

SECTION 6, CHAPTER 5

MOBILE GENERATING PLANT

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Introduction

1. The vast range of electrically operated 'consumer' services on modern aircraft has led to the adoption of mobile electrical power-supply units for use on aircraft servicing, testing and starting procedures. These units are basically mobile power stations; each unit consists, as a rule, of a suitable wheeled chassis on which is mounted a prime mover (spark or compression ignition), a generator of suitable type and output, full automatic control equipment for the generating plant, and the necessary switchgear and cables for distributing the generated output to the 'consumer' services. Similar units are also used for the supply of general purposes electrical power on isolated sites, etc., where general mains supply from permanent installations is not available.

2. Mobile power-supply units vary widely in design and capability, and range from small highly-mobile systems producing about 6 kW of electrical power at 28-V d.c., to large diesel-operated generating sets capable of delivering 3-phase a.c. supply of up to 100 kVA (about 125 h.p.) at 'conventional' voltages (230V/400V)—these latter units are, naturally, of considerable bulk and weight. Each type of electrical servicing and starting trolley available for Service use is described in A.P. 2306M, and no attempt is made in this Chapter to cover such a wide field; a typical low-voltage low output d.c. system is described in the subsequent paragraphs, and this can be accepted as a broad outline

of current practice in the field of mobile power-supply.

Description

3. **Generating Set.** The generating set consists of a 6 kW generator coupled directly to a 500 c.c. air-cooled engine, the speed of the engine being governed to 4,000 r.p.m. The fuel and oil tanks are combined in one unit which is secured to a tubular frame above the generator.

4. **Batteries.** Two 12-volt batteries of the lead-acid type, each having a capacity of 40 amp. hr., are secured on the trolley platform. They are connected in series to give a 24-volt supply, and for energizing the generator when it is used as a motor for starting the engine.

5. **Instrument Panel and Cable Box.** Both the instrument panel and cable box are made of sheet metal, and are mounted in a metal frame which is secured to the chassis. The cable box is positioned above the instrument panel, and the electrical components for starting the trolley engine are mounted at one end. These engine starting components are a starting resistance, two magnetic relay switches types P and J, and the starter-switch. The other electrical components which are secured to the instrument panel are: a switch-panel (incorporating a master switch, a switch-box, a warning lamp and a push-button switch); a battery cut-out; a circuit breaker; a voltage regulator; a radio interference suppressor; two resistance units; and a terminal block.

The Electrical System

6. The functions of the electrical system are:—

- (a) To supply current to aircraft and other equipments for servicing and testing purposes. The current is supplied by the generator when the latter is operating, or by the batteries when the generator set is not operating.
- (b) To use the generator to charge the batteries and to maintain them in a fully charged condition while the generating set is operating.
- (c) To use current from the batteries to cause the generator to behave as a motor when it is required to start the engine of the generating set.
- (d) To prevent damage to the generator which would otherwise be caused by overloading and reversal of current.
- (e) To promote, or make easy, the function of each and all the electrical components by the coordination of the functions of the components and by the controlling effects of particular components.
- (f) To give warning when the circuit is interrupted by the circuit-breaker and energy is not being taken from the generator.

Electrical Components

7. **General.** The detailed wiring of the components on the instrument panel and in the cable box is as shown in the diagram on a brass plate secured to the hinged front cover of the cable box; a block diagram of a simple system is shown at Fig. 1.

8. **Suppressor.** Sparking at the brushes of a generator, no matter how slight, results in the radiation of electromagnetic waves which interfere with radio reception. Such radiation may take place not only from the actual source of interference, i.e. the generator, but also from any circuit connected to it.

The interference may also be conducted along the wiring to the power unit of the radio equipment if this is supplied from the general distribution bus-bars. Prevention of radio interference is achieved in two stages. The generator is totally enclosed in a metallic casing and the supply cables from the generator are either sheathed with metal braid or are enclosed in a metal conduit; this prevents direct radiation. To prevent interference being conducted along the wiring, a suppressor is fitted to the ends of the "screened" cables as close to the generator as is practicable. The case of the suppressor is bonded to the metal screen of the supply cables, but wiring on the "output" side of the suppressor need not be screened. A typical suppressor is shown at Fig. 2.

