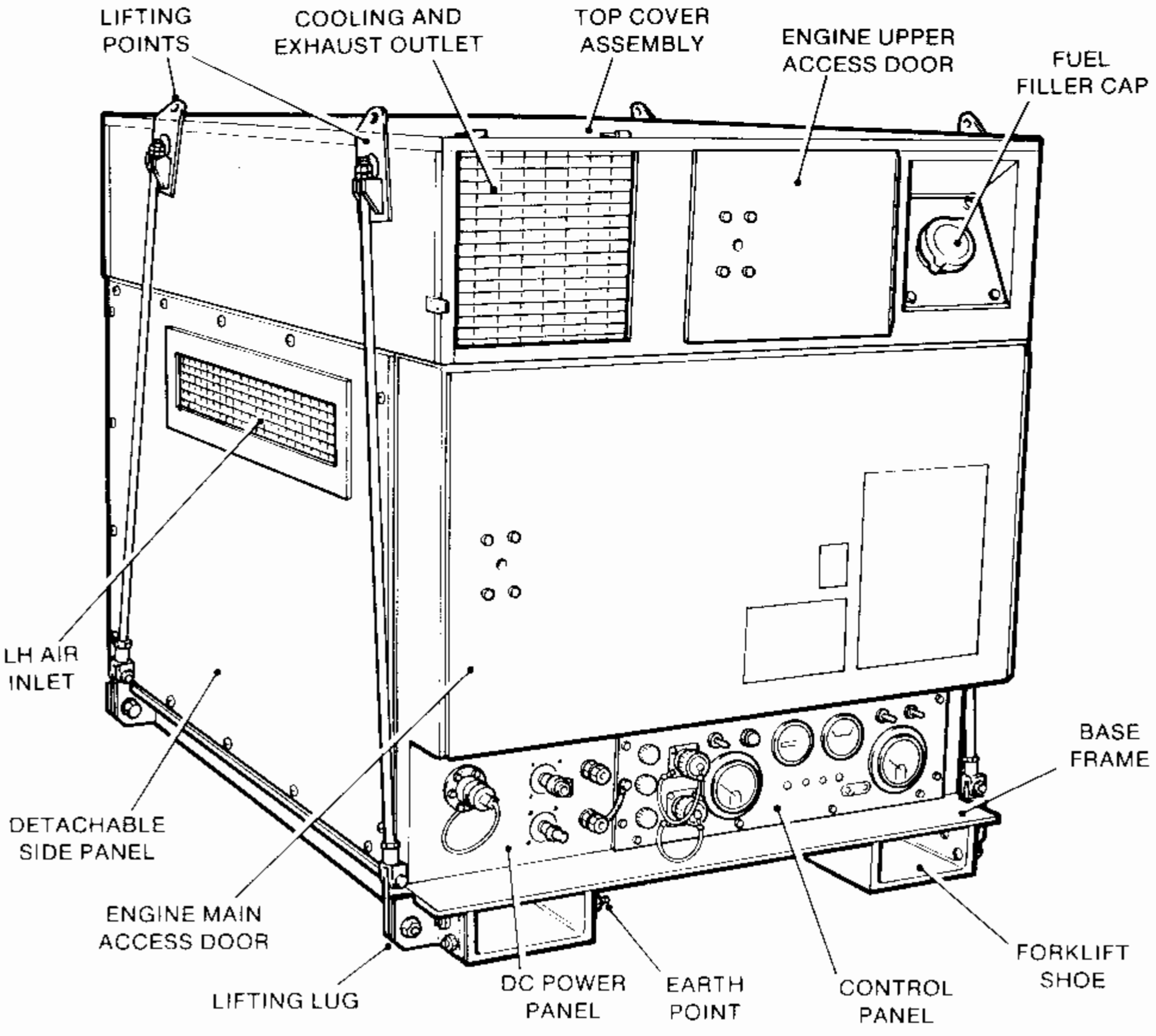

Fig 1 Principal external features

4. The D.C. power output from the set, and the D.C. starting power supply to the set, are connected by means of heavy duty terminals on a panel adjacent to the control panel (see Fig 4), which also incorporates a self-sealing coupling for a fuel transfer hose. The hose is used for transferring fuel between the two generator sets in the SCRA installation. Normal fuel filling is conducted via a fuel filler panel in the top cover; the panel incorporates an automobile type fuel cap.

5. The set is finished in a NATO green paint which possesses infra red reflective properties. For operational reasons, the finish should be maintained in good condition.

INTERNAL ARRANGEMENT (Figs 2 and 3)

6. The principal interior units are the engine/generator assembly, the fuel tank and the transformer. The fuel tank is secured to the baseframe at the rear of the set, and the engine/generator assembly is centrally located in the remaining baseframe floor area. The transformer is located on the left hand side of the set, between the engine and the fuel tank.

7. The generator is secured to a mounting plate which is suspended between two transverse members attaching to the engine flywheel housing. The generator shaft projects through the mounting plate and carries a pulley which is belt-driven from a larger pulley on the engine.

8. The engine assembly is mounted on a frame, which is secured via anti-vibration mounts, to the baseframe. This arrangement prevents engine vibration being transmitted to the rest of the generator set, and all connections between the engine assembly and the rest of the set incorporate a flexible element to absorb vibration.

