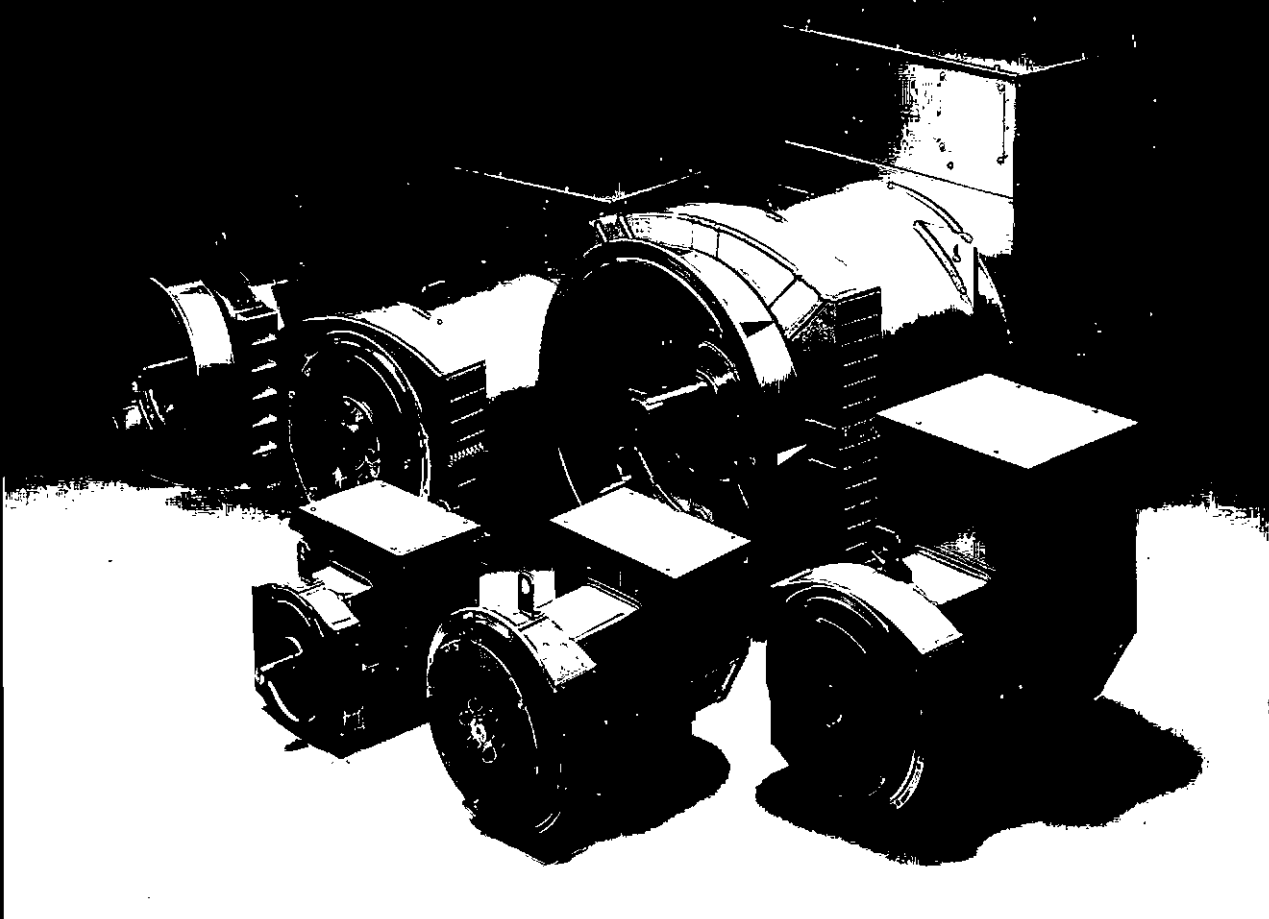
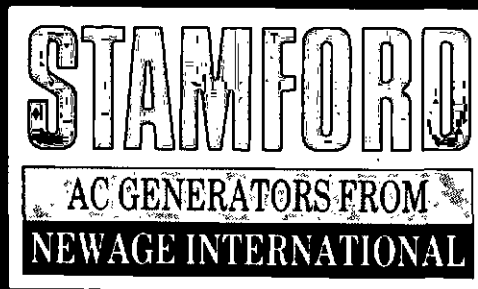


Publication No: MVH-073
1st Edition



Operation, Service & Maintenance Manual

for AC generators with the following prefixes:

MV634; MV636; MV734 & MV736.

SAFETY PRECAUTIONS

Before operating the generating set, read the generating set operation manual and this generator manual and become familiar with it and the equipment.

SAFE AND EFFICIENT OPERATION CAN ONLY BE ACHIEVED IF THE EQUIPMENT IS CORRECTLY OPERATED AND MAINTAINED.

Many accidents occur because of failure to follow fundamental rules and precautions.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

Observe all **WARNING/CAUTION** notices.

- Ensure installation meets all applicable safety and local electrical codes. Have all installations performed by a qualified electrician.
- Do not operate the generator with protective covers, access covers or terminal box covers removed.
- Disable engine starting circuits before carrying out maintenance.
- Disable closing circuits and/or place warning notices on any circuit breakers normally used for connection to the mains or other generators, to avoid accidental closure.

FOREWORD

The function of this book is to provide the user of the Stamford generator with an understanding of the principles of operation, the criteria for which the generator has been designed, and the installation and maintenance procedures. Specific areas where the lack of care or use of incorrect procedures could lead to equipment damage and/or personal injury are highlighted, with **WARNING** and/or **CAUTION** notes, and it is important that the contents of this book are read and understood before proceeding to fit or use the generator.

The Service, Sales and technical staff of Newage International are always ready to assist and reference to the company for advice is welcomed.

WARNING !



Incorrect installation, operation, servicing or replacement of parts can result in severe personal injury or death, and/or equipment damage.

Service personnel must be qualified to perform electrical and mechanical service.

CONTENTS

SAFETY PRECAUTIONS		IFC
FOREWORD		1
CONTENTS		2
SECTION 1	INTRODUCTION	3
1.1	INTRODUCTION	3
1.2	DESIGNATION	3
SECTION 2	PRINCIPLE OF OPERATION	4
SECTION 3	APPLICATION OF THE GENERATOR	5
SECTION 4	INSTALLATION - PART 1	7
4.1	LIFTING	7
4.2	ASSEMBLY TO ENGINE	7
4.2.1	TWO BEARING MACHINES	7
4.2.2	SINGLE BEARING MACHINES	7
4.3	EARTHING	7
4.4	PRE-RUNNING CHECKS	8
4.4.1	INSULATION CHECK	8
4.4.2	DIRECTION OF ROTATION	8
4.4.3	VOLTAGE AND FREQUENCY	8
4.4.4	AVR SETTINGS	8
4.5	GENERATOR SET TESTING	8
4.5.1	TEST METERING/CABLING	8
4.6	INITIAL START-UP	9
4.7	LOAD TESTING	9
4.7.1	AVR ADJUSTMENTS	9
4.7.2	UFRO (Under Frequency Roll Off)	9
4.7.3	OVER/V (Over Voltage)	10
4.7.4	EXC TRIP (Excitation Trip)	10
4.7.5	TRANSIENT LOAD SWITCHING ADJUSTMENTS	10
4.7.5.1	DIP	10
4.7.5.2	DWELL	10
4.8	ACCESSORIES	10
SECTION 5	INSTALLATION - PART 2	12
5.1	GENERAL	12
5.2	GLANDING	12
5.3	EARTHING	12
5.4	PROTECTION	12
5.5	COMMISSIONING	13
SECTION 6	ACCESSORIES	14
6.1	GENERAL	14
6.2	DROOP	14
6.2.1	SETTING PROCEDURE	15
6.2.2	ASTATIC CONTROL	15
6.3	VAR/PF CONTROL	15
6.3.1	VAR/PF CONTROLLER SETTING UP PROCEDURE	15
6.3.1.1	- PF MODE AND VAR MODE	15
6.3.1.2	DROOP POLARITY AND SETTING	16
6.4	VAR POLARITY AND SETTING	16
6.4.1	FAULT CURRENT LIMIT TRANSFORMERS	17
	SETTING PROCEDURE	17
SECTION 7	SERVICE AND MAINTENANCE	19
7.1	WINDING CONDITION	19
7.2	BEARINGS	19
7.3	AIR FILTERS	19
7.3.1	CLEANING PROCEDURE	19
7.3.2	RECHARGING (CHARGING)	20
7.4	FAULT FINDING	20
7.5	SEPARATE EXCITATION TEST PROCEDURE	20
7.5.1	GENERATOR WINDINGS, SENSING TRANSFORMER, ROTATING DIODES AND PMG.	20
7.5.1.1	BALANCED MAIN TERMINAL VOLTAGES	21
7.5.1.2	UNBALANCED MAIN TERMINAL VOLTAGES	21
7.5.2	AVR STATIC TEST	21
7.5.3	REMOVAL AND REPLACEMENT OF COMPONENT ASSEMBLIES	22
7.5.3.1	PERMANENT MAGNET GENERATOR	22
7.5.3.2	REMOVAL OF BEARINGS	22
7.5.3.3	MAIN ROTOR ASSEMBLY	23
SECTION 8	PARTS IDENTIFICATION	24
10	TYPICAL SINGLE BEARING MACHINE	25
11	TYPICAL TWO BEARING MACHINE	27
12	ROTATING RECTIFIER ASSEMBLY	28
WARRANTY DETAILS		IBC
SUBSIDIARY COMPANIES		BC

SECTION 1

INTRODUCTION

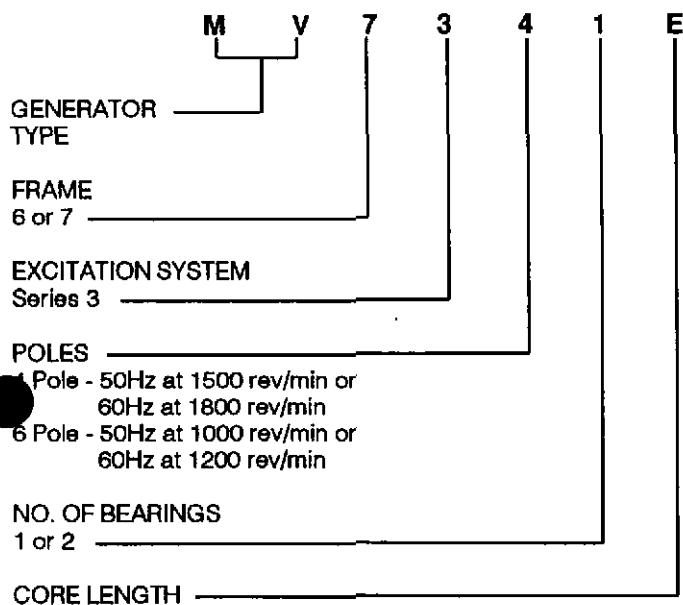
1.1 INTRODUCTION

The MV range of generators is of brushless rotating field design, available up to 3.3kV/50Hz (1500 rpm, 4 pole and 1000 rpm, 6 pole) and 4.16kV/60Hz (1800 rpm, 4 pole and 1200 rpm, 6 pole), and built to meet BS5000 Part 3 and international standards.

All MV generators use a permanent magnet generator (PMG) excitation system incorporating the MX321 AVR. Detailed specification sheets are available on request.

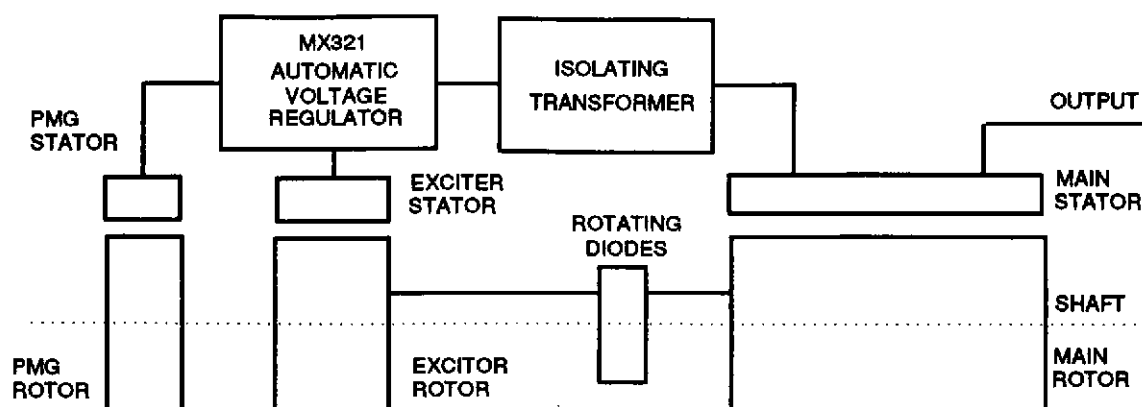
1.2 DESIGNATION

The generator frame size is designated by a code as follows:-



SECTION 2

PRINCIPLE OF OPERATION



The permanent magnet generator provides power for excitation of the exciter field via the MX321 AVR which is the controlling device governing the level of excitation provided to the exciter field. The AVR responds to a voltage sensing signal derived, via the isolating transformer, from the main stator winding. By controlling the low power of the exciter field, control of the high power requirement of the main field is achieved through the rectified output of the exciter armature.