9. **Voltage Regulators.** The voltage supplied by the generator must remain constant if electrical equipment is to operate with maximum efficiency. Since the generator speed is directly proportional to the speed of the engine, some form of automatic voltage control is necessary to maintain the generator output voltage at the correct value over the entire speed range of the machine. The output voltage of a shunt-wound d.c. generator which is driven at varying speed can be regulated to a predetermined value by automatic control of the field current. If, for example, the voltage rises because of increased speed or decreased load, the field current must be reduced accordingly. Two methods of controlling the field current are in common use:—

(a) **Tirrell Control.** A resistance of specified value is connected in series with the shunt field winding but is normally short-circuited by a pair of contacts. These contacts open whenever the output voltage exceeds a predetermined level, thereby increasing the field resistance and reducing the field current.

(b) **Carbon Pile Control.** A stack of carbon discs or washers, held in contact by

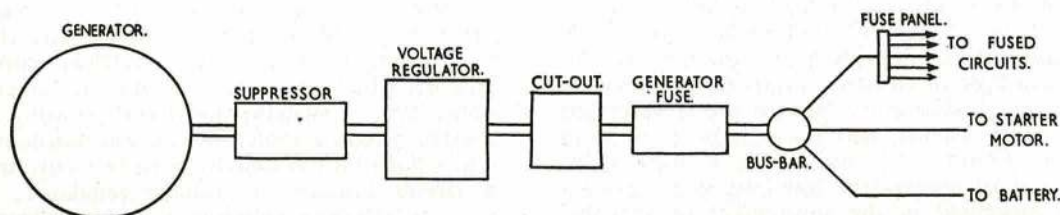


Fig. 1. BLOCK DIAGRAM OF SIMPLE SINGLE-GENERATOR SYSTEM.