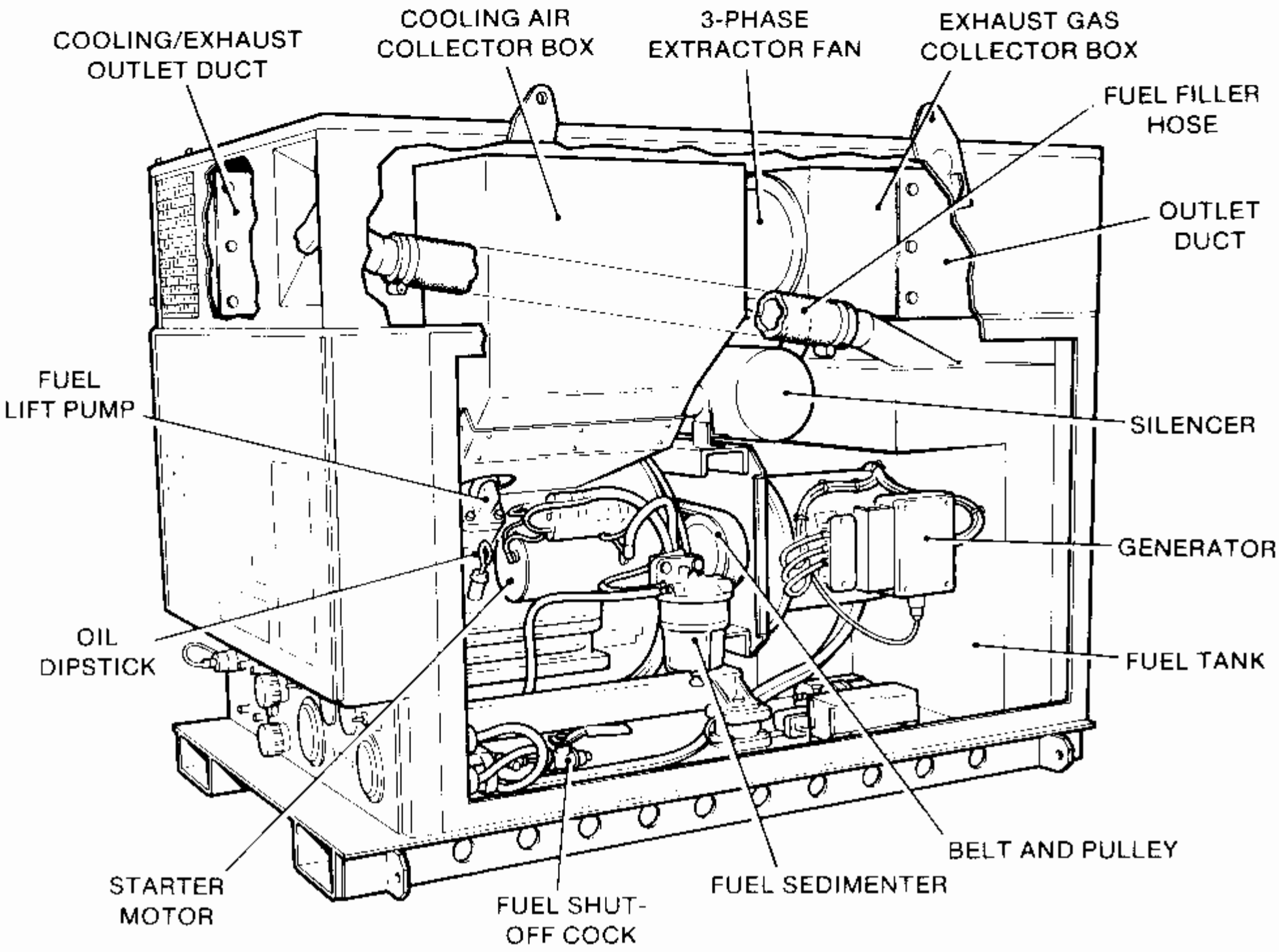

Fig 2 Internal arrangement (RHS)

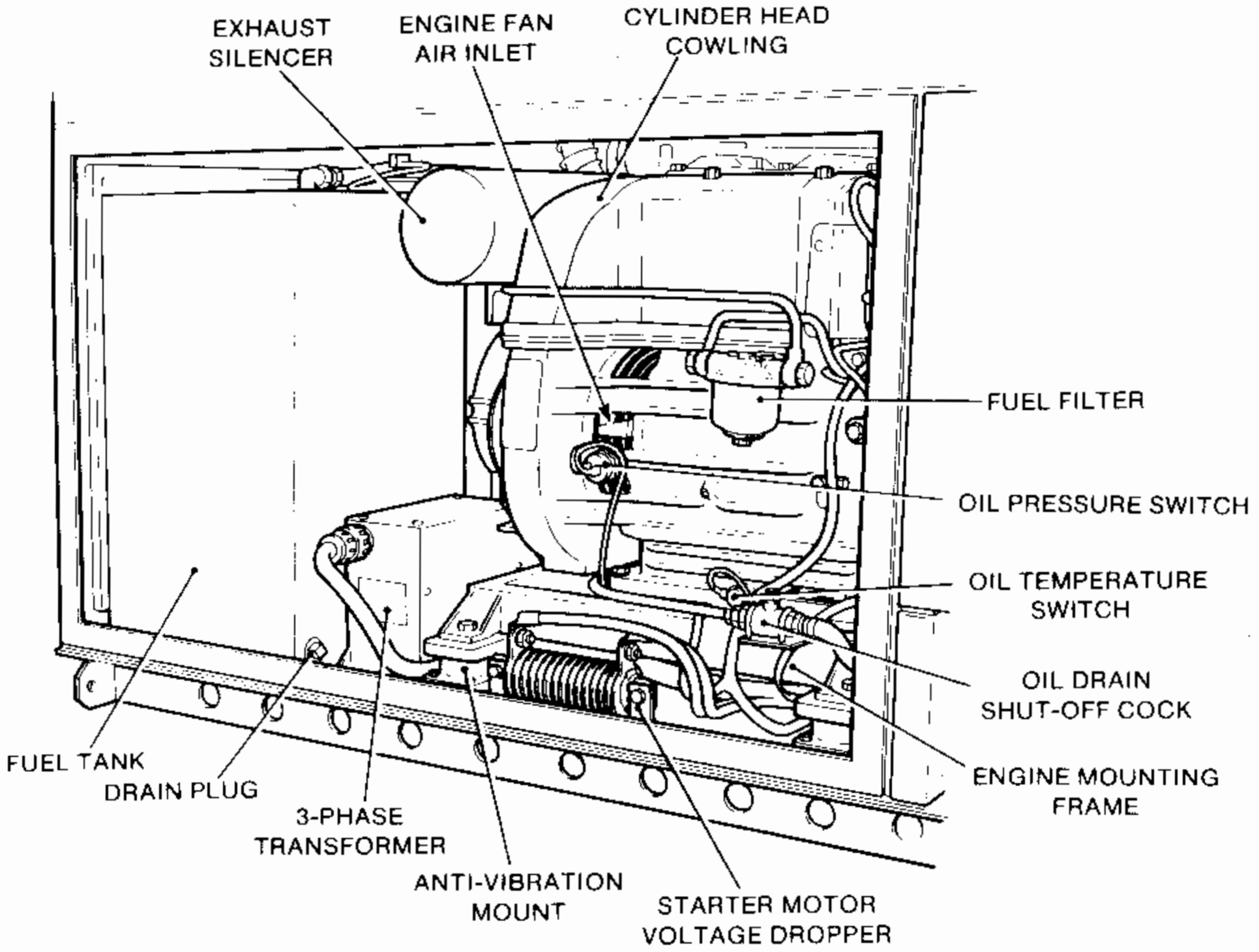

Fig 3 Internal arrangement (LHS)

COOLING AND EXHAUST EXTRACTION (Figs 2 and 3)

9. The engine and generator are both air-cooled, and efficient cooling is a critical operating feature. Cold air is drawn into the set via inlet grills (Fig 1), by fans in the engine and generator. The cooling air is circulated around the machines and deflected into an extraction system in the top cover. The engine exhaust gases also discharge into the extraction system, after passing through an exhaust silencer. The silencer is transversely mounted between the engine and fuel tank, and discharges upwards into the extraction system. The extraction system consists of a cooling air collector box, an extractor fan, an exhaust collector box and ducting, all connected in a continuous circuit around the top cover. The system discharges from an outlet duct in the front of the top cover.

ENGINE ASSEMBLY (Figs 3 and 4)

10. The engine assembly consists of a basic engine and various special-to-role, bolt-on accessories. The following sub-paragraphs provide a brief description of the basic engine, together with details of the special-to-role accessories. For details of the basic engine refer to the associated publication. (See Preface.)

Basic engine

11. The basic engine is a Petter's type AC2 air-cooled, two-cylinder, 608 cc diesel engine. The engine incorporates a 12 V D.C. starter motor, but can also be started by hand, using a cranking handle which is stowed inside the engine upper access door (Fig 4, detail A). The performance of the engine is automatically controlled by a governor in conjunction with a fuel injection pump. To facilitate manual starting and stopping a STOP/RUN lever is provided. An engine-mounted OVERLOAD STOP lever is provided for use during the starting cycle.

Special-to-role equipment

12. The engine is required to operate without manual supervision for long periods, in an enclosed area, under wide ranging ambient conditions. To satisfy these requirements, the following modifications to the basic engine have been implemented.

12.1 **Engine protection switches** (Fig 3). An oil pressure switch and an oil temperature switch are fitted. These switches are connected into the generator set fault protection and warning circuit. The installation of these switches facilitates unsupervised operation of the engine.