The simple control principle described above hides the complexity of the electronic AVR which drives it. The AVR senses true rms voltage on three phases ensuring close regulation even with a generator output distorted by non-linear load e.g. thyristor controlled DC drive. In addition it detects engine speed and provides variable levels of voltage fall off with speed, below a pre-selected speed (Hz) setting, preventing over-excitation at low engine speeds and softening the effect of load switching to relieve the burden on the engine.

It also provides over-excitation protection during fault conditions, and over-voltage protection, with provision for operating an external circuit breaker, and additional adjustable elements are incorporated to shape and optimise the heavy load switching capability of the generating set, by varying the generator performance during load switching to match the engine performance.

The detailed function of the AVR circuits and their adjustment are covered in the load testing section 4.7.1.

In addition the AVR incorporates circuits which, when used in conjunction with accessories, can provide for parallel operation either with 'droop' or 'astatic' control, short circuit current limit, and VAR/PF control.

Function and adjustment of the accessories which can be fitted inside the generator terminal box are covered in the accessories section of this book.

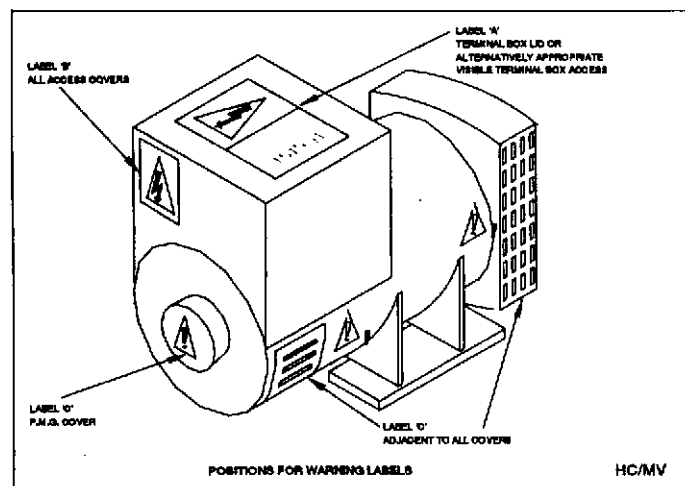
Separate instructions are provided with other accessories available for control panel mounting.

SECTION 3

APPLICATION OF THE GENERATOR

The generator is supplied as a component part for installation in a generating set. It is not, therefore, practicable to fit all the necessary warning/hazard labels during generator manufacture. The additional labels required are packaged with this Manual, together with a drawing identifying their locations (see above).

It is the responsibility of the generating set manufacturer to ensure that the correct labels are fitted, and are clearly visible.



ratings - refer to the generator nameplate for rating and ambient. In the event that the generator is required to operate in an ambient in excess of the nameplate value or at altitudes in excess of 1000 metres above sea level, refer to the factory.

The generators are of air-ventilated screen protected drip-proof design and are not suitable for mounting outdoors unless adequately protected by the use of canopies. Anti-condensation heaters are recommended during storage and for standby duty to ensure winding insulation is maintained in good condition.

When installed in a closed canopy it must be ensured that the ambient temperature of the cooling air to the generator does not exceed that for which the generator has been rated.

The canopy should be designed such that the engine air intake to the canopy is separated from the generator intake, particularly where the radiator cooling fan is required to draw air into the canopy. In addition the generator air intake to the canopy should be designed such that the ingress of moisture is prohibited, preferably by use of a two stage filter.

The air intake/outlet must be suitable for the air flow given in the following table with additional pressure drops less than or equal to those given below:

Frame	Air Flow		Additional (intake/outlet) Pressure Drop
	50Hz	60Hz	
6	0.81m ³ /sec (1720cfm)	0.97m ³ /sec (2060cfm)	6mm water gauge (0.25")
7	1.32m ³ /sec (2800cfm)	1.58m ³ /sec (3360cfm)	6mm water gauge (0.25")

If specified at the time of ordering, the generator itself may be fitted with air filters. These are oil charged gauze filters and require charging during installation.



CAUTION !

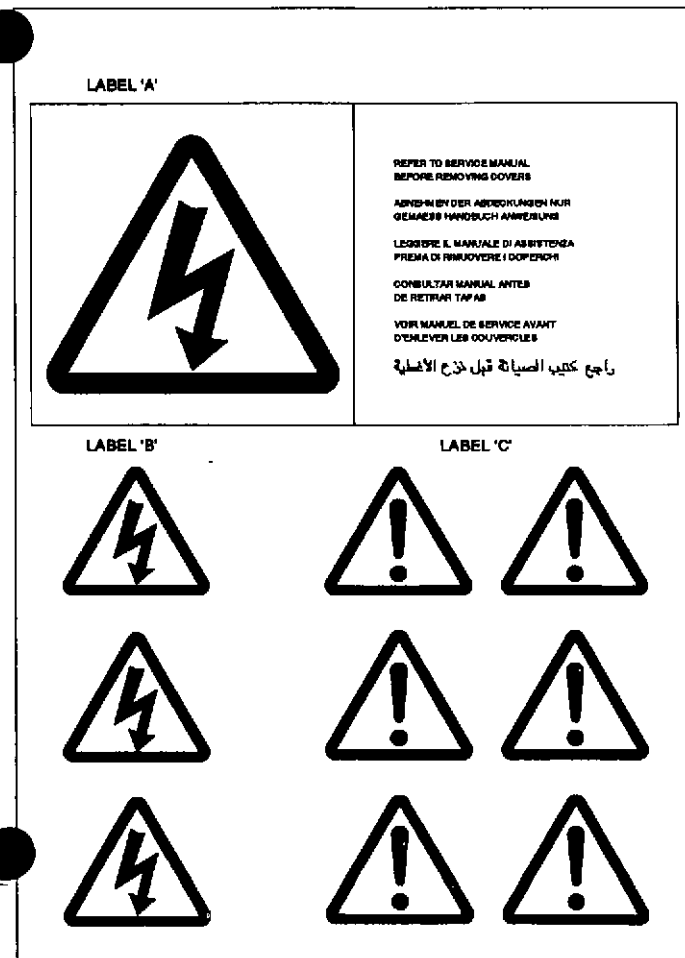
Reduction in cooling air flow or inadequate protection to the generator can result in damage and/or failure of windings.

Dynamic balancing of the generator rotor assembly has been carried out during manufacture in accordance with BS 6861 Part 1 Grade 2.5 to ensure vibration limits of the generator are in accordance with BS 4999 Part 142.

The main vibration frequencies produced by the component generator are as follows:-

4 pole	1500 rpm	25Hz
	1800 rpm	30Hz
6 pole	1000 rpm	16.7Hz
	1200 rpm	20Hz

However, vibrations induced by the engine are complex and contain frequencies of 1.5, 3, 5 or more times the fundamental frequency of vibration. These induced vibrations can result in generator vibration levels higher than those derived from the generator itself. It is the responsibility of the generating set



The generators have been designed for use in a maximum ambient temperature of 40°C. in accordance with BS5000

bedplate and mountings are such that the vibration limits of B.S. 5000 Part 3 are not exceeded.

In standby applications where the running time is limited and reduced life expectancy is accepted, higher levels than specified in BS5000 can be tolerated, up to a maximum of 18mm/sec.

Two bearing generators require a substantial bedplate with engine/generator mounting pads to ensure a good base for accurate alignment. Close coupling of engine to generator can increase the overall rigidity of the set. For the purposes of establishing set design the bending moment at the engine flywheel housing to generator adaptor interface should not exceed 2000 ft lbs (275 kgm). A flexible coupling, designed to suit the specific engine/generator combination, is recommended to minimise torsional effects.

Alignment of single bearing generators is critical and vibration can occur due to the flexing of the flanges between the engine and generator. As far as the generator is concerned the maximum bending moment at this point must not exceed 2000 ft lbs (275 kgm).

Single bearing generators require a substantial bedplate with engine/generator mounting pads to ensure a good base for accurate alignment.

The maximum bending moment of the engine flange must be checked with the engine manufacturer.

Torsional vibrations occur in all engine-driven shaft systems and may be of a magnitude to cause damage at certain critical speeds. It is therefore necessary to consider the torsional vibration effect on the generator shaft and couplings.

It is the responsibility of the generator set manufacturer to ensure compatibility, and for this purpose drawings showing the shaft dimensions and rotor inertias are available for customers to forward to the engine supplier. In the case of single bearing generators coupling details are included.

**CAUTION !**

Torsional incompatibility and/or excessive vibration levels can cause damage or failure of generator and/or engine components.

The terminal box is designed to separate the electrical connections from the generator air intake and is constructed with removable panels for easy adaptation to suit specific glanding requirements. Within the terminal box there are insulated terminals for line and neutral connections and provision for earthing. Additional earthing points are provided on the generator feet.

The neutral is NOT connected to the frame.

The main stator winding has six leads brought out to the terminals in the terminal box. The three leads brought to the neutral terminal have sufficient length allowed to provide for the mounting of differential protection current transformers.

**WARNING !**

No earth connections are made on the generator and reference to site regulations for earthing must be made. Incorrect earthing or protection arrangements can result in personal injury or death.

The generator AVR incorporates protection circuits which operate on overload or fault conditions. The circuit operates after a time delay of approximately 8 seconds and causes removal of generator excitation with subsequent collapse of generator output. The circuit latches after operation and in order to reset it the generator must be stopped and restarted. The system designer should ensure that these AVR functions are compatible with the overall system protection.

Fault current curves (decrement curves), together with generator reactance data, are available on request to assist the system designer to select circuit breakers, calculate fault currents and ensure discrimination within the load network.

This instruction book must be read before installation of the generator into a generating set. Maintenance must be carried out with the generating set out of service and precautions taken to avoid accidental starting of the generator set during maintenance.

**WARNING !**

Incorrect installation, service or replacement of parts can result in severe personal injury or death, and/or equipment damage. Service personnel must be qualified to perform electrical and mechanical service.

SECTION 4

INSTALLATION - PART 1

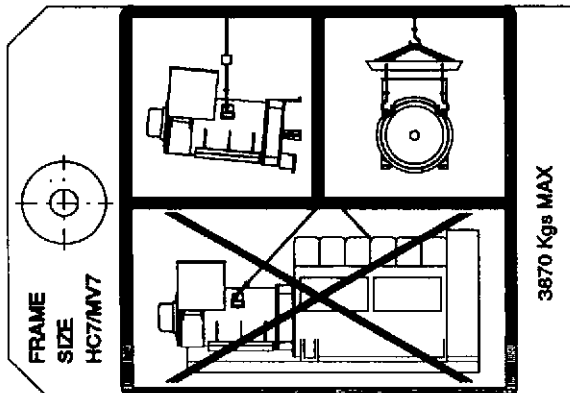
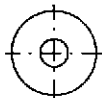
4.1 LIFTING

Two lifting lugs are provided for use with a shackle and pin type lifting aid. Chains of suitable length and lifting capacity must be used. Lifting points are designed to be as close to the centre of gravity of the generator as possible, but due to design restrictions it is not possible to guarantee that the generator frame will remain horizontal while lifting. Care is therefore needed to avoid personal injury or equipment damage. Correct lifting arrangement is shown on the label attached to the lifting eye (see below).

Single bearing generators are supplied with the rotor clamped to the stator frame with a transit strap to prevent axial movement of the rotor. Once this strap is removed, to couple the rotor to the engine, the rotor is free to move in the frame, and care is needed during coupling and alignment to ensure the frame is kept in the horizontal plane.

IMPORTANT

REFER TO SERVICE MANUAL BEFORE REMOVING COVERS. IT IS THE GENERATOR SET MANUFACTURER'S RESPONSIBILITY TO FIT THE SELF ADHESIVE WARNING LABELS SUPPLIED WITH THE GENERATOR. THE LABEL SHEET CAN BE FOUND WITH THE INSTRUCTION BOOK



WARNING !

Incorrect lifting or inadequate lifting capacity can result in severe personal injury or equipment damage. MINIMUM LIFTING CAPACITY REQUIRED IS 5 TONNES. Generator lifting lugs should not be used for lifting the complete generating set.



WARNING !

Incorrect guarding and/or generator alignment can result in personal injury and/or equipment damage.

4.2.2 SINGLE BEARING MACHINES

Alignment of single bearing generators is critical. If necessary shim the generator feet to ensure alignment of the machined surfaces.

The sequence of assembly to the engine should generally be as follows:

1. On the engine check the distance from the coupling mating face on the flywheel to the flywheel housing mating face. This should be within 0.5mm of nominal dimension. This is necessary to ensure that a thrust is not applied to the AC generator bearing or engine bearing.
2. Check that the bolts securing the flexible plates to the coupling hub are tight and locked into position. Torque tightening is 84kgm (822Nm; 607 lb ft).
3. Remove covers from the drive end of the generator to gain access to coupling and adaptor bolts.
4. Check that coupling discs are concentric with adaptor spigot. This can be adjusted by the use of tapered wooden wedges between the fan and adaptor. Alternatively the rotor can be suspended by means of a rope sling through the adaptor opening.
5. Offer the AC generator to engine and engage both coupling discs and housing spigots at the same time, finally pulling home by using the housing and coupling bolts. Use heavy gauge washers between bolt head and discs on disc to flywheel bolts.
6. Tighten coupling disc to flywheel bolts. Refer to engine manual for torque setting of disc to flywheel bolts.
7. Remove wooden wedges.
8. Replace covers. Check for excessive vibration at the time of initial run-up.