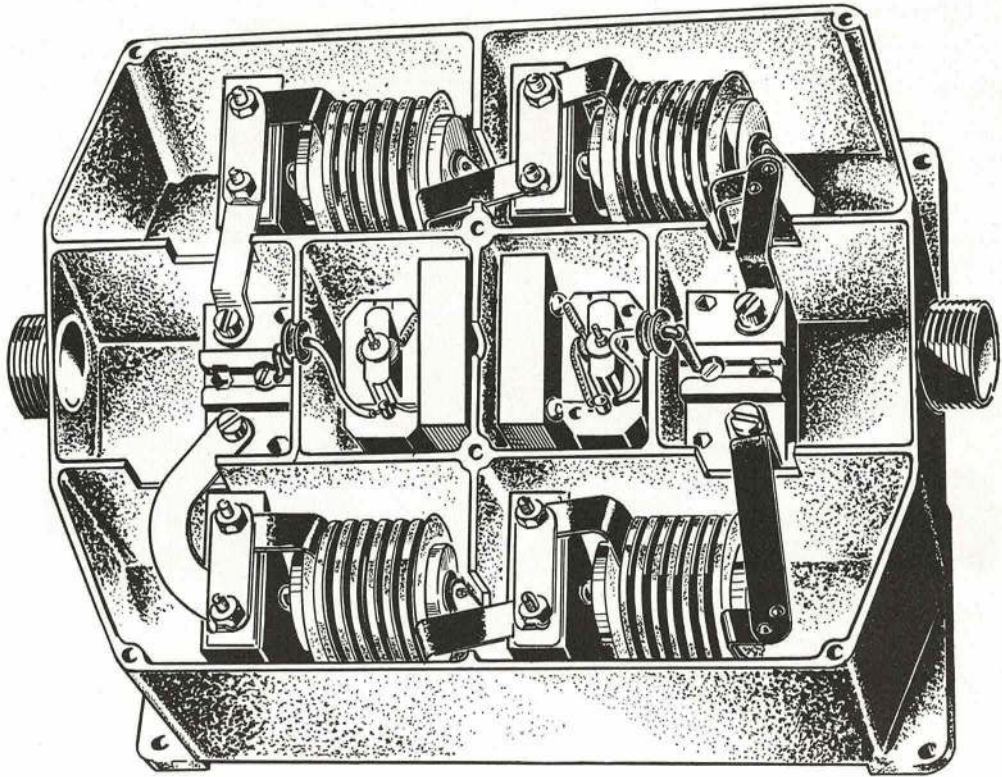


Fig. 2. TYPE W SUPPRESSOR.

spring pressure, is connected in series with the field winding. If the output voltage exceeds a given value the spring pressure on the carbon washers is reduced, thereby increasing the field resistance and reducing the field current. A typical regulator of this type is shown at Fig. 3.

10. Cut-Outs. Under normal operating conditions with the generator output voltage at its correct level, the battery takes a small charging current and the entire load is supplied by the generator. In the event of the generator voltage falling below the battery voltage, the entire load will fall on the battery and the generator will take a reverse current which, because of the low resistance of the generator armature, may be quite heavy. It is therefore essential to ensure that the generator is not connected to the bus-bars until the generator voltage exceeds the battery voltage, and it is equally important that the generator is disconnected from the bus-bars whenever a sizeable reverse current begins to flow through its

windings. These functions are performed automatically by the cut-out.

11. Two entirely different types of cut-out are at present in use. The older type connects the generator to the bus-bars when the generator voltage reaches a predetermined level, irrespective of the actual bus-bar (battery) voltage. The newer type, operating on a differential principle, connects the generator to the bus-bars when the generator voltage exceeds the bus-bar voltage by a predetermined amount. The disconnecting action of both types depends on the magnitude of the reverse current flowing back through the generator.

12. Circuit Breaker. A circuit breaker is a switch for making and breaking an electric circuit under normal conditions, and also under abnormal conditions such as a short circuit. Thus it acts as a fuse and protects the test set from possible damage by overload. Its trip operation is caused by an increase of temperature due to a flow of current in

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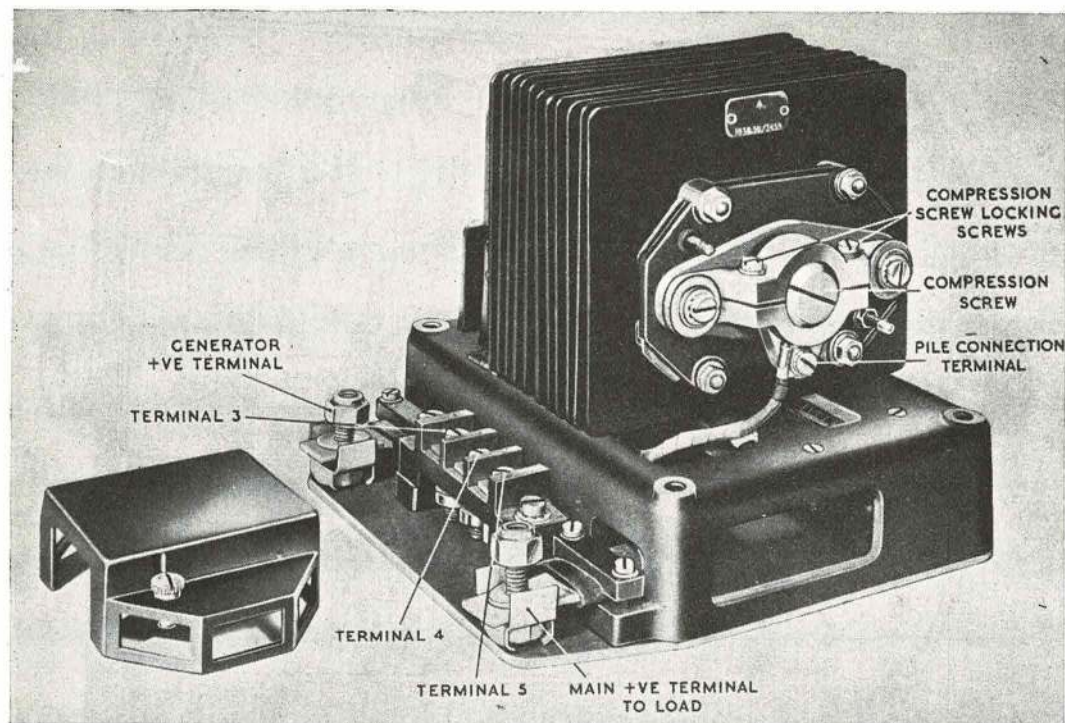