12.2 **Engine control solenoids** (Fig 4). Bracket-mounted solenoids are linked to the STOP/RUN lever and to the OVERLOAD STOP lever. The solenoids facilitate full electrical control of the engine during starting and stopping, and thereby enable remote control of these actions.

12.3 **Cold start aids** (Fig 4). The basic engine incorporates cylinder head oil priming plungers and decompression levers to facilitate cold starting. The cold start characteristics of the engine are further improved by provision of a Start Pilot kit. The Start Pilot kit consists of a hand pump, reservoir bowl and nozzle, interconnected with PVC tubing. The nozzle is installed in the inlet manifold and the pump and bowl are at the front of the set, for routine access. The kit is used to pump an ether-based fluid into the inlet manifold during starting. The fluid is very volatile and will promote combustion at low ambient temperatures. The fluid is supplied in an aerosol container.

12.4 **Oil drain pump** (Fig 4). Gravity draining of the engine oil sump is not possible and a hand pump is provided for this purpose. The pump is used in conjunction with a shut-off cock (Fig 3), connected in the sump-to-pump drain line.

12.5 **Fuel sedimenter.** The basic engine incorporates a fuel filter (Fig 3). Additionally, pre-filtration is provided by a fuel sedimenter, installed on the right hand side of the engine (Fig 2) and connected between the fuel tank and lift pump. The fuel drawn from the fuel tank by the lift pump may contain water and dirt. The sedimenter removes the water and large particles of dirt (sediment from the fuel tank). The water and dirt accumulate in the lower part of the sedimenter, and can be drained off by means of a tap underneath the sedimenter. Fine particles of dirt are removed by the fuel filter which contains a replaceable element.

FUNCTION OF CONTROLS

ENGINE CONTROLS

13. The following engine controls are provided to start and stop the engine.

13.1 **Overload stop lever.** Normally operated by a solenoid during electric starting; must be manually operated during hand starting. When operated, this lever disengages the fuel injection pump maximum fuel limiting mechanism, thereby allowing excess fuel to be supplied during the starting cycle. The lever is spring-loaded and automatically resets when the associated solenoid is de-energized.

13.2 **Stop/Run lever.** Normally operated by a solenoid during electric starting; must be manually operated during hand starting. When operated to the 'Run' position allows normal operation of the fuel injection pump. The lever is spring-loaded to the 'stop' position and, when the solenoid de-energizes, will shut off the fuel injection supply within the pump, causing the engine to stop. The lever is manually operated by means of a notched extension arm (Fig 4, detail B). When the extension arm is released, the lever remains in the 'Run' position because the notched arm engages with a catch plate. This allows the operator a free hand for other starting actions. The stop/run solenoid automatically energizes when the generator is excited following starting. This causes the lever extension arm to disengage from the catch plate; thus when the solenoid is de-energized during engine shutdown, the lever returns to the 'Stop' position under spring action.

13.3 **Decompression levers.** One, manually operated, lever provided for each cylinder head. When operated the levers unseat the inlet valves and thereby reduce pressure in the cylinder during cranking. The levers are operated during hand starting in order to reduce resistance to cranking and allow higher cranking speed to be attained. The levers must be manually reset, one at a time, during the starting cycle.

ELECTRICAL CONTROLS

14. All switches, indicators and instruments are mounted on the control panel which is illustrated in Fig 5. Details of the control panel accessories are contained in Table 1.

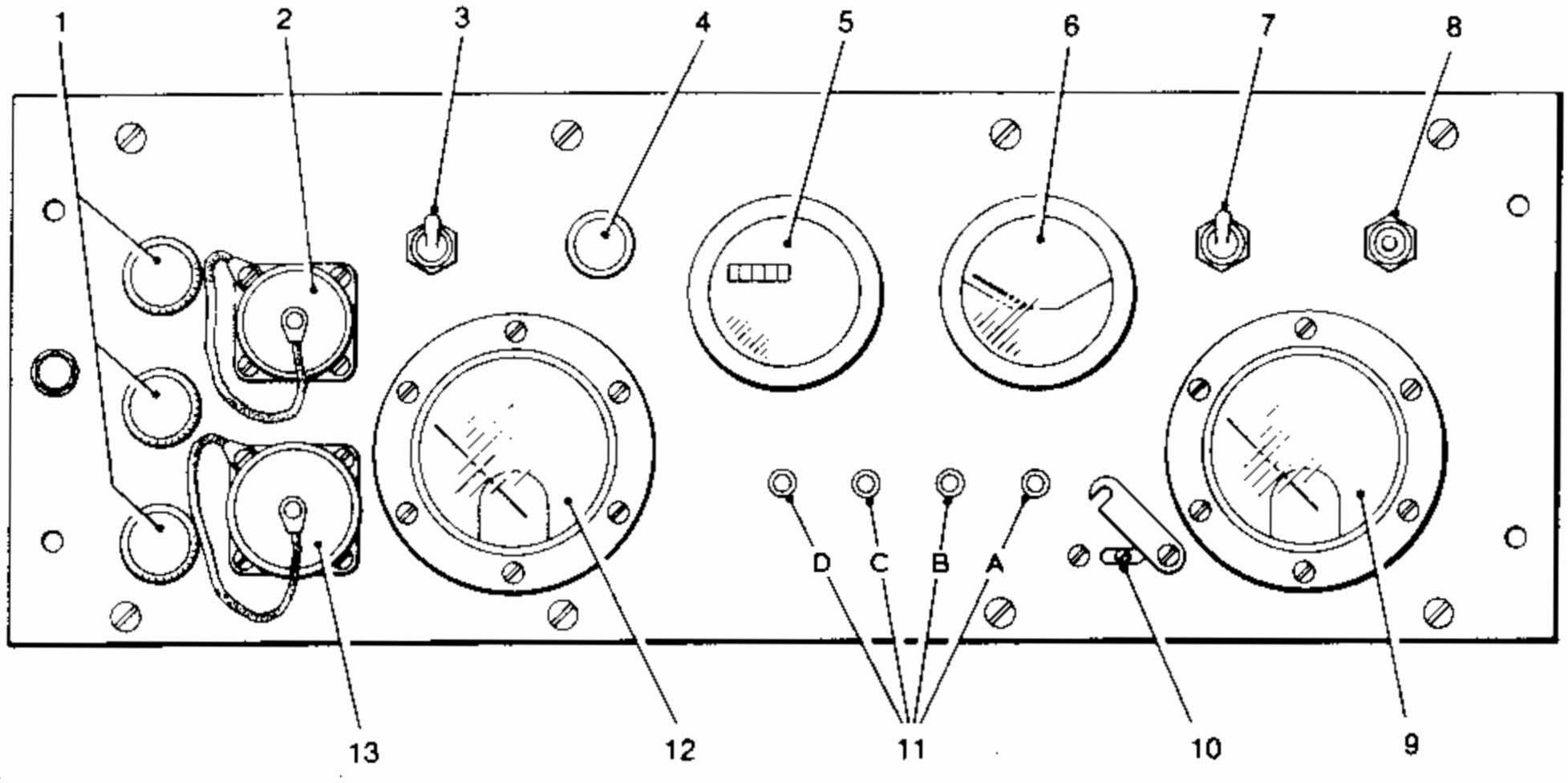

Fig 5 Generator set control panel

TABLE 1 CONTROL PANEL DETAILS

Fig 5 Item (1)	Nomenclature (2)	Function (3)	Remarks (4)
1	Fuses A, B and C	Protect A.C. output circuit	Rating 10 A
2	Connector, A.C. OUT	Connection point for 115 V/ 200 V, 400 Hz A.C. supply	Has attaching protection cap
3	Switch, GEN EXCITE/IND RESET	A spring-loaded, 2-position switch. Excites generator and resets fault indicators following manual starting. Not used following electric start (ref paragraph 19)	Spring-loaded to (un-marked) off
4	Indicator, SYSTEM ON	Illuminates when generator excited	Coloured green
5	Counter, HOURS	Indicates cumulative operating time	Operates when SYSTEM ON indicator illuminates
6	Gauge, FUEL	Indicates the approximate fuel tank content	Scaled 'E', 1/2 and 'F'