WARNING !

Incorrect guarding and/or generator alignment can result in personal injury and/or equipment damage.

4.2 ASSEMBLY TO ENGINE

4.2.1 TWO BEARING MACHINES

A flexible coupling should be fitted and aligned in accordance

4.3 EARTHING

The generator frame should be solidly bonded to the generating set bedplate. If antivibration mounts are fitted between the

main line cables) should bridge across the antivibration mount.



CAUTION !

Refer to local regulations to ensure that the correct earthing procedure has been followed.

4.4 PRE-RUNNING CHECKS

4.4.1 INSULATION CHECKS

Before starting the generating set after completing assembly, test the insulation resistance of the main stator windings.

The AVR should be disconnected during this test and Resistance Temperature Detector (RTD) leads grounded.

A 2500V motorised Megger or similar instrument should be used. Separate the three neutral leads, ground V and W leads and megger U to ground. Repeat for V phase with U and W grounded and W phase with U and V grounded.

The insulation resistance should not be less than 400MΩ and the polarisation index should be in the order of 2 or greater at 20°C.

If these values cannot be achieved the winding should be dried out as detailed in the Service and Maintenance section of this manual.

4.4.2 DIRECTION OF ROTATION



WARNING !

The windings have been H.V. tested during manufacture and further H.V. testing may degrade the insulation with consequent reduction in operating life. Should it be necessary to demonstrate H.V. testing, for customer acceptance, the tests must be carried out at reduced voltage levels i.e. (Test Voltage = 0.8 (2 X Rated Voltage + 1000))

All machines are fitted with a radial bladed fan and are suitable for running in either direction of rotation. The generator is supplied to give a phase sequence of U V W with the generator running clockwise looking at the drive end (unless otherwise specified at the time of ordering). If the generator phase rotation has to be reversed after the generator has been despatched apply to factory for appropriate wiring diagrams.

4.4.3 VOLTAGE AND FREQUENCY

Check that the voltage and frequency levels required for the generating set application are within the range indicated on the generator nameplate.

4.4.4 AVR SETTINGS

To make AVR selections and adjustments remove the AVR cover and refer to Fig. 1 for location of selection links.

Most of the AVR adjustments are factory set in positions which will give satisfactory performance during initial running tests. Subsequent adjustment may be required to achieve optimum performance of the set under operating conditions. Refer to section 4.7 for details.

The following 'jumper' connections on the AVR should be

checked to ensure they are correctly selected for the generating set application:

1) Frequency selection

Connect jumper link to suit generator poleage, i.e. 4 or 6 poles and frequency, i.e. 50 or 60Hz.

6P/50Hz	corresponds to	1000 r.p.m.	No Link
6P/60Hz	"	1200 r.p.m.	Link 1-2
4P/50Hz	"	1500 r.p.m.	Link 2-3
4P/60Hz	"	1800 r.p.m.	Link 1-3

2) Stability selection

Connect jumper link to terminals A and B i.e. OVER 550kW.

4.5 GENERATOR SET TESTING

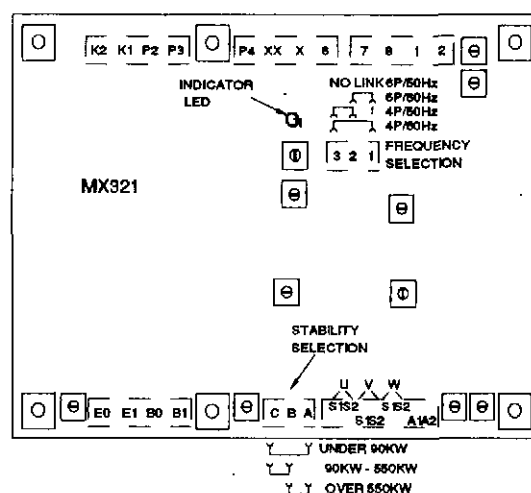


Fig. 1

4.5.1 TEST METERING/CABLING



WARNING !

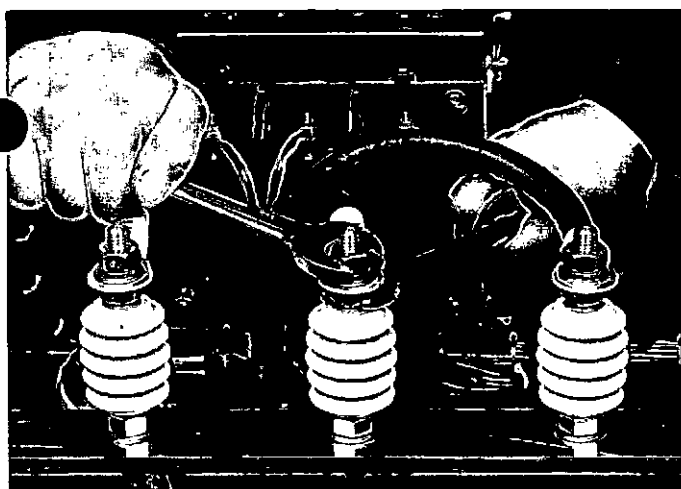
During testing it may be necessary to remove covers to adjust controls exposing 'live' terminals or components. Only personnel qualified to perform electrical service should carry out testing and/or adjustments.

Connect any instrument wiring and cabling required for initial test purposes with permanent or spring-clip type connectors. Minimum instrumentation for testing should be line to line or line to neutral voltmeter, Hz meter, load current metering and kW meter. If reactive load is used a power factor meter is desirable.



CAUTION !

When fitting power cables for load testing purposes, ensure cable voltage rating is at least equal to the generator rated voltage. The load cable termination should be placed on top of the winding lead termination and clamped between the two nuts provided, as shown sideleaf. Support the cables to prevent side load on the terminal.



WARNING !

Check that all wiring terminations for internal or external wiring are secure, and fit all terminal box covers and guards. Failure to secure wiring and/or covers may result in personal injury and/or equipment failure.

4.6 INITIAL START-UP

On completion of generating set assembly and before starting the generating set ensure that all engine manufacturer's pre-running procedures have been completed, and that adjustment of the engine governor is such that the generator will not be subjected to speeds in excess of 125% of the rated speed.

In addition remove the AVR cover and turn "VOLTS" control fully anti-clockwise.

CAUTION !

Overspeeding of the generator during initial setting of the speed governor can result in damage to the generator rotating components.

Start the generating set and run on no-load at nominal frequency. Slowly turn "VOLTS" control potentiometer clockwise until rated voltage is reached. Refer to Fig. 2 for potentiometer location.

CAUTION !

Do not increase the voltage above the rated generator voltage shown on the generator nameplate.

The "STABILITY" control potentiometer will have been pre-set and should normally not require adjustment, but should this be required, usually identified by oscillation of the voltmeter, refer to Fig. 2 for potentiometer location and proceed as follows:-

- 1 Run the generating set on no-load and check that speed is correct and stable
- 2 Turn the "STABILITY" control potentiometer clockwise, then turn slowly anti-clockwise until the generator voltage starts to become unstable.

The correct setting is slightly clockwise from this position (i.e. where the machine volts are stable but close to the unstable region).

4.7 LOAD TESTING

4.7.1 AVR ADJUSTMENTS

Refer to Fig. 2 for control potentiometer locations.

Having adjusted "VOLTS" and "STABILITY" during the initial start-up procedure, the AVR control functions "UFRO", "OVER/V" and "EXC. TRIP" should not normally need adjustment. If however, poor voltage regulation on-load, or voltage collapse is experienced, refer to the following paragraphs on each function to a) check that the symptoms observed do indicate adjustment is necessary, and b) to make the adjustment correctly.

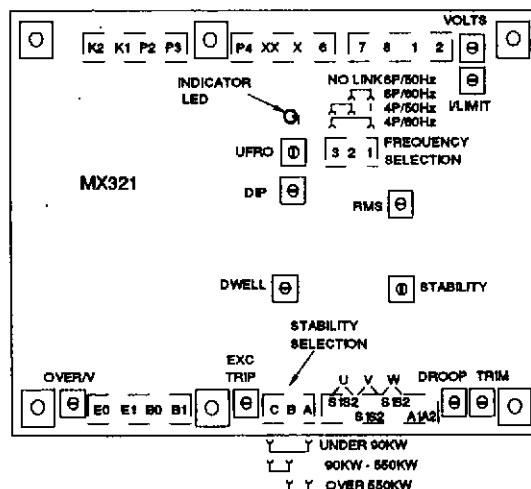


Fig. 2

4.7.2 UFRO (Under Frequency Roll Off)

The AVR incorporates an underspeed protection circuit which gives a voltage/speed (Hz) characteristic as shown in Fig. 3.

The UFRO control potentiometer sets the "knee point".

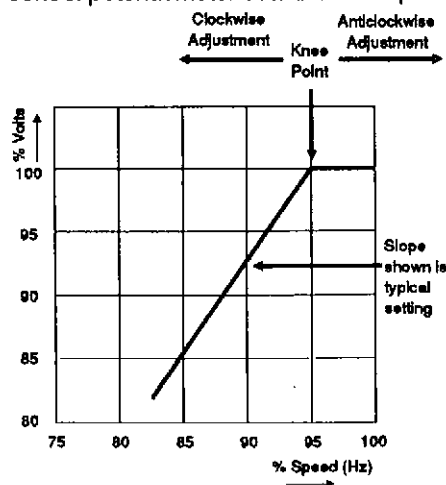


Fig. 3

Symptoms of incorrect setting are a) the light emitting diode (LED) indicator, just above the "UFRO" control potentiometer, being permanently lit when the generator is on load, and b) poor voltage regulation on load, i.e. operation on the sloping part of the characteristic.

Clockwise adjustment lowers the frequency (speed) setting of the "knee point" and extinguishes the LED. For optimum setting the LED should illuminate as the frequency falls just below



CAUTION !

If the LED is illuminated and no output voltage is present, refer to EXC TRIP and/or OVER/V sections below.

4.7.3 OVER/V (Over Voltage)

Over voltage protection circuitry is included in the AVR to remove generator excitation in the event of loss of AVR sensing input.

Incorrect setting would cause the generator output voltage to collapse at no-load or on removal of load, and the LED to be illuminated.

The correct setting is 300V $\pm$ 5% across terminals E1, E0.

Clockwise adjustment of the "OVER/V" control potentiometer will increase the voltage at which the circuit operates.

4.7.4 EXC TRIP (Excitation Trip)

An AVR supplied from a permanent magnet generator inherently delivers maximum excitation power on a line to line or line to neutral short circuit. In order to protect the generator windings the AVR incorporates an over excitation circuit which detects high excitation and removes it after a pre-determined time, i.e. 8-10 seconds.

Symptoms of incorrect setting are the generator output collapses on load or small overload, and the LED is permanently illuminated.

The correct setting is 70 volts $\pm$ 5% between terminals X and XX.

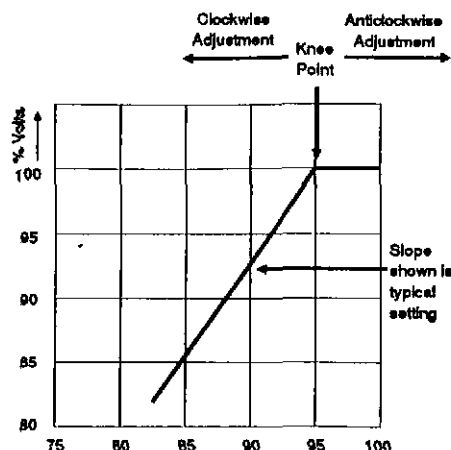
4.7.5 TRANSIENT LOAD SWITCHING ADJUSTMENTS

The additional function controls of "DIP" and "DWELL" are provided to enable the load acceptance capability of the generating set to be optimised. The overall generating set performance depends upon the engine capability and governor response, in conjunction with the generator characteristics.

It is not possible to adjust the level of voltage dip or recovery independently from the engine performance, and there will always be a 'trade off' between frequency dip and voltage dip.

4.7.5.1 DIP

The dip function control potentiometer adjusts the slope of the voltage/speed (Hz) characteristic below the knee point as shown in Fig.4.



4.7.5.2 DWELL

The dwell function introduces a time delay between the recovery of voltage and recovery of speed.

The purpose of the time delay is to reduce the generator kW below the available engine kW during the recovery period, thus allowing an improved speed recovery.

Again this control is only functional below the 'knee point', i.e. if the speed stays above the knee point during load switching there is no effect from the "DWELL" function setting. Clockwise adjustment gives increased recovery time.

The graphs shown below are representations only, since it is impossible to show the combined effects of voltage regulator and engine governor performance. A typical generating set load switching trace is illustrated in Fig. 6.