Fig. 3. VOLTAGE REGULATOR, TYPE 23.

excess of a predetermined value, or to some other faulty condition. After tripping on overload, the circuit breaker can be re-set by the type B No. 2 push-button control, provided that sufficient time has been allowed for the thermal element to cool. If the breaker trips a second time shortly after re-setting, it must be assumed that the overload still exists, and no further attempt at re-setting should be made until the overload has been cleared. A type DI circuit breaker is shown at Fig. 4.

13. Switchbox. The switchbox is used to disconnect the generator from the batteries and the output plug by open-circuiting the voltage coil of the cut-out, thus causing both the cut-out and the circuit breaker to open.

14. Master Switch. The master switch is used for disconnecting the output circuit of the generating set, but leaves the generator connected to the batteries. No current can be obtained from the plug on the supply cable when the master switch is in the OFF position. This switch is a standard ground/flight switch, with the markings GROUND

and FLIGHT covered by metal plates or which are the words OFF and ON respectively

15. Starting Resistance. The starting resistance reduces the voltage from the batteries, and thereby ensures that the generator is not overloaded when it is used as a starting motor.

16. Relay, Type P. The type P magnetic relay switch automatically breaks the shunt circuit in the generator when the starter button is depressed, and thereby prevents damage when the generator is used as a motor.

17. Relay, Type J. The type J magnetic relay switch automatically ensures that the voltage from the batteries is fed to the starter resistance. The reduced voltage from the starting resistance is then led to the compensating field windings in the generator to cause rotation and start the engine.

18. Starter Push Button. The starter push button is used to cause the operation of the types P and J relay switches, and thus control

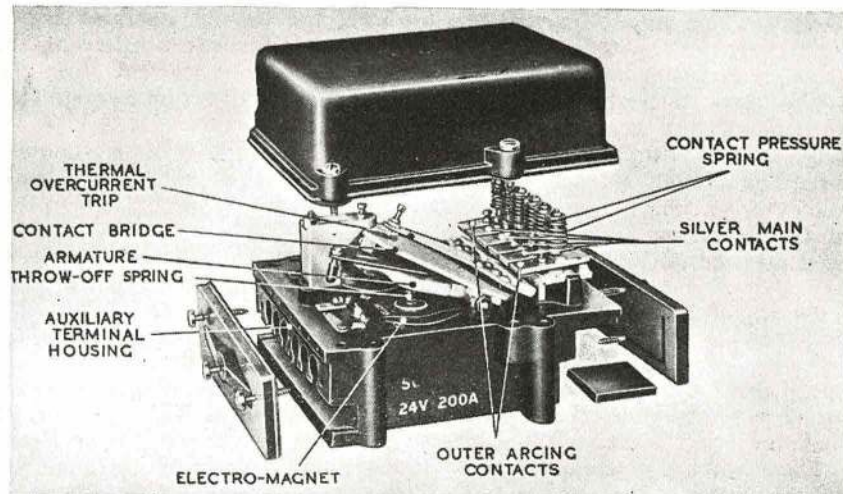


Fig. 4. TYPE DI CIRCUIT BREAKER.

the current supply to the generator for engine starting purposes.