TABLE 1 CONTROL PANEL DETAILS (continued)

(1)	(2)	(3)	(4)
7	Switch, BATT VOLTS/FUEL	A 2-position spring-loaded switch. When depressed, switch connects items 5, 6 and 9 to starting battery supply. When released, switch connects items 5, 6 and 9 to generator D.C. output	Enables operator to check battery voltage and fuel content, prior to starting engine
8	Switch START-STOP	A 3-position, spring-loaded switch. When selected (down) to START, starter motor and engine solenoids operate. When selected (up) to STOP, engine stops	Switch spring-loaded to (unmarked) centre-off position
9	Meter, Total Load	Indicates total A.C./D.C., internal/external load supplied by generator	Incorporates a red segment of scale to indicate overload
10	Potentiometer, ADJUST VOLTS	Trims D.C. output voltage; only adjusted when external load disconnected	Normally blanked off
11	Fault indicators	Provide a magnetically retained indication of fault (yellow) or normal (black) condition	Electrically reset by operation of START switch or IND RESET switch
11A	L/P fault indicator	Indicates a low oil pressure condition	
11B	O/H fault indicator	Indicates an engine over-heating condition	
11C	O/V fault indicator	Indicates D.C. output voltage in excess of 32 V	
11D	U/V fault indicator	Indicates D.C. output voltage less than 24 V	May also indicate an overload condition (ref paragraph 24)
12	Meter, D.C. Voltage	Indicates D.C. output voltage, range 0 to 40 V	See also item 7
13	Connector, REMOTE	Connection point for remote control link	Has attaching protection cap

PRINCIPLES OF OPERATION

ENGINE STARTING (Fig 6)

15. Electrical starting power is obtained from the 24 V D.C. BATTERY terminals. A standing battery positive is connected to the START/STOP switch and to the input side of relay contacts which are under the control of the START/STOP switch. The electric starting sequence is initiated by holding the START/STOP switch to START, and is thereafter automatic. The sequence terminates when the SYSTEM ON light illuminates, shortly after the engine attains normal speed; the START/STOP switch must be held to START until this occurs, otherwise the starting circuit will prematurely de-energize. The operational sequence is as follows:

15.1 When the START/STOP switch is held in the START position, battery positive is applied to the coil of the Stop/Run relay (RL5), to the stop/run control circuit and to the starter motor protection circuit. The stop/run control circuit is an electronic switch connected in the negative (earth) side of RL5. When a positive ('run') signal is applied to the 'switch', it closes. When a negative ('stop') signal is applied to the 'switch', it opens. As a result of the positive signal from the START/STOP switch, the stop/run control circuit completes RL5 coil circuit, and RL5 closes.

15.2 When RL5 closes, one contact connects battery positive to the Stop/Run lever solenoid, the other contact applies battery positive to the generator field relay (RL4) and to a master warning relay (RL3). The Stop/Run lever solenoid and RL4 are permanently earthed, and therefore operate. RL3 earth circuit is controlled by an undervoltage switch; because the generator voltage is at this point zero, the undervoltage switch is open. Therefore RL3 remains de-energized.

15.3 The operation of RL4 initiates automatic excitation of the generator, as described in paragraph 19. The operation of the Stop/Run lever solenoid actuates the associated lever, which opens a fuel shut-off mechanism within the fuel injection pump. Hence the engine fuel system is now ready for operation.

15.4 The starter motor protection circuit (paragraph 15.1) is a voltage sensitive switch. The 'switch' is normally closed, but opens when a sense signal from the starter motor terminal rises above a predetermined voltage. When the 'switch' is closed, the 24 V D.C. signal from the START/STOP switch is applied to the coils of the engine auxiliary relays, which therefore operate.

15.5 When Eng Aux Relay 1 closes, a D.C. supply is applied to the starter motor solenoid, which operates. As the solenoid operates, it engages the starter motor with the engine. When engagement is completed (but not before) the solenoid contact closes and connects the battery supply to the starter motor, via a voltage dropper. The 12 V starter motor initially draws a heavy current from the 24 V batteries, and the passage of this current through the voltage dropper reduces the supply voltage to a safe value for the motor.

15.6 The closing of the Eng Aux Relay 2 completes the battery supply circuit to the Overload Stop Lever solenoid. The solenoid energizes and actuates the lever to the excess fuel position. This overrides the normal governed range of the fuel injection pump, allowing excess fuel delivery for starting.

15.7 The selection of the START/STOP switch to the START position automatically actuates all engine controls to the starting position, and operates the starter motor. As the motor turns it cranks the engine, which drives the fuel lift pump and the fuel injection pump.

15.8 When the engine fires, the load on the starter motor reduces and draws less current from the batteries. As the starter motor current reduces, the voltage drop across the voltage dropper also reduces. Thus the voltage applied to the starter motor increases. As the engine speed increases, so does the voltage applied to the starter motor. This voltage is also applied to the starter motor protection circuit and, at a predetermined value, causes the protection circuit to change state and switch off the supply to the engine auxiliary relays. When this occurs both the starter motor solenoid and the Overload Stop lever solenoid de-energize. The lever returns to the normal position under the influence of a return spring in the solenoid. The starter motor de-energizes as soon as the solenoid contact opens, and is automatically thrown out of engagement.

15.9 If the engine fails to attain self-sustaining combustion, the START/STOP switch must be released and, after a pause to allow the starter motor to cool down, the cycle must be repeated. When the engine is successfully started, the START/STOP switch must not be released from the START position until the SYSTEM ON light illuminates. This will indicate that the generator has excited and that a self-maintaining power source is available to supply the control system which, during the starting cycle, is supplied from starting batteries, via the START/STOP switch. If the START/STOP switch is released prematurely, the engine stop/run control circuit de-energizes and the Stop/Run lever returns to the STOP position.

GENERATOR (Fig 6)

16. The generator is a brushless, air-cooled, A.C. machine, which incorporates rectifiers to supply three D.C. outputs. In addition, an A.C. output is taken direct from the stator. The three D.C. outputs comprise a main output, a battery charging output, and an excitation and control output.

17. The generator is automatically controlled by a voltage regulator, which senses the main D.C. output voltage and adjusts the field current until the correct level of excitation is obtained. This is a continuous process which holds the D.C. output voltage at a specified value, throughout the designed range of load. The A.C. output voltage is not a critical parameter, and though the nominal value is 21 V line-to-line, the actual voltage will vary slightly, depending on the excitation level, as controlled by the D.C. voltage regulator. The frequency of the A.C. supply is directly proportional to the engine speed, and at the governed speed the frequency is 400 Hz.

18. The generator is rated at 5 kW, but the set is only rated at 4.5 kW because some power is reserved for internal use (excitation, control and for the A.C. extractor fan) and for charging the starting batteries.