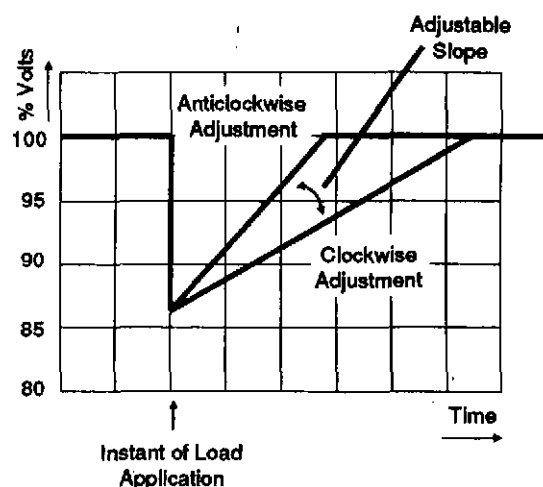


Fig. 5

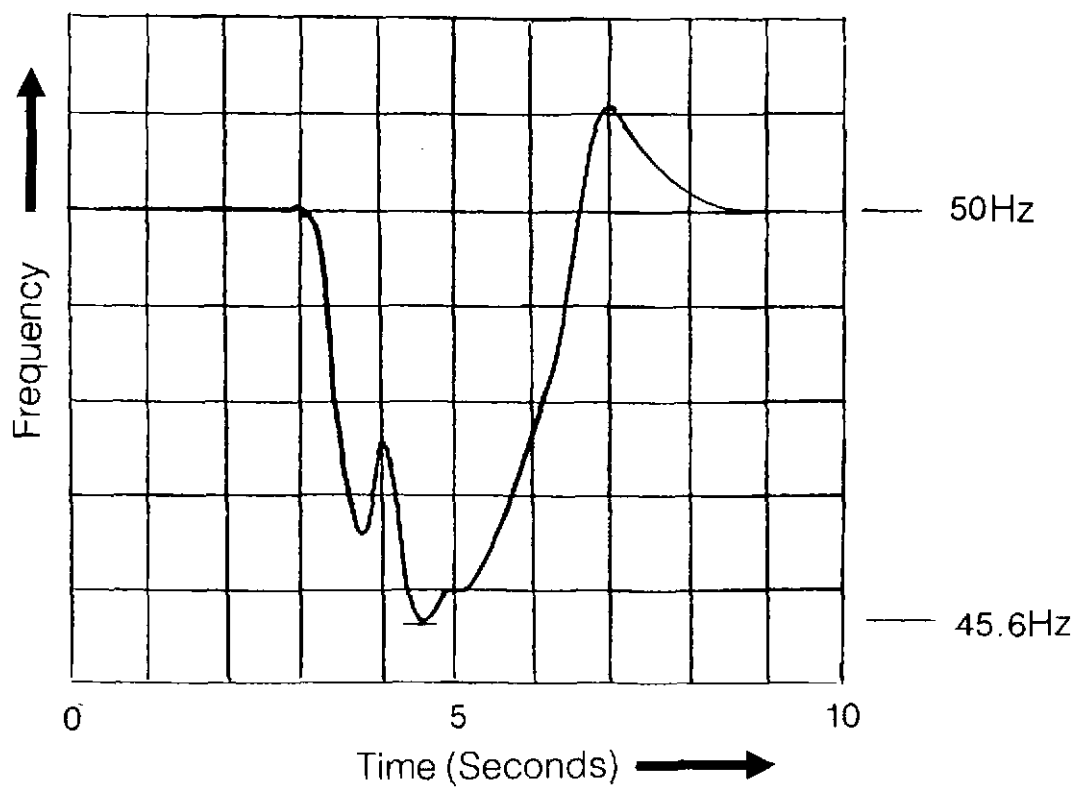
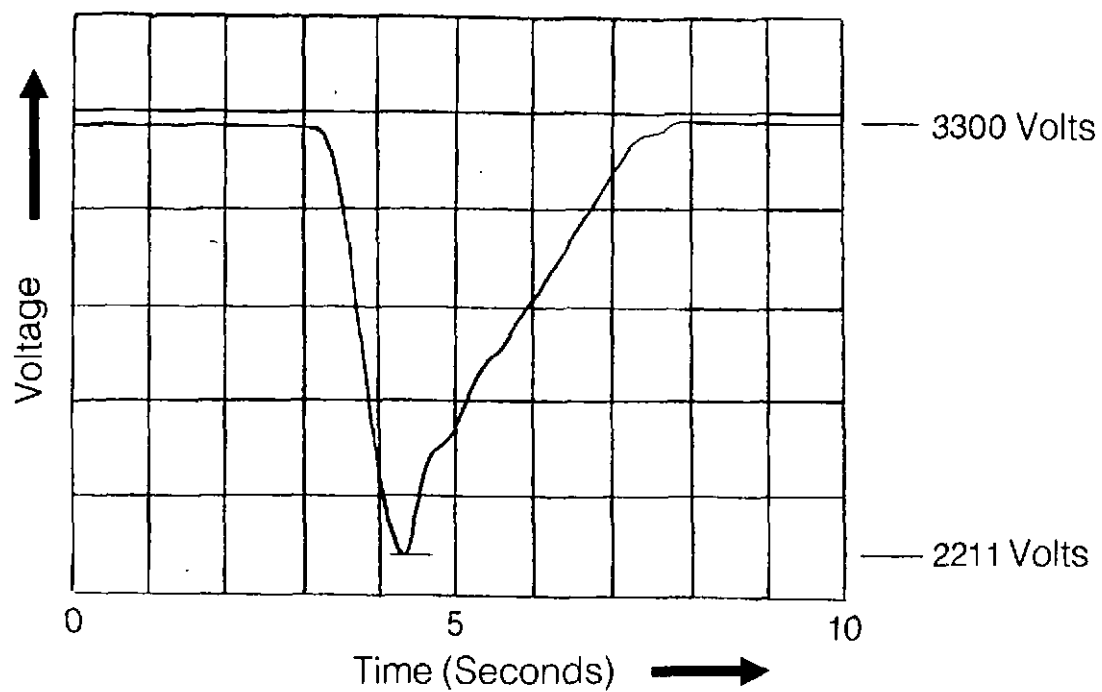
4.8 ACCESSORIES

Refer to the "ACCESSORIES" Section of this Manual for setting up procedures related to generator mounted accessories.

If there are accessories for control panel mounting supplied with the generator refer to the specific accessory fitting procedures inserted inside the back cover of this book.

Replace AVR access cover after all adjustments are completed.

TYPICAL PERFORMANCE OF 1250kVA GENERATING SET WITH 900kW STEP LOAD APPLIED



SECTION 5

INSTALLATION - PART 2

5.1 GENERAL

The extent of site installation will depend upon the generating set build, e.g. if the generator is installed in a canopied set with integral switchboards and circuit breaker, on site installation will be limited to connecting up the site load to the generating set output terminals. In this case reference should be made to the generating set manufacturer's instruction book and any pertinent local regulations.

If the generator has been installed on a set without switchboard or circuit breaker the following points relating to connecting up the generator should be noted.

5.2 GLANDING

The terminal box is most conveniently glanded on either the right or left hand side. Both panels are removable for drilling/punching to suit glands/or glanding boxes. If single core cables are taken through the terminal box side panel an insulated or non-magnetic gland plate should be fitted.

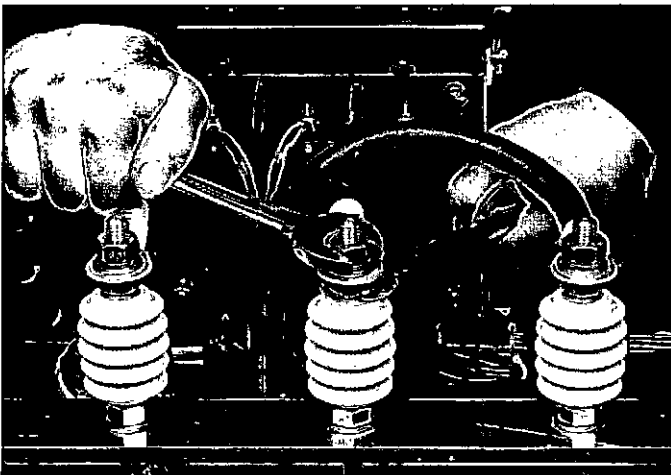
Incoming cables should be supported from either below or above the box level and at a sufficient distance from the centre line of the generating set so as to avoid a tight radius at the point of entry into the terminal box panel, and allow movement of the generator set on its anti-vibration mountings without excessive stress on the cable.

In addition the cable should be clamped at the gland so that forces on the cable due to set movement cannot be transmitted to the insulated terminals in the terminal box.

Before making final connections, test the insulation resistance of the windings. The AVR should be disconnected during this test and RTD leads grounded.

A 2500V motorised Megger should be used for the main stator winding. The insulation resistance should not be less than 400M Ω and the polarisation index should be in the order of 2 or greater at 20°C. If these values cannot be achieved the windings should be dried out as detailed in the Service and Maintenance section of this manual.

A 1000V instrument is suitable for all other windings and a minimum insulation resistance value of 1M Ω should be recorded.



When making connections to the insulated terminals the incoming cable termination should be placed on top of the winding lead termination(s) and clamped between the two nuts provided as shown in Fig. 7.

5.3 EARTHING

The neutral of the generator is not bonded to the generator frame as supplied from the factory. An earth terminal is provided inside the terminal box adjacent to the main terminals. Should it be required to operate with the neutral earthed a substantial earth conductor (normally equivalent to one half of the section of the line conductors) must be connected between the neutral and the earth terminal inside the terminal box. Additional earth terminals are provided on the generator feet. These should be already bonded to the generating set bedplate by the generating set builder, but will normally be required to be connected to the site earth system.



CAUTION !

To avoid the possibility of swarf entering any electrical components in the terminal box, panels must be removed for drilling.



CAUTION !

Reference to local electricity regulations or safety rules should be made to ensure correct earthing procedures have been followed.

5.4 PROTECTION

Although the AVR incorporates certain protective elements as already described, it is the responsibility of the end user and his contractors/sub-contractors to ensure that the overall system protection meets the needs of any inspectorate, local electricity authority or safety rules, pertaining to the site location.

High voltage transient surges above 14kV generated by a switching device or lightning strikes on overhead cables must be prevented from reaching the generator terminals by the fitting of correctly designed surge suppression devices. These must be connected as close to the generator terminals as practicable.

To enable the system designer to achieve the necessary protection and/or discrimination, fault current curves are available on request from the factory, together with generator reactance values to enable fault current calculations to be made.

Space and sufficient winding lead length is allowed in the generator terminal box for the fitting of differential protection current transformers if required.



WARNING !

Incorrect installation and/or protective systems can result in personal injury and/or equipment damage. Installers must be qualified to perform electrical installation work.

5.5 COMMISSIONING

Ensure that all external cabling is correct and that all the generating set manufacturer's pre-running checks have been carried out before starting the set.

Generators fitted with air filters should have the filters charged with oil prior to commissioning tests. Refer to Service and Maintenance section for charging (subsection 7.3.2).

The generator AVR controls will have been adjusted during the generating set manufacturer's tests and should normally not require further adjustment.

Should malfunction occur during commissioning refer to Service and Maintenance section 'Fault Finding' procedure.

SECTION 6

ACCESSORIES

6.1 GENERAL

Generator control accessories may be fitted, as an option, in the generator terminal box. If fitted at the time of supply, the wiring diagram(s) in the back of this book shows the connections. When the options are supplied separately, fitting instructions are provided with the accessory.

Available accessories for generator mounting are as follows:

Droop transformer;
VAr/PF controller and current transformers;
Fault current limit transformers.

There are two terminal box mounted accessories, which relate to parallel operation i.e. DROOP and VAr/PF controller. (See Paragraph 6.2 and 6.3 respectively). Understanding of the following notes on parallel operation is essential before attempting the fitting or setting of either accessory.

When operating in parallel with other generators or the mains, it is essential that the phase sequence of the incoming generator matches that of the busbar and also that all of the following conditions are met before the circuit breaker of the incoming generator is closed on to the busbar (or operational generator).

1. Frequency must match within close limits
2. Voltages must match within close limits
3. Phase angle of voltages must match within close limits.

A variety of techniques, varying from simple synchronising lamps to fully automatic synchronisers, can be used to ensure these conditions are met.



CAUTION !
Failure to meet conditions 1, 2, and 3 when closing the circuit breaker, will generate excessive mechanical and electrical stresses, resulting in equipment damage.

Once connected in parallel a minimum instrumentation level per generator of voltmeter, ammeter, wattmeter (measuring total power per generator), and frequency meter is required in order to adjust the engine and generator controls to share kW in relation to engine ratings and kVAr in relation to generator ratings.

It is important to recognise that:

1. True kW are derived from the engine, and speed governor characteristics determine the kW sharing between sets

and

2. kVAr are derived from the generator, and excitation control characteristics determine the kVAr sharing.

Reference should be made to the generating set manufacturer's instructions for setting the governor controls.

