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