GENERATOR EXCITATION AND CONTROL (Fig 6)

19. Excitation of the generator is the method by which the generator attains its rated output voltage from an initially de-energized condition. It is initiated during the start sequence, when the exciter field circuit is completed either by the closure of the field relay, or by the operation of the GEN EXCITE/IND RESET switch. The generator is a self-exciting machine and, once the field circuit is complete, excitation occurs automatically.

20. When the generator voltage exceeds the undervoltage protection level, the undervoltage sensor switch changes state and causes the master warning relay (RL3) to operate. When this occurs the SYSTEM ON light on the control panel illuminates, and the remote warning light in the container extinguishes, indicating that the generator set is ready for use. At this point, if the engine was started by hand, the GEN EXCITE/IND RESET switch should be released.

21. Following excitation, the generator D.C. output voltage is automatically controlled by a voltage regulator. The regulator forms part of a closed loop control system which maintains the generator D.C. output voltage within specified limits, over the full range of load.

22. The A.C. supply voltage is not independently regulated and may therefore be influenced by D.C. loading conditions. This will cause some variation in the A.C. output voltage, but will have little practical effect upon the generator set's internal A.C. load, or that of the container.

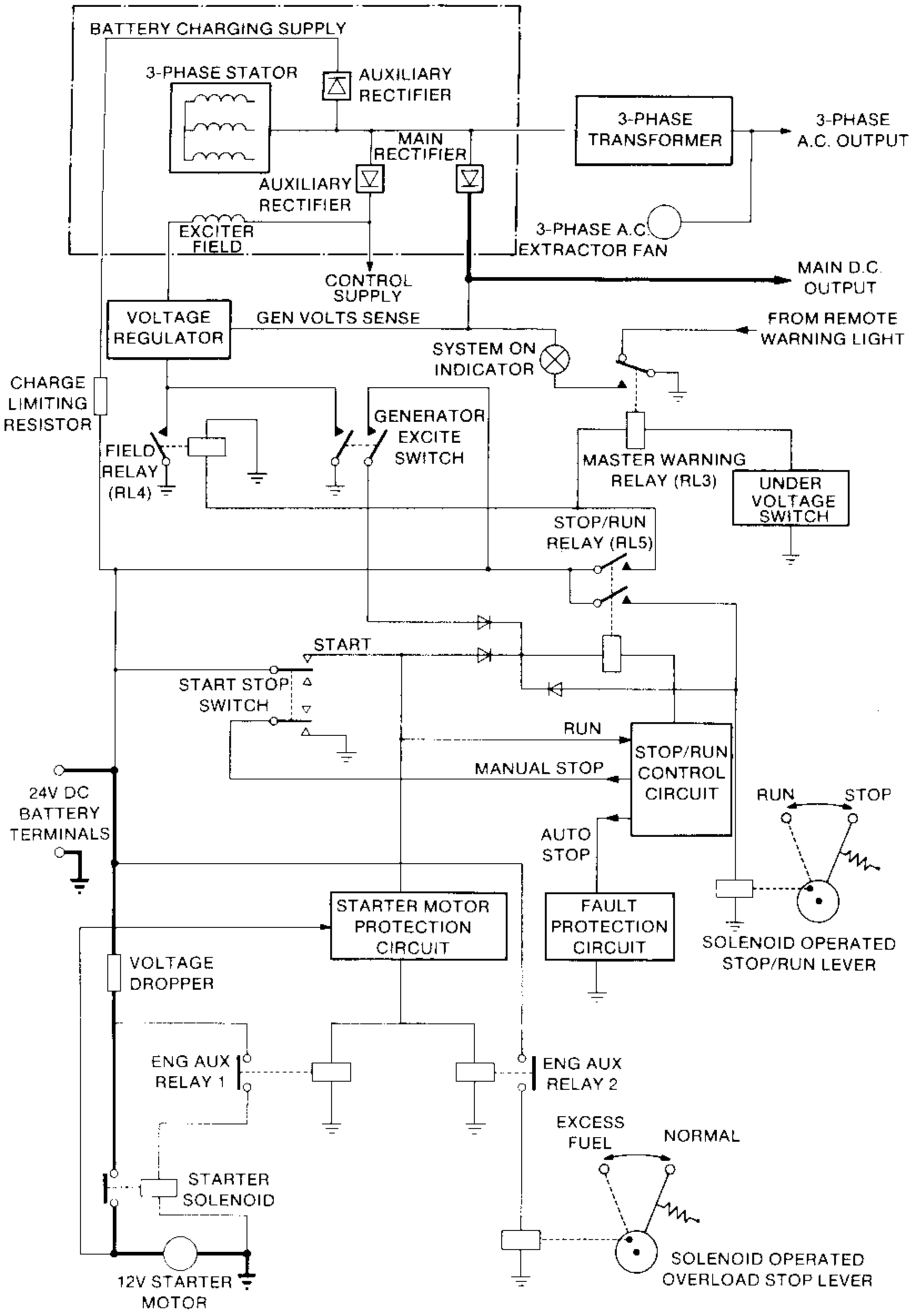

Fig 6 Simplified circuit diagram of

FAULT PROTECTION (Fig 6)

23. Following starting and excitation the fault protection circuit assumes supervisory control of the generator set. The fault protection circuit normally applies a 'run' signal to the engine Stop/Run control circuit, which maintains relay RL5 operated (ref paragraph 15.1) and the Stop/Run lever in the Run position. In the event that a fault sensor (ref Table 1) operates, the fault protection circuit changes state and applies a 'stop' signal to the Stop/Run control circuit. RL5 immediately de-energizes and the Stop/Run lever returns to the Stop position. This shuts off the fuel supply within the fuel injection pump and the engine stops. When RL5 opens, relays RL3 and RL4 also open. This causes the generator to de-excite and the SYSTEM ON light to extinguish. Simultaneously, a warning light in the SCRA container illuminates. The general nature of the fault is indicated by an activated fault indicator on the general control panel.

24. If after an automatic shutdown, the U/V indicator is found to be activated, it is necessary to check for an overload condition before the indicated undervoltage fault can be assumed reliable. This is because the generator set incorporates overload protection circuitry which operates by feeding a signal into the voltage regulator, to create an undervoltage condition. The action of this circuit is progressive and, if the overload persists, results in the undervoltage sensor switch operating. Following the consequential shutdown, a check for an overload condition can be effected by isolating all load and re-starting the generator set. If the generator set remains on line, then a fault in the load is clearly indicated. Note that an overload condition can be created by both A.C. and D.C. consumer equipment, since the overload sensing device senses total load.

SHUTTING DOWN

25. It is recommended that all switched loads are selected OFF before shutting the generator set down. This procedure serves two purposes. Firstly it avoids overdriving the voltage regulator during shutdown, and secondly it minimises the surge of load current during the next starting cycle. Following this procedure, it is only necessary to select the START/STOP switch to STOP. This immediately de-energizes relays RL3, RL4 and RL5, causing the generator to de-excite and the Stop/Run lever to return to the Stop position, thus shutting off the fuel supply and stopping the engine.

A.C. POWER SUPPLY

26. A 3-phase power transformer (Fig 3) is provided to raise the 21 V line-to-line A.C. output from the generator, to 200 V line-to-line (115 V line-to-neutral). The transformer windings are enclosed in a metal box, which incorporates louvres for convection cooling. A plug is provided for the input connections and a socket for the output connections.