6.2 DROOP

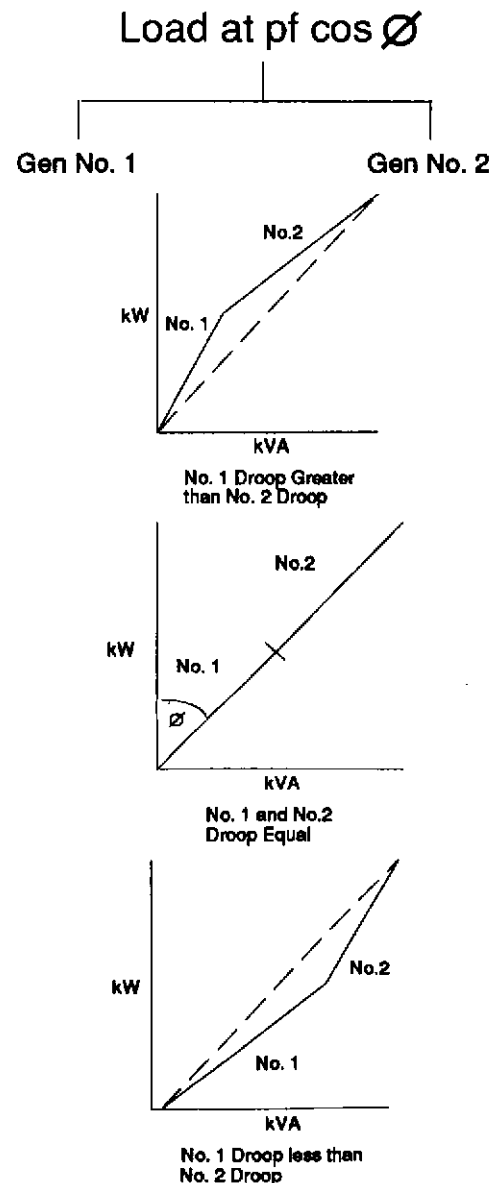
The most commonly used method of kVAr sharing is to create a generator voltage characteristic which falls with decreasing power factor (increasing kVAr). This is achieved with a current transformer (CT) which provides a signal dependent on current phase angle (i.e. power factor) to the AVR.

Note: if 'current limit' transformers are fitted the 'W' phase CT provides both droop and current limit.

The current transformer has a burden resistor on the AVR board, and a percentage of the burden resistor voltage is summed into the AVR circuit. Increasing droop is obtained by turning the "DROOP" control potentiometer clockwise.

Fig. 8. indicates the effect of droop in a simple two generator system.

Generally 5% droop at full load current zero pf is sufficient to ensure kVAr sharing.



If the droop accessory has been supplied with the generator it will have been set to a nominal 5% droop at full load zero power factor current, and diagrams will be included inside the back cover of this book.

6.2.1 Setting procedure

Depending upon available load the following settings should be used - all are based on rated current level.

0.8pf. LOAD	(at full load current)	SET DROOP TO 3%
0pf LOAD	(at full load current)	SET DROOP TO 5%

Setting the droop with low power factor load is the most accurate.

Run each generator as a single unit at rated frequency or rated frequency + 4% depending upon type of governor and nominal voltage. Apply available load to rated current of the generator. Adjust 'DROOP' control to give droop in line with above table. Clockwise rotation increases amount of droop.

Note 1

Reverse polarity of the CT will raise the generator voltage with load. The polarities S1-S2 shown on the wiring diagrams are correct for clockwise rotation of the generator looking at the drive end. Reversed rotation requires S1-S2 to be reversed.

Note 2

The most important aspect is to set all generators equal. The precise level of droop is less critical.

Note 3

A generator fitted with droop circuit, operated as a single unit at rated load 0.8pf, is unable to maintain the usual $\pm 1\frac{1}{2}\%$ regulation. A shorting switch can be connected across S1-S2 to restore regulation for single running.

WARNING !



LOSS OF FUEL to an engine can cause its generator to motor with consequent damage to the generator windings. Reverse power relays should be fitted to trip main circuit breaker.

LOSS OF EXCITATION to the generator can result in large current oscillations with consequent damage to generator windings. Excitation loss detection equipment should be fitted to trip main circuit breaker.

6.2.2 Astatic control

The 'droop' current transformer can be used in a connection arrangement which enables the normal regulation of the generator to be maintained when operating in parallel.

This feature is only supplied from the factory as a fitted droop kit. However, if astatic control is requested at the time of order, the diagrams inside the back cover of this book will give the necessary site connections. The end user is required to provide a shorting switch for the droop current transformer secondaries.

Should the generator be required to be converted from standard droop to 'astatic' control, diagrams are available on request.

The setting procedure is exactly the same as for DROOP. (Paragraph 6.2.1)

CAUTION !



When using this connection arrangement a shorting switch is required across each C.T. burden (terminals S1 and S2.)

The switch must be closed a) when a generating set is not running and b) when a generating set is selected for single running.

6.3 VAR/PF CONTROL

This accessory is primarily designed for those generator applications where operation in parallel with the mains is required.

Protection against loss of mains or generator excitation is not included in the unit and the system designer must incorporate suitable protection.

The electronic control unit requires both droop and kVar current transformers. When supplied with the generator, wiring diagrams inside the back cover of this book show the connections.

The unit has two modes of operation - VAR and PF.

In VAR mode the unit monitors the level of kVar supplied by the generator and adjusts excitation to maintain constant kVar.

In pf mode the unit monitors the power factor of the generator current and adjusts excitation to maintain the power factor constant. This mode can also be used to control the power factor of the mains if the point of current monitoring is moved to the mains cables. Refer to the factory for appropriate details.

6.3.1 VAR/PF Controller Setting Up Procedure - PF Mode and VAR Mode

It is recommended that a pre-setting check is carried out.

Check that both droop and VAR current transformers are in the correct phases and have been correctly connected for polarity, as indicated on the diagrams. E2 and E1 must be connected to terminals 7 and 8 respectively, via an auxiliary contact on generator breaker.

Check that jumper links are connected as below:-

Link terminals	-	240 and E1
Link terminals	-	4 and 3
Link terminals	-	1 and 2
Link terminals	-	K and -

Select mode of operation with a jumper link.

PF mode	-	link terminal	C - PF
VAR mode	-	link terminal	C - VAR

Positions of terminals are shown on Fig. 9.

Setting is most simply carried out in two parts:-

1. Checking of droop polarity and setting;
2. Checking of VAR polarity and setting.

It is recommended that a remote hand trimmer is connected for setting purposes. Refer to Fig. 9 for location of control potentiometers.

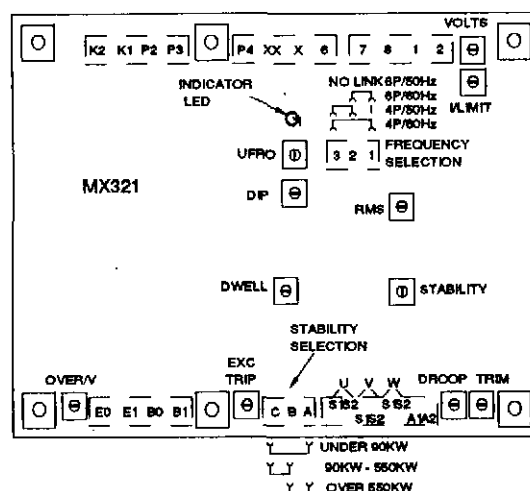
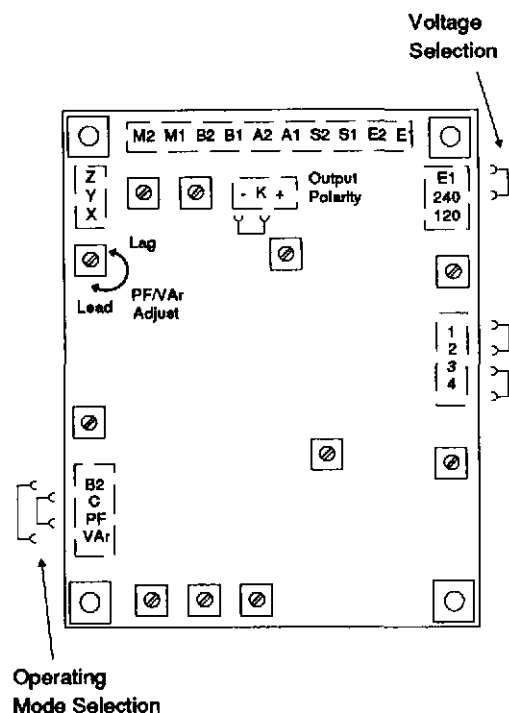


Fig. 9

6.3.1.1 Droop Polarity and Setting

The S1-S2 droop CT polarities shown on the wiring diagrams are correct for clockwise rotation on drive end. If the rotation is reversed then the S1-S2 droop CT wires should be reversed on the auxiliary terminal board. The VAr/PF controller CT is not affected by rotation. See Fig. 9 for potentiometer locations.

Before running the generator, the AVR "DROOP" control potentiometer should be turned fully clockwise. The AVR "TRIM" control potentiometer should be turned fully anti-clockwise to disable the VAr/PF controller. The "I/LIMIT" control potentiometer should be turned fully clockwise.

The external hand trimmer (if fitted) should be turned to the midway position.

After starting the generator the AVR volts control potentiometer should be adjusted so that the generator volts are equal to the mains volts.

Paralleling with the mains can be attempted after checking phase rotation and observing the usual synchronising procedure.

Immediately after paralleling there should be little or no current showing on the generator ammeter when the engine load (kW) are zero. If the current rises to a high level when the circuit breaker is closed, the generator should be tripped out immediately and stopped. In this case it is likely that the droop CT is reversed. Interchange leads S1 and S2 at the AVR terminals.

After successful paralleling has been achieved, the load on the generator should be increased slowly to 50%. The power factor should be kept to near unity by careful adjustment of the remote hand trimmer. The AVR S1-S2 voltage should be measured and recorded for future reference and should be between 1 and 4 volts AC.

6.3.1.2 VAr Polarity and Setting

potentiometer should be adjusted to the fully anti-clockwise position (maximum lag). See Fig. 9 for potentiometer location.

The AVR A1-A2 voltage should be measured and should be between 2-5 volts DC (positive on A2, negative on A1). If the polarity is wrong then stop the generating set and interchange the S1-S2 connections on the VAr/PF controller terminals. Restart the generating set and proceed as follows. Rotate the 'PF/VAr' control potentiometer fully clockwise (maximum lead).

Now the AVR A1-A2 voltage should again be 2-5 volts DC with positive now on A1, negative on A2.

Note: It may take 10 - 20 seconds to change polarity after adjusting the PF/VAr control potentiometer.

Stop the generator and turn the "PF/VAr" control potentiometer to the desired operating power factor.

Turn the AVR "TRIM" control potentiometer to the half way position.

The optimum setting position of the "DROOP" control potentiometer can now be calculated by using the following formula and the recorded S1-S2 droop voltage at 50% load (as recorded from 6.3.1.1 procedure).

Potentiometer setting (0-100%) = $\frac{1}{\text{Measured S1-S2 volts}} \times 100\%$

EXAMPLE If the measured volts across S1-S2 at 50% load was 2 volts, then

$$\frac{1}{2} \times 100 = 50\%$$

Therefore the AVR "DROOP" control potentiometer should be adjusted to halfway position (50%).

Adjust the "DROOP" control potentiometer to the calculated setting (0% setting is with the control potentiometer fully anticlockwise).

The AVR and VAR/PF controller are now correctly set and may be put into service.

6.4 FAULT CURRENT LIMIT TRANSFORMERS

These accessories work in conjunction with the AVR circuits to provide an adjustment to the level of current delivered into a fault. One current transformer (CT) per phase is fitted to provide current limiting on any line to line or line to neutral fault.

Note: the W phase CT can also provide "DROOP". Refer to 6.2.1 for setting droop independent of current limit.

Adjustment means is provided with the "I/LIMIT" control potentiometer on the AVR. Refer to Fig. 9. for location. If current limit transformers are supplied with the generator the limit will be set in accordance with the level specified at the time of order, and no further adjustment will be necessary. However should the level need to be adjusted, refer to the setting procedure given in 6.4.1.

6.4.1 SETTING PROCEDURE

Run the generating set on no-load and check that engine governor is set to correct nominal speed.

Stop the generating set. Remove the link between terminals K1-K2 at the auxiliary terminal block and connect a 5A switch across the terminals K1-K2.

Turn the I/LIMIT control potentiometer fully anticlockwise. Short circuit the stator winding with a bolted 3 phase short at the main terminals. An AC current clip-on ammeter is required to measure the winding lead current.

With the switch across K1-K2 open start the generating set.

Close the switch across K1-K2 and turn the "I/LIMIT" control potentiometer clockwise until required current level is observed on the clip-on ammeter. As soon as correct setting is achieved open the K1-K2 switch.

Should the current collapse during the setting procedure, the internal protective circuits of the AVR will have operated. In this event shut down the set and open the K1-K2 switch. Restart the set and run for 10 minutes with K1-K2 switch open, before attempting to resume the setting procedure.

SECTION 7

SERVICE AND MAINTENANCE

WARNING !



Service and fault finding procedures present hazards which can result in severe personal injury or death. Only personnel qualified to perform electrical and mechanical service should carry out these procedures. Ensure engine starting circuits are disabled before commencing service or maintenance procedures. Isolate any anti-condensation heater supply.

No routine maintenance procedure is required on the standard generator but periodic attention to winding condition (particularly when generators have been idle for a long period) and bearings is recommended. (Refer to subsections 7.1 and 7.2 respectively).

When generators are fitted with air filters regular inspection and filter maintenance is required. (Refer to subsection 7.3).

7.1 WINDING CONDITION

The condition of the windings can be assessed by measurement of insulation resistance to earth.

The AVR should be disconnected during this test and the resistance temperature detector leads grounded. A 2500V motorised megger or similar instrument should be used for the main stator windings. A 1000V instrument is suitable for all other windings.