19. **Generator.** The type of generator, an example of which is shown at Fig. 5, will have been selected specially for the generating

set because its output matches the requirements of the set.

Operation

20. When the starter button is pressed for the electrical starting of the engine, it operates

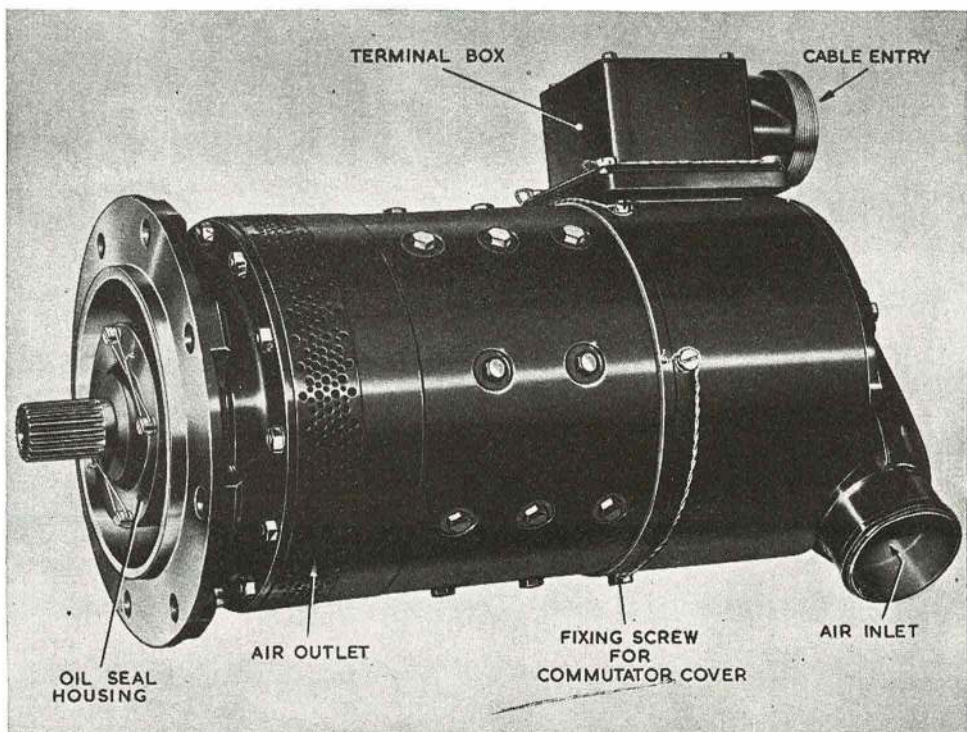


Fig. 5. GENERATOR.

the type J relay which allows current to flow from the batteries to the generator armature through the starting resistance; the current also flows through the type P relay which connects the generator shunt or field circuit to the positive terminal of the batteries. The circuit breaker is not operated and the warning lamp will be "ON" until the generator is running fast enough to generate the normal voltage.

21. When the engine is running, releasing the pressure on the starter button will break the starter circuit; the generator output will then be controlled by the voltage regulator. The warning lamp will be "OFF" when the predetermined level of current is being generated. The switchbox connects the generator to the batteries, and the circuit breaker and cut-out are operated to complete the circuit. If the output voltage from the generator falls below the predetermined

level, the cut-out operates and the circuit breaker is opened; this prevents the flow of a heavy discharge current from the batteries in a reversed direction through the generator.

22. The warning lamp should be "ON" when the set is not running and when the batteries are connected.

23. When the generating set is running the warning lamp will normally be "OFF". If the warning lamp comes "ON" it will indicate that the circuit breaker has opened; this will usually be caused by an overload. To close the circuit breaker, wait until the thermal unit has had time to cool and then press the type B No. 2 re-set button. If the warning lamp still remains "ON" after pressing the re-set button, a fault in the output circuit is indicated; this must be rectified before the generating set can be used again for supplying power.

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