27. The 3-phase 115 V/200 V A.C. supply is connected to the extraction fan in the top cover (ref Fig 2) and to the A.C. OUT connector SK1, on the control panel (Fig 5). The A.C. output circuit is protected by 10 A fuses mounted on the control panel.

Chapter 3

OPERATING INSTRUCTIONS

CONTENTS

Para

1 **Initial setting up instructions**
2 **Starting and putting into operation**
3 **Starting - general**
4 **Cold start priming procedures**
5 **Start pilot priming**
6 **Oil priming (CAUTION)**
7 **Starting the engine**
8 **Electric start**
9 **Hand start (WARNINGS)**
10 **Exciting the generator (CAUTION)**
11 **Putting the generator on line**
12 **In operation procedures (CAUTION)**
13 **Refuelling**
15 **Adjusting D.C. output voltage**
16 **Shutting down (CAUTION)**

Fig *Page*

1 **Start Pilot operating sequence** 3
2 **D.C. output voltage adjustment facility** 7
3 **Location of controls and connection points** 9/10

INITIAL SETTING UP INSTRUCTIONS

1. The following procedure details the tasks necessary to prepare the equipment for operation, on arrival at the operating site.

1.1 Park the vehicle on a firm base, having a maximum incline of 10 degrees in either axis.

1.2 Secure the vehicle.

1.3 Unreel and ground the earthing spike to a depth of 750 mm (30 in) at a minimum distance of 2 metres (78 in) from the vehicle.

Note

If the vehicle is located on hard standing, connect the earthing cable to the nearest earthed structure.

1.4 Connect the other end of the earth cable to the container earthing stud.

1.5 Check that the BATTERY and D.C. OUT terminals are correctly and securely connected.

1.6 Check the oil level using the dip-stick (Fig 3); top up as necessary.

1.7 Connect the exhaust extension assembly to the exhaust outlet grill (if required) and secure with the three toggle latches.

1.8 Depress the BATT VOLTS/FUEL switch and check the voltmeter indicates approximately 24 V and the fuel gauge indicates sufficient fuel; release the switch and refuel (ref paragraph 13) as necessary.

1.9 Check the generator set air inlet and outlet grills are unobstructed; check all panels and covers are secure; check the control panel voltmeter and loadmeters are zeroed.

1.10 Check that the appropriate GENERATOR SELECTOR switch in the container is OFF.

1.11 Check the fuel tank shut-off cock is in the in-line position.

STARTING AND PUTTING INTO OPERATION

2. The following procedures detail the general method of starting and operating the generator set. Special instructions may apply when the generator set is installed in the parent SCRA installation. Any such instructions are contained in the Operating Instructions for the complete installation, and override any conflicting instructions contained in this publication.

Starting - general

3. When the set is installed in the parent SCRA installation electric starting is normally employed. When the set is to be operated independent of the SCRA installation, or a suitable (24 V D.C.) power supply is not available, the engine is started by hand. In cold conditions it is necessary to prepare the engine, as indicated in paragraph 4 before starting.

Cold Start Priming Procedures

WARNING

EXPLOSION HAZARD. OPERATORS USING START PILOT CAPSULE/CANISTER MUST BE WARNED OF THE EXPLOSION RISK, AND ALSO THAT THE VAPOURS CAUSE DROWSINESS AND LOSS OF CONCENTRATION.

4. In ambient temperatures of 13 deg C (55 deg F) or less, a cold engine is unlikely to start unless one of the two possible cold start techniques is employed. This is particularly true of a new engine but, with a partly worn engine, normal starting may be possible down to freezing point. The following procedures are effective down to an ambient temperature of -5 deg C (23 deg F). Below this temperature the cold start techniques are only effective if engine winterization procedures are implemented, eg winter grade diesel fuel and low viscosity lubricating oil used. Either of the following cold start techniques may be employed, but the Start Pilot system (paragraph 5) is likely to be more effective than the oil priming technique (paragraph 6). During hand starting, an assistant is required to operate the Start Pilot Pump.

Start Pilot priming (Fig 1)

5. This cold start technique introduces a volatile fluid into the inlet manifold. The resultant vapour promotes combustion during cranking.

5.1 Open the lid of the Start Pilot bowl and engage a VISO F Start Pilot aerosol can.

5.2 Withdraw the Start Pilot pump handle (twist to unlock it).

5.3 Press down on the aerosol can and fill the reservoir to the MAXI level.

5.4 Disengage the aerosol can and close the lid.

5.5 Operate the pump several times to prime the supply line.

5.6 During cranking (paragraph 8 or 9) rapidly operate the pump.

5.7 Repeat the procedure if the engine fails to start; after starting press the pump handle in and lock it in position.

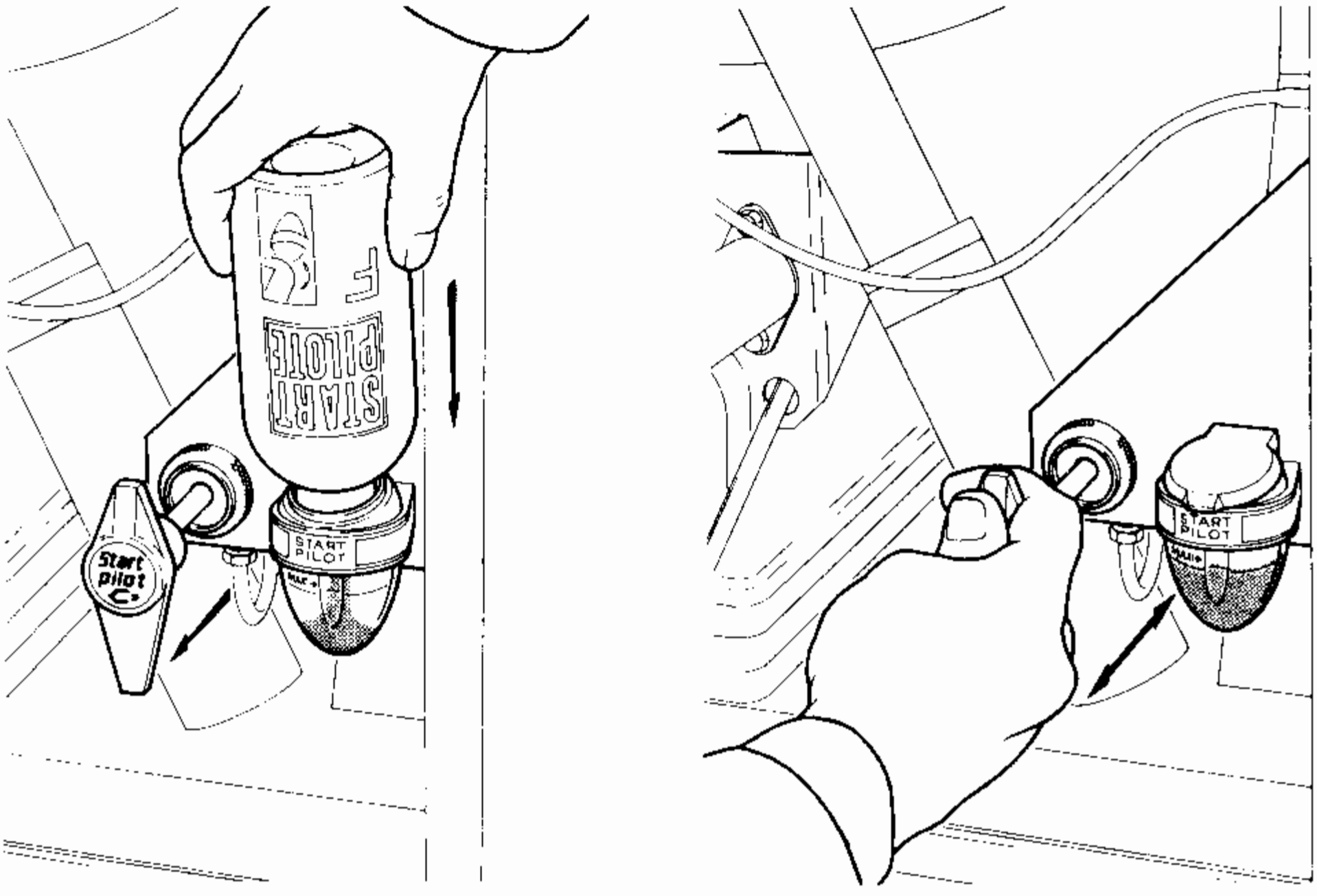

Fig 1 Start pilot operating sequence

Oil priming (Fig 3)