The main stator winding insulation resistance to earth should be in excess of 50M Ω and the polarisation index in the order of 2 or greater at 20°C. All other windings should have insulation resistances in excess of 0.5M Ω .

Should the values be less than quoted, drying out the generator windings is essential.

Drying out may be carried out by directing warm air from a fan heater or similar apparatus into the generator air inlets and/or outlets.

Alternatively, the alternator main stator windings may be short circuited with a bolted 3 phase short at the main terminals and the generating set run with the AVR disconnected at terminals X and XX. A DC supply is connected to the leads X and XX (X must be connected to the positive of the DC supply and XX to the negative of the DC supply). The DC supply must be variable from 0 - 24V and capable of supplying 1.0A. An AC current clip-on ammeter or similar instrument is required to measure the winding lead current.

Set the DC supply voltage to zero. Start the generating set and slowly increase the DC voltage to pass current through the main stator winding. The current level should not exceed the rated current of the generator.

Normally - 1 hour is sufficient to dry out windings by this method.

WARNING !



The short circuit must not be applied with the AVR connected in circuit. Current in

After drying out the insulation resistances and polarisation index of the main stator windings should be rechecked.

On re-testing it is recommended that the main stator insulation resistance and polarisation index is checked as follows:-

- 1 Separate the three neutral leads
- 2 ground V and W phase and megger U phase to ground
U and W U and V W

If the minimum value of insulation resistance or polarisation index are not obtained, drying out must be continued and the test repeated.

If the minimum value of insulation resistance or polarisation index can not be achieved, rewinding or refurbishment of the main stator winding will be necessary.

7.2 BEARINGS

All bearings are packed and sealed for maintenance free operation. During major overhaul, however, it is recommended that they are flushed out and repacked with grease. Periodic checks for overheating or noise during the life of the bearing are recommended.

If excessive vibration develops after a period of time this may be due to bearing wear - the bearing should then be examined for damage or loss of grease.

The grease should be occasionally checked for signs of emulsification (milky coloured grease). If present the bearing must be dismantled, cleaned and repacked. In any event, after 40,000 hours running the bearing should be replaced. Refer to the procedure at the end of this section, (Subsection 7.5.3).

7.3 AIR FILTERS

DANGER !



Removal of filter elements enables access to LIVE parts. Only remove elements with the generator out of service.

The frequency of filter maintenance will depend upon the severity of the site conditions. Regular inspection of the elements will be required to establish when cleaning is necessary.

7.3.1 Cleaning procedure

Remove the filter elements from the filter frames. Immerse or flush the element with a suitable degreasing agent until the element is clean.

As an alternative procedure a high pressure water hose with a flat nozzle can be used. Sweep the water spray back and forth across the element from the clean side (fine mesh side of element) holding the nozzle firmly against the element surface. Cold water may be adequate depending upon type of contamination although hot water is preferable.

The element can be inspected for cleanliness by looking through the filter towards the light. When thoroughly clean, no cloudy areas will be seen.

Dry elements thoroughly before attempting to carry out the recharging procedure.

7.3.2 Recharging (Charging)

Charging is best done by totally immersing the dry element into a dip tank containing "Filterkote Type K" or commercial lubricating oil SAE 20/50. Oils of higher or lower viscosity are not recommended.

Allow elements to completely drain before refitting the elements into the frames and putting into service.

7.4 FAULT FINDING

FAULT	ACTION
No voltage build-up when starting set	Follow Separate Excitation Test 7.5.
Loss of voltage when set running	First stop and re-start set. If no voltage or voltage collapses after short time, follow Separate Excitation Test Procedure 7.5
Generator voltage high followed by collapse	Check sensing leads to AVR. Check isolating transformer secondary output - Refer to Separate Excitation Test Procedure 7.5.
Voltage unstable, either on no-load or with load	Check speed stability. Check "STABILITY" setting - Refer to Initial Start Up 4.6.
Voltage low on load	Check speed. If correct check "UFRO" setting - Refer to Load Testing section 4.7.2.
Phase voltages unbalanced	Check stator winding and cables to main circuit breaker. Refer to Unbalanced Main Terminal Voltages 7.5.1.2.
Excessive voltage/speed dip on load switching	Check governor response - Refer to generating set manual. Check "DIP" setting - Refer to Load Testing Section 4.7.5.
Sluggish recovery on load switching	Check governor response - Refer to generating set manual. Check "DWELL" setting - Refer to Load Testing section 4.7.5.

Before commencing any fault finding procedures examine all wiring for broken or loose connections.

7.5 SEPARATE EXCITATION TEST PROCEDURE

The generator windings, diode assembly and AVR can be checked using this procedure.

- 2 Connect a 60W 240V household lamp to AVR terminals X and XX. (Only required for section 7.5.2).
- 3 Connect a 0-12V, 1.0A DC supply to leads X and XX. The positive of the DC supply is connected to the lead marked X and the negative to the lead marked XX.

The procedure is simplified by dividing into two sections:

GENERATOR WINDINGS, SENSING TRANSFORMER, ROTATING DIODES AND PERMANENT MAGNET GENERATOR



CAUTION !

The reference voltages and resistances quoted apply to a standard winding. For generators having voltages other than those specified refer to factory for details.



DANGER !

THE GENERATOR MAIN TERMINALS ARE LIVE WHEN THE GENERATOR IS RUNNING, WITH OR WITHOUT VOLTAGE APPLIED TO X - XX. Ensure all disconnected leads are isolated and free from earth.

(PMG),
and
AVR STATIC TEST.

7.5.1 GENERATOR WINDINGS, SENSING TRANSFORMER, ROTATING DIODES and PMG.

This procedure is carried out with leads P2-P3-P4 and leads 6-7-8 disconnected at the AVR and using a 0 - 1.0V DC supply to X and XX.

A 1.0V DC supply will give voltages of less than 1000 volts line to line at the generator terminals thus allowing the use of a standard digital multimeter to check line to line and line to neutral voltages.

Start the set and run at full speed with the DC supply to X - XX set at zero volts.

Measure the voltages between P2-P3-P4. These should be balanced and within the voltages given below:

50Hz Generators	170 -180V
60Hz Generators	200 -216V

If voltages are incorrect or unbalanced, replacement of permanent magnet generator, stator and/or rotor is required. Refer to removal and replacement of component assemblies at the end of this section.

The PMG stator resistances and insulation resistances to earth should be checked. Resistances should be balanced and between values given below:-

4 pole generators	- 2.1 - 2.5Ω
6 pole generators	- 4.9 - 5.9Ω

Insulation resistance should be at least 0.5 megohms.

Increase the d.c. supply to 1.0V and check voltages at leads 6-7-8, and main terminals U-V-W.

Generator Rated Voltage	DC supply	AC Voltage 6-7-8	Main Terminal Voltage
3.3kV 50Hz	1.0V	37-44V	650-750V
4.16kV 60Hz	1.0V	49-55V	850-950V
2.4kV 60Hz (Delta)	1.0V	49-55V	490-550V

7.5.1.1 BALANCED MAIN TERMINAL VOLTAGES

If all voltages are balanced within 1% at leads 6-7-8 and main terminals, it can be assumed that all exciter windings, main windings and main rotating diodes and isolating transformer are in good order. If main terminal voltages are balanced and correct but voltages at 6-7-8 are NOT balanced or correct, the isolating transformer is faulty and should be replaced.

If voltages are balanced but low, there is a fault in the main excitation windings or rotating diode assembly. Proceed as follows to identify:-

Rectifier Diodes

The diodes on the main rectifier assembly can be checked with a multimeter. The flexible leads connected to each diode should be disconnected at the terminal end, and the forward and reverse resistance checked. A healthy diode will indicate a very high resistance (infinity) in the reverse direction, and a low resistance in the forward direction. A faulty diode will give a full deflection reading in both directions with the test meter on the 10,000 ohms scale, or an infinity reading in both directions.

On an electronic digital meter a healthy diode will give a low reading in one direction, and a high reading in the other.

The rectifier assembly is split into two plates, the positive and negative, and the main rotor is connected across these plates. Each plate carries 3 diodes, the negative plate carrying negative biased diodes and the positive plate carrying positive biased diodes. Care must be taken to ensure that the correct polarity diodes are fitted to each respective plate. When fitting the diodes to the plates they must be tight enough to ensure a good mechanical and electrical contact, but should not be overtightened. The recommended torque tightening is 4.06 - 4.74Nm (36-42lb in).

Surge Suppressor

The surge suppressor is a metal-oxide varistor connected across the two rectifier plates to prevent high transient reverse voltages in the field winding from damaging the diodes. This device is not polarised and will show a virtually infinite reading in both directions with an ordinary resistance meter. If defective this will be visible by inspection, since it will normally fail to short circuit and show signs of disintegration. Replace if faulty.

Main Excitation Windings

If after establishing and correcting any fault on the rectifier assembly the output is still low when separately excited, then the main rotor, exciter stator and exciter rotor winding resistances should be checked (see Resistance Charts). The exciter stator resistance is measured across leads X and XX. The exciter rotor is connected to six studs which also carry the diode lead terminals. The main rotor winding is connected across the two rectifier plates. The respective leads must be disconnected before taking the readings.

Incorrect resistances indicate faulty windings and component replacement is necessary. Refer to dismantling/re-assembly procedures at the end of the section.

	FRAME SIZE	MAIN ROTOR	EXCITER STATOR	EXCITER ROTOR
MV6 4 Pole	MV634WG	1.37	17	0.0158
	MV634WJ	1.66	17	0.0158
MV6 6 Pole	MV636WK	1.67	17	0.2
MV7 4 Pole	MV734WE	1.20	17	0.096
	MV734WF	1.34	17	0.096
	MV734WG	1.58	17	0.096
	MV734WH	1.75	17	0.096
MV7 6 Pole	MV736WF	2.69	17	0.2
	MV736WG	3.18	20	0.28

7.5.1.2 UNBALANCED MAIN TERMINAL VOLTAGES

If voltages are unbalanced, this indicates a fault on the main stator winding or main cables to the circuit breaker. NOTE: Faults on the stator winding or cables may also cause noticeable load increase on the engine when excitation is applied. Disconnect the main cables and separate the three neutral winding leads or open the delta connection in case of 2.4kV 60Hz.

Measure each phase resistance - values should be balanced and within +/- 10% of the value given below:-

MV6 4 Pole	MV634WG	0.32
	MV634WJ	0.19
MV6 6 Pole	MV636WK	0.265
MV7 4 Pole	MV734WE	0.125
	MV734WF	0.089
	MV734WG	0.068
	MV734WH	0.056
MV7 6 Pole	MV734WF	0.14
	MV734WG	0.115

Measure insulation resistance of all phases as previously described under WINDING CONDITION 7.1.

Unbalanced or incorrect winding resistances and/or low insulation resistances to earth indicate rewinding of the stator will be necessary. Refer to removal and replacement of component assemblies at the end of this section.

7.5.2 AVR STATIC TEST

This procedure is carried out with leads 6-7-8 and P2-P3-P4 connected to the AVR and a 0 - 12V DC supply to leads X and XX. Links 1-2 and K2-K1 should be in place on the AVR terminals.



DANGER !

During this test HIGH VOLTAGE will exist at the generator main terminals. Ensure terminal box cover is in place.

With the DC supply set at 12 volts and the "VOLTS" control potentiometer turned fully clockwise, start the set and run at full speed. Check that generator output voltage or voltage at 6-7-8 is in line with the table below:-

Generator Rated Voltage	DC supply	AC voltage 6-7-8	Main Terminal Voltage
3.3kV 50Hz	12V	165-195V	2.8-3.5kV
4.16kV 60Hz	12V	200-240V	3.5-4.3kV
2.4kV 60Hz (Delta)	12V	200-240V	2.0-2.5kV

The lamp connected across terminals X and XX should glow for 8 - 10 seconds and then switch off.

Voltages at terminals P2-P3-P4 should be as given in 7.5.1.

If the lamp does not light the AVR is faulty - replace AVR and re-check.



CAUTION !

After this test turn VOLTS control potentiometer fully anticlockwise.

After rectification of any faults found remove all test connections and connect leads X - XX to the AVR.

Re-start the set and adjust "VOLTS" control potentiometer by slowly turning clockwise until rated voltage is obtained.

Refit all terminal box covers/access covers and reconnect heater supply.



WARNING !

Failure to re-fit all guards, access covers and terminal box covers can result in personal injury or death.

7.5.3 REMOVAL AND REPLACEMENT OF COMPONENT ASSEMBLIES (Metric threads are used throughout.)

7.5.3.1 PERMANENT MAGNET GENERATOR

1. Remove access cover (Frame 7 only).
2. Disconnect P2, P3, P4 at the multiway connector inside the access cover.
3. Remove the 4 screws and clamps retaining the stator housing (Frame 6) or the stator pack (Frame 7).
4. Tap the stator pack or housing out of its spigot.

NOTE: As the highly magnetic rotor will attract the stator core,

care must be taken to avoid a contact which may damage the winding.

5. Remove the exciter rotor securing bolt and stow safely and firmly pull the complete rotor assembly from its location.

N.B. Keep the rotor clean and avoid contact with metal dust or particles - preferably place in plastic bag.

IMPORTANT

The permanent magnet rotor should under no circumstances be dismantled or the magnetic properties will be destroyed.