6. This cold start technique increases the compression ratio during starting, by partly filling the combustion chamber with engine oil. Due to the resultant rise in cylinder temperature during cranking, the probability of combustion is considerably increased.

6.1 Open the upper service door and withdraw the priming plungers from the cylinder head. Fill the exposed cavities with clean engine oil.

6.2 Refit the priming plungers and press them fully in.

6.3 Crank the engine (paragraph 8 or 9); if the engine starts, but fails to run up to normal speed, press and hold the priming plunger in until normal speed is obtained.

CAUTION

EXCESSIVE PRIMING. Excessive priming with oil may create an hydraulic lock within the cylinder, necessitating removal of the fuel injectors to blow out the oil.

6.4 If the engine fails to fire, a further starting cycle must be performed before the cylinder can be primed again.

6.5 If the engine fires, but fails to start, repeat the priming procedure detailed in paragraphs 6.1 to 6.3.

Starting the engine

7. The engine may be started electrically, or by hand, as indicated in paragraph 3. In the case of a cold start, the following procedures must be applied in conjunction with the instructions detailed in paragraph 5 or 6.

Electric start (Fig 3)

8. During an electric start the engine control solenoids are operated by the battery power supply, until the generator excites and supplies the D.C. power. The control solenoids are supplied via the START/STOP switch, and it is necessary to hold the switch to the START position until the SYSTEM ON light illuminates, indicating that the generator has excited. If the START switch is released prematurely, the starting cycle is immediately terminated.

8.1 Hold the START/STOP switch to START and crank the engine for a maximum continuous period of 15 seconds.

8.2 If the engine fails to start, release the START switch and observe a ten second recovery period for the starter motor and batteries.

8.3 Repeat paragraphs 8.1 and 8.2 as necessary, until the engine starts. When this occurs, wait until the SYSTEM ON light illuminates and then release the START/STOP switch.

Note

When the engine starts, the starter motor is automatically de-energized by a special control circuit which is independent of the START/STOP switch.

Hand start (Fig 3)

9. An assistant will be required if the Start Pilot system is to be used during hand starting. To start the engine by hand, proceed as follows:

WARNING

FRONT DOOR HAZARD. ALWAYS SECURE THE FRONT SERVICE DOOR BEFORE WORKING IN FRONT OF THE EQUIPMENT. IN WINDY CONDITIONS THE FRONT SERVICE DOOR IS A POTENTIAL HAZARD IF UNSECURED.

9.1 Open the front door and secure in the open position.

9.2 Swivel the starting shaft cover about its pivot screw, to expose the starting shaft adaptor.

9.3 Check that the locating spigot and driving lugs of the starting handle are greased (to prevent seizure in engagement).

9.4 Engage the starting handle in the starting shaft adaptor.

9.5 Push the overload stop lever down and release it.

9.6 Pull the Stop/Run lever outwards until the notch in the lever engages with the catch plate. The lever should remain in position, under spring tension, pending excitation of the generator (paragraph 10).

9.7 Open the upper access panel and position the decompression levers against their stops, by pushing both levers to the right.

WARNING

ENGINE BACKFIRE. RISK OF INJURY TO OPERATOR'S HAND IF ENGINE BACKFIRES. WHEN GRIPPING STARTING HANDLE, DO NOT WRAP THUMB AROUND HANDLE.

9.8 Turn the starting handle slowly until the fuel injectors squeak, then turn the handle as fast as possible whilst holding the decompression levers; when the highest cranking speed is attained, reset one of the decompression levers. Reset the other decompression lever when the engine fires.

9.9 If self-sustaining combustion does not occur, lift the decompression levers and repeat the procedure from paragraph 9.5

9.10 When the engine starts, disengage and stow the starting handle, replace the starting shaft cover and excite the generator as detailed in paragraph 10.

Exciting the Generator

10. Following an electric start the generator will automatically excite. This is indicated by the deflection of the control panel voltmeter and the illumination of the SYSTEM ON light. Following a hand start, excite the generator as follows:

10.1 Operate and hold the GEN EXCITE/IND RESET switch until the SYSTEM ON light illuminates. Any fault indicator which previously indicated a yellow (fault) display, should now reset to a black (normal) display.

10.2 Check that the Stop/Run lever has disengaged from its catch plate.

CAUTION

DISENGAGEMENT OF THE STOP/RUN LEVER. It is essential for unsupervised operation of the generator set that the Stop/Run lever disengages from its catch plate, thus enabling the protection circuitry to assume control of the fuel shut-off mechanism.

10.3 On completion close the front door.

Putting the generator on line

11. Following excitation of the generator, the generator set is to be switched on line as follows:

11.1 Check that the no-load D.C. voltage, as indicated by the generator set control panel voltmeter, is within the range 27.0 to 27.5 V. If necessary adjust the voltage using the ADJ VOLTS potentiometer, as detailed in paragraph 15.

11.2 Select the generator set on line in accordance with the container operating procedures.

Note

The generator set has sufficient capacity to supply the electrical requirements of the installation and, provided the main batteries are serviceable, an overload condition should not normally arise. The set incorporates overload protection circuitry which, during overload conditions, effects a progressive reduction in the D.C. output voltage as the load current increases. This may initiate shutdown if the undervoltage trip level is reached, and the control panel fault indicator will record a 'U/V' fault.

IN OPERATION PROCEDURES

12. The generator set does not require manual supervision in operation, since any significant deviation from the specified operating parameters results in automatic shutdown of the set. Such an event is signalled to the container by a fault lamp on the D.C. Distribution Box, and the failure mode is indicated on the generator set control panel. Even periodic monitoring of the fuel level is not necessary, since a LOW FUEL warning is signalled well in advance (approximately 30 minutes) of the fuel tank emptying. The set should not be allowed to run out of fuel, although no damage will occur in this event. However, to avoid excessive engine cranking at next engine start, the fuel system may be primed by manual operation of the priming lever on the lift pump (Fig 3). The set may be safely refuelled in operation, as described in paragraphs 13 and 14, but this facility must not be used to extend the maximum continuous running time of the engine, which is limited by the necessity to check the oil level.

CAUTION

ENGINE OIL LEVEL. The engine oil level must be checked at the start of each shift or at least once in every 24 hours continuous operation. Check the oil level with the sump dip-stick (Fig 3) approximately two minutes after shutdown.

► ◄

► **Refuelling**

WARNING

FIRE HAZARD. DO NOT FILL THE FUEL TANK MORE THAN THREE QUARTERS FULL WHEN USING THE FUEL GAUGE AS AN INDICATOR. THE FUEL GAUGE MAY NOT INDICATE THAT THE TANK IS FULL.

13. **Bowser or Jerrican Refuelling.** The set can be refuelled via a filler pipe which is terminated with an automobile type fuel cap (Fig 3). The usable capacity of the fuel tank is approximately 71 litre (15.5 imp gal) and the capacity above the low level warning point is approximately 69 litre (15 imp gal). The control panel fuel gauge is not a precision instrument and should only be used as a guide when checking the fuel level. Care should be taken during the latter stages of refuelling, to avoid overfilling; the angle of the fuel filler pipe is such that any automatic cut-out device in a fuel delivery nozzle is not likely to operate before overfilling occurs. Ensure the fuel cap is refitted on completion of refuelling. ◄

14. **Set-to-Set fuel transfer.** The generator set can alternatively be refuelled by transferring fuel from the other generator set, via self-sealing couplings and an interconnecting hose, which is part of the fitted pallet installation. In this situation fuel initially flows from the full to the empty tank, until the fuel levels equalize; thereafter the levels should fall evenly, such that when the LOW FUEL warning is signalled by the operative generator set, it will indicate that BOTH fuel tanks are nearly empty. The detailed procedure is as follows:

14.1 On receipt of a LOW FUEL warning remove the blanking plugs from the fuel transfer ports (Fig 1) of both generator sets.

14.2 Connect the interconnecting hose between the transfer ports.

14.3 Check the fuel tank shut-off cock of the inoperative set is in the in line position; do not shut off the tank of the operating set.

14.4 Check that the LOW FUEL warning is cancelled after a short delay, indicating that a fuel transfer has occurred.

14.5 Continue operating the set until a LOW FUEL warning is signalled, then disconnect the accessory hose and refit the blanking plugs; refuel both sets as indicated in paragraph 13. Shut off the fuel tank of the inoperative set whenever set-to-set fuel transfer is not required.

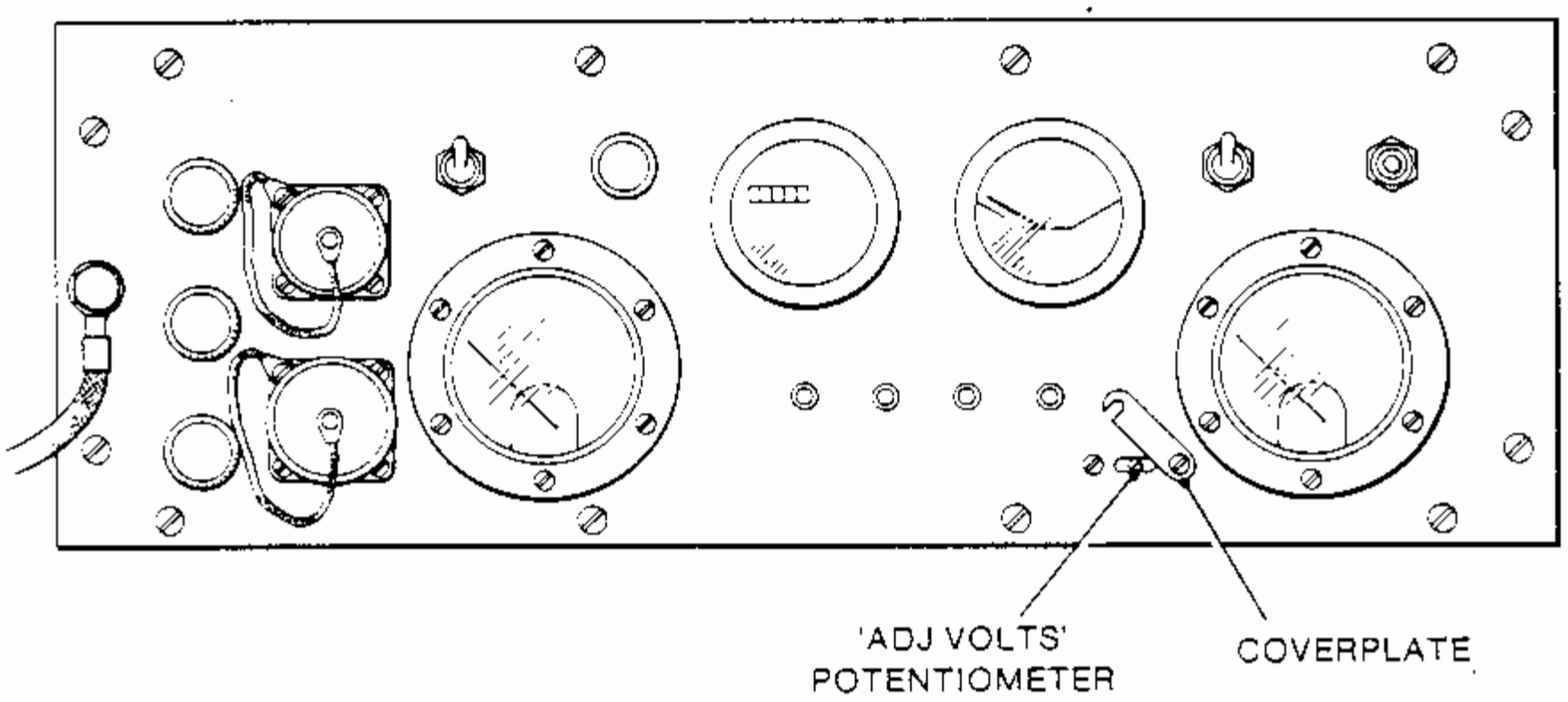

Fig 2 D.C. output voltage adjustment facility

►◄

► Adjusting D.C. output voltage (Fig 2)

15. Small changes of D.C. output voltage may result from extreme changes of ambient temperature and from ageing of electronic components. Such changes can be compensated for by use of the ADJ VOLTS potentiometer in the control box. The potentiometer is adjusted by means of a slotted wiper spindle, which accommodates a small screwdriver. The adjustment procedure is as follows:

15.1 Isolate all A.C. and D.C. external loads from the generator set, except the starting batteries.

15.2 Start the engine and allow to operate for five minutes before proceeding further.

15.3 Slacken the ADJ VOLTS potentiometer cover plate locking screws and swivel the plate clockwise about the right hand screw, to expose the potentiometer spindle.

15.4 Using a small screwdriver, turn the potentiometer spindle clockwise to increase the generator D.C. voltage, or anti-clockwise to decrease the voltage. Adjust the voltage to 27.0 -27.5 V, by reference to the control panel voltmeter.

15.5 On completion reset and lock the cover plate. ◄

SHUTTING DOWN

16. To shut down the set proceed as follows:

16.1 Isolate the generator set from the container load, using the appropriate GENERATOR SELECTOR switch in accordance with the container operating procedures.

16.2 Allow the generator set to operate on no load for a few minutes (this is a recommendation from the engine manufacturer which should be observed when time permits).

16.3 Select the START/STOP switch to STOP and check that the SYSTEM ON light (or the equivalent indicator in the container) immediately extinguishes; the engine should stop within five seconds.

16.4 If, by reason of defect, the engine fails to respond to the STOP switch, open the front door and push the Stop/Run lever in.

CAUTION

DECOMPRESSION LEVERS. Do not use the decompression levers to stop the engine; this may damage the engine.

16.5 On completion, check all doors/panels are secure and record any operating incidents/defects, together with the hours run total, in accordance with local procedures.

END