Re-assembly is a reversal of above procedure having due regard for the notes below:-

1. Ensure rotor magnet assembly is free of metal pieces or particles.
2. Care is needed to avoid winding damage when re-assembling the stator pack, due to strong magnetic attraction.

7.5.3.2 REMOVAL OF BEARINGS

NOTE:

Removal of the bearings may be effected either after the rotor assembly has been removed OR more simply by removal of endbracket(s). Refer to Main Rotor assembly section 7.5.3.3.

NOTE:

The bearings are enclosed in pre-packed cartridge housings and should not be dismantled unless absolutely necessary, such as for relubrication, replacement of bearings or during a major overhaul. If bearings are to be refitted, withdrawal force must not be applied through the rolling elements.

1. The bearings are a press fit on the shaft and can be removed with standard tooling, i.e. 2 or 3 legged manual or hydraulic bearing pullers.
2. Remove 4 screws holding bearing cap.
3. Remove cap.
4. Remove circlip (1-bearing machines - non drive end) or waved washer (2-bearing machines - drive end)
5. Remove bearing cartridge housing complete with bearing.

When replacing bearings the housings must be flushed out and refilled as follows:-

Recommended lubricant:	Lithium-based Grease Mobilux No. EP2 or Shell Alvania R3
Temperature range:	-30°C. to + 120°C.
Quantity:	110 ml Drive end and non drive end bearing.

7.5.3.3 MAIN ROTOR ASSEMBLY

SINGLE BEARING MACHINE

NOTE:

On single bearing machines, before removal from, or re-assembly to the prime mover, position the rotor, if possible, such that a full pole face is at bottom dead centre.

1. Remove all access covers and terminal box lid.
2. Disconnect exciter leads X and XX and PMG leads P2-P3-P4 at the auxiliary terminals inside the terminal box.
3. Ensure that these leads are free to come away with the non drive endbracket when removed.
4. Remove the 8 bolts holding the drive end adaptor to the frame.
5. With rope sling around drive end adaptor, tap adaptor out of its spigot location; guide over fan and remove.
6. Remove the 4 bolts retaining the non drive end bearing cartridge in the non drive end endbracket (outer 4 bolts).
7. Remove the 8 bolts securing the non drive endbracket to the frame.
8. Supporting the non drive endbracket with a hoist, insert two M10 bolts in the two holes provided for 'jacking' purposes (on the endbracket horizontal centre line). Screw in the bolts until the endbracket spigot is clear of the locating recess, lower the whole assembly until the main rotor is resting in the stator bore.

Still supporting the non drive endbracket, tap the bracket off the non drive end bearing cartridge (taking care that the exciter stator does not foul exciter rotor windings) and remove.

9. To withdraw the rotor from the stator the rotor must be supported by a rope at the drive end and eased out of the stator core until half the main rotor is protruding out of the stator. At this point it is safe to release the weight from the rope sling.
10. Tightly bind a rope sling around the rotor core, and, supporting the non drive end of the rotor, guide it clear of the stator.

WARNING !



The rope sling may not be at the centre of gravity of the rotor and guidance at the ends of the rotor is essential. As the rotor is fully withdrawn from the stator core, THE FULL WEIGHT OF THE ROTOR MUST BE SUPPORTED BY THE CRANE. If the rotor core is allowed to drop more than a few millimetres at this point, it will make contact with the stator windings and may damage them.

Damaged components must be replaced.

When refitting discs ensure that 6 plates totalling a thickness of 7.2mm are used and the pressure ring is refitted. Torque setting for the disc to coupling hub fixing bolts is 84 kgfm (822Nm).

Refer to engine manual for torque setting of disc to flywheel fixing bolts.

TWO BEARING MACHINES

NOTE:

Position rotor, if possible, such that a full pole face is at bottom dead centre.

Turn rotor until a full pole face is at bottom dead centre.

The procedure for removal of a two bearing rotor is similar to that outlined for single bearing machines with the exception of Steps 4 and 5 relating to the drive end adaptor.

For removal of this item proceed as follows:-

1. Remove the 8 bolts holding drive end adaptor to frame and 4 bolts retaining bearing cartridge in drive end bracket (outer 4 bolts).
2. With rope sling around the shaft extension, supporting the rotor weight tap the drive endbracket spigot out of its locating recess and lower rotor assembly to rest in the stator bore.
3. Take the weight of the drive endbracket on the sling and tap the bracket off the drive end bearing cartridge, guide over the fan and remove.

Re-assembly is a reversal of the above procedure.

Re-assembly is a reversal of the above procedure.

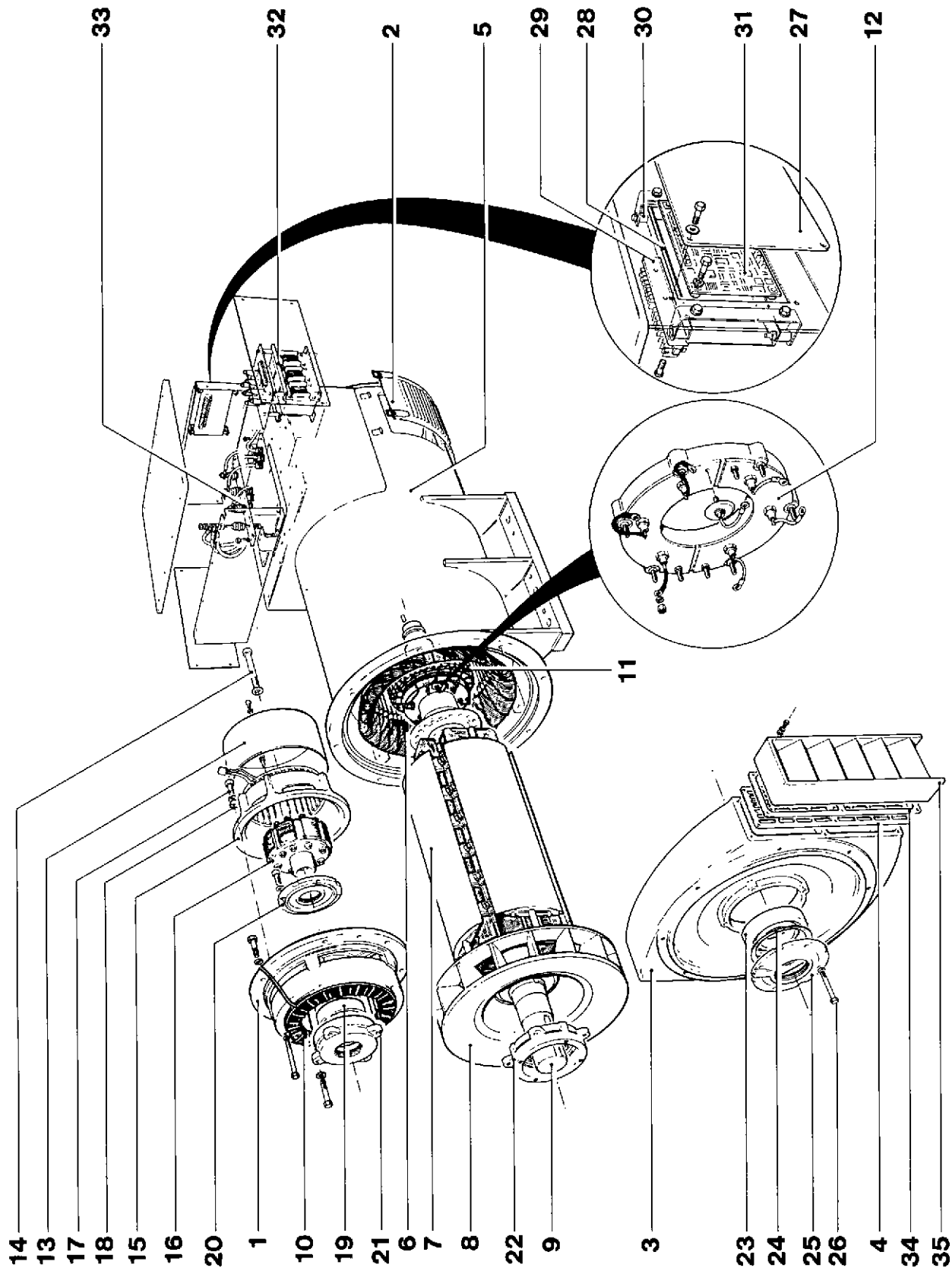
Before assembly of a single bearing rotor into stator housing check that the drive discs are not damaged or cracked or showing any other signs of fatigue. Also check that holes in the discs for drive fixing screws are not elongated.

PARTS LIST
TYPICAL MV6 TWO BEARING GENERATOR

Plate Ref.	Description	Plate Ref.	Description
1	N.D.E. Bracket	25	D.E. Bearing Cap Outer
2	N.D.E. Cover	26	D.E. Bearing Cap Bolt
3	D.E. Bracket	27	AVR Cover Plate
4	D.E. Screen	28	AVR Mounting Bracket
5	Main Frame	29	Auxiliary Terminal Block
6	Wound Main Stator	30	Anti-Vibration Mount
7	Wound Main Rotor	31	Automatic Voltage Regulator (AVR)
8	Fan	32	Isolating Transformer
9	Shaft	33	Terminal Insulator
10	Wound Exciter Stator	34	Gasket
11	Wound Exciter Rotor	35	Drip Proof Louvres
12	Main Rectifier Assembly		
13	PMG Cover		
14	PMG Rotor Stud		
15	PMG Stator Assembly		
16	PMG Rotor Assembly		
17	PMG Stator Clamping Bolt		
18	PMG Stator Clamp		
19	N.D.E. Bearing		
20	Bearing Cap		
21	Bearing Cartridge		
22	D.E. Bearing Cap Inner		
23	D.E. Bearing		
24	D.E. Bearing Wave Washer		

N.D.E. Non Drive End
D.E. Drive End
PMG Permanent Magnet Generator
AVR Automatic Voltage Regulator

Fig. 10.
TYPICAL MV6 TWO BEARING GENERATOR



PARTS LIST
TYPICAL MV7 SINGLE BEARING GENERATOR

Plate Ref.	Description	Plate Ref.	Description
1	N.D.E. Bracket	25	Coupling Disc Pressure Plate
2	N.D.E. Cover	26	Coupling Bolt
3	D.E. Bracket	27	AVR Cover Plate
4	D.E. Screen	28	AVR Mounting Bracket
5	Main Frame	29	Auxiliary Terminal Block
6	Wound Main Stator	30	Anti-Vibration Mount
7	Wound Main Rotor	31	Automatic Voltage Regulator (AVR)
8	Fan	32	Isolating Transformer
9	Shaft	33	Terminal Insulator
10	Wound Exciter Stator		
11	Wound Exciter Rotor		
12	Main Rectifier Assembly		
13	PMG Cover		
14	PMG Rotor Stud		
15	PMG Stator Assembly		
16	PMG Rotor Assembly		
17	PMG Stator Clamping Bolt		
18	PMG Stator Clamp		
19	N.D.E. Bearing		
20	N.D.E. Bearing Circlip		
21	Bearing Cap/PMG Stator Support		
22	N.D.E. Bearing Cartridge		
23	Coupling Disc		
24	Coupling Spacer		

N.D.E. Non Drive End
D.E. Drive End
PMG Permanent Magnet Generator
AVR Automatic Voltage Regulator

Fig. 11.
TYPICAL MV7 SINGLE BEARING GENERATOR

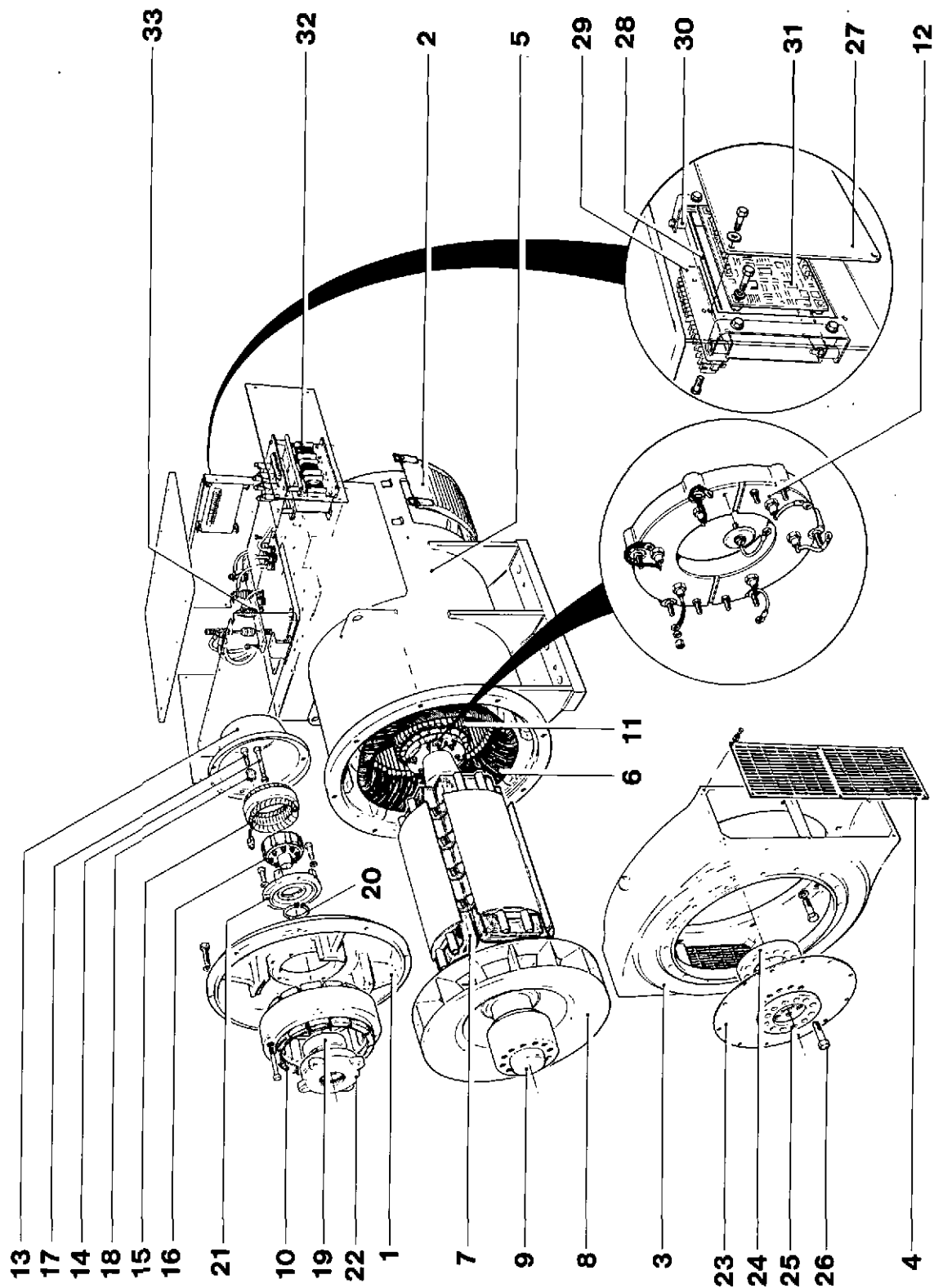
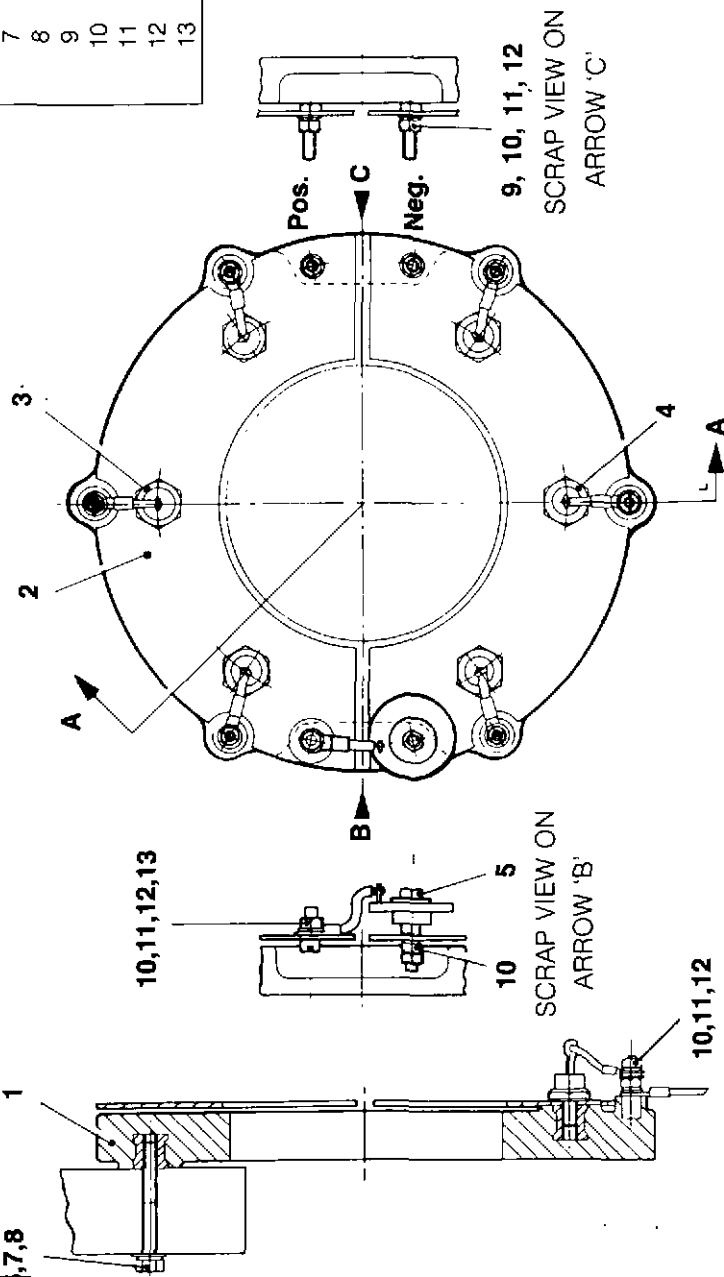


Fig. 12.
ROTATING RECTIFIER ASSEMBLY

Plate Ref.	Description	Qty
1	Moulded Base	1
2	Fin	2
3	Diode (Forward)	3
4	Diode (Reverse)	3
5	Varistor	1
6	Hexagonal Head Bolt M6 x 65	4
7	Plain Washer M6	4
8	S.C. Lockwasher M6	4
9	Hexagonal Head Screw M5 x 20	2
10	Hexagonal Nut M5	17
11	Plain Washer M5	21
12	S.C. Lockwasher M5	15
13	CH. HD. Screw	1

EXCITER ROTOR CORE

1,7,8



SECTION ON 'AA'

1. A rectifier assembly **must** comprise diodes from one manufacturer only.
2. 4 Bolts (Plate ref 6) holding the moulding to the exciter core should be given an application of Loctite 241.
3. When fitting replacement diodes the undersides should if possible be smeared with Midland Silicone Heat Sink compound Type MS2623 or similar (available from our Nupart Dept.) **IMPORTANT** This compound **MUST NOT** be applied to the diode stud threads.
4. Diode tightening torque: 4-4.8N-m(36 — 42lbf-in).

A.C. GENERATOR WARRANTY

WARRANTY PERIOD:

A.C. Generators: In respect of a.c. generators the warranty period is

- (i) twelve months after the goods have been notified as ready for despatch
- OR (ii) provided that the Dealer tests the goods before despatch, twelve months from the date the goods are despatched by the Dealer or eighteen months have been notified as ready for despatch by us (whichever is the shorter)

DEFECTS AFTER DELIVERY:

We will make good by repair, or, at our option, by the supply of a replacement any fault which appears in any goods manufactured by us within the warranty period and is found on examination solely due to defective material and workmanship provided that

- (a) We receive notice in writing of the alleged defect within 30 days of its discovery and the goods are promptly returned, carriage paid, with all identification numbers and marks intact and we have supplied the goods or, if required by us, to our Works.
- (b) We shall be under no liability for defects in any goods which:
 - (i) have not been stored, installed, used and maintained properly and carefully in accordance with our current recommendations; or
 - (ii) have been used after the defect has been, or ought reasonably to have been discovered; or
 - (iii) have been repaired, adjusted or altered without prior authorisation or by any person other than ourselves;

nor in any second-hand goods, proprietary articles or goods not of our own manufacture, although such articles and goods being covered by the warranty (if any) given by the separate manufacturer.

- (c) Our liability shall be fully discharged by either repair or replacement as above, and in any event shall not exceed the current list price of the defective goods.
- (d) Our liability under this clause shall be in lieu of any warranty or condition implied by law or fitness for any particular purpose of the goods, and save as expressly provided in this clause we shall be under no liability, whether in contract, tort or otherwise, in respect of any defect or for any damage or loss (whether direct or consequential resulting from such defect or in connection therewith).
- (e) Any claim under this clause must contain full particulars of the alleged defect, the description of the goods, the serial number (as shown on the manufacturers identification plate) or, for spares, the date of purchase and the name and address of the vendor.
- (f) Our judgement in all cases of claims shall be final and conclusive and the claimant shall be liable on all questions as to defects and the exchange of a part or parts. The repaired or replaced goods shall be delivered by us free of charge ex-Works. We shall not be liable for any expense which may be incurred in removing or replacing any part sent to us for inspection or in fitting any replacement supplied by us.

MACHINE SERIAL NUMBER

--

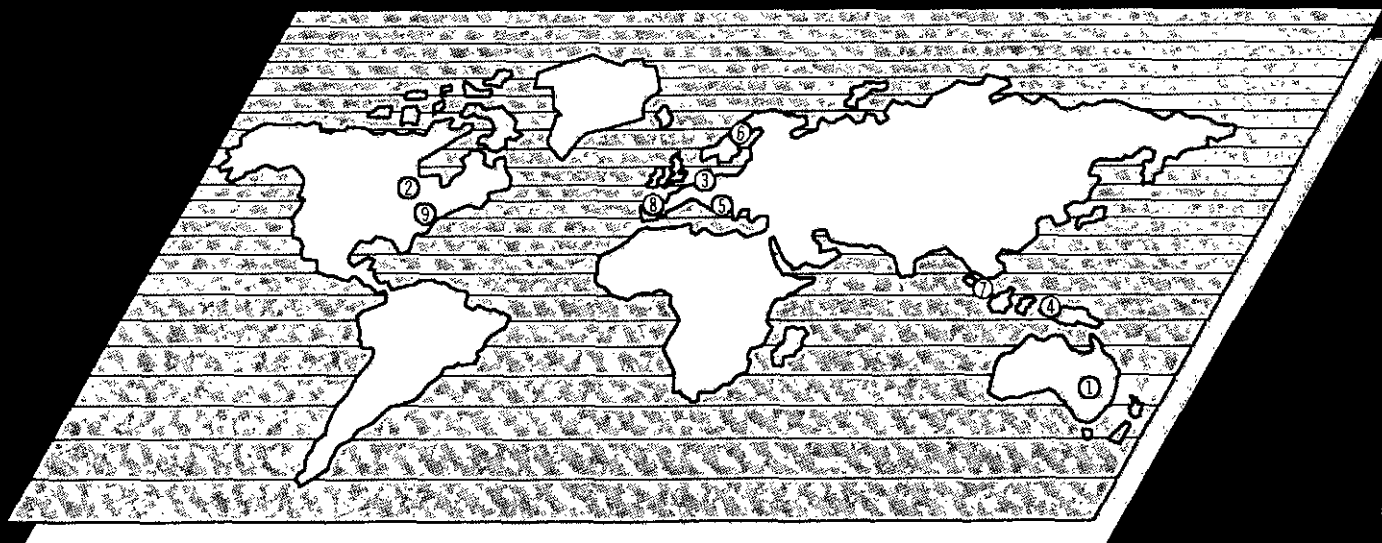
NEWAGE INTERNATIONAL LIMITED

REGISTERED OFFICE AND ADDRESS:

PO BOX 17
BARNACK ROAD
STAMFORD
LINCOLNSHIRE
PE9 2NB ENGLAND

Telephone: 0780 62552
Fax: 0780 51617
Telex: 32268

SUBSIDIARY COMPANIES



- | | | | |
|---------------------|---|---------------------|---|
| 1 AUSTRALIA: | NEWAGE ENGINEERS PTY. LIMITED
29 Victoria Avenue, Castle Hill, P.O. Box 746,
New South Wales 2154.
Telephone: Sydney (02) 680 2299
Fax: (02) 680 1545 | 6 NORWAY: | NEWAGE NORGE A/S
Staaljæra 12, 0975, Oslo 9.
Telephone: Oslo (02) 25 1635
Fax: (02) 25 1393
Telex: 78835 |
| 2 CANADA: | NEWAGE EQUIPMENT LIMITED
P.O. Box 427, Islington, Ontario M9A 4X4.
Telephone: Toronto (416) 259 3741
Fax: (416) 259 7167 | 7 SINGAPORE: | NEWAGE (FAR EAST) PTE LIMITED
Ghim Moh, P.O. Box 1016,
Singapore 9127.
Telephone: Singapore 469 1631
Fax 466 2765
Telex: 33404 |
| 3 GERMANY: | NEWAGE ENGINEERS G.m.b.H.
Archenholzstr 69, 2000 Hamburg 74.
Telephone: Hamburg (040) 7 12 2044/2045
Fax: (040) 7 12 5544
Telex: 2174397 | 8 SPAIN: | STAMFORD IBERICA S.A.
Paseo de la Castellana 62, E28046 Madrid.
Telephone: Madrid (91) 261 8558/8566
Fax: (91) 411 2858 |
| 4 INDONESIA: | P.T. NEWAGE ENGINEERS INDONESIA
P.O. Box 1070/JAT,
Jl. Pulogadung 21,
Kawasan Industri Pulogadung,
Jakarta 13010.
Telephone: Jakarta (21) 471 3043/
460 1685 / 460 1687
Fax: (21) 499 6654
Telex: 48804 | 9 U.S.A.: | NEWAGE LIMITED
P.O. Box 103, 3 Independence Court,
Folcroft Industrial Park,
Folcroft, Pennsylvania 19032.
Telephone: Philadelphia (215) 534 9500
Fax: (215) 534 0505
Telex: 845276 |
| 5 ITALY: | NEWAGE ITALIA S.r.l.
Viale Fulvio Testi 56, 20125 Milan.
Telephone: Milan (02) 642 0868/643 6602 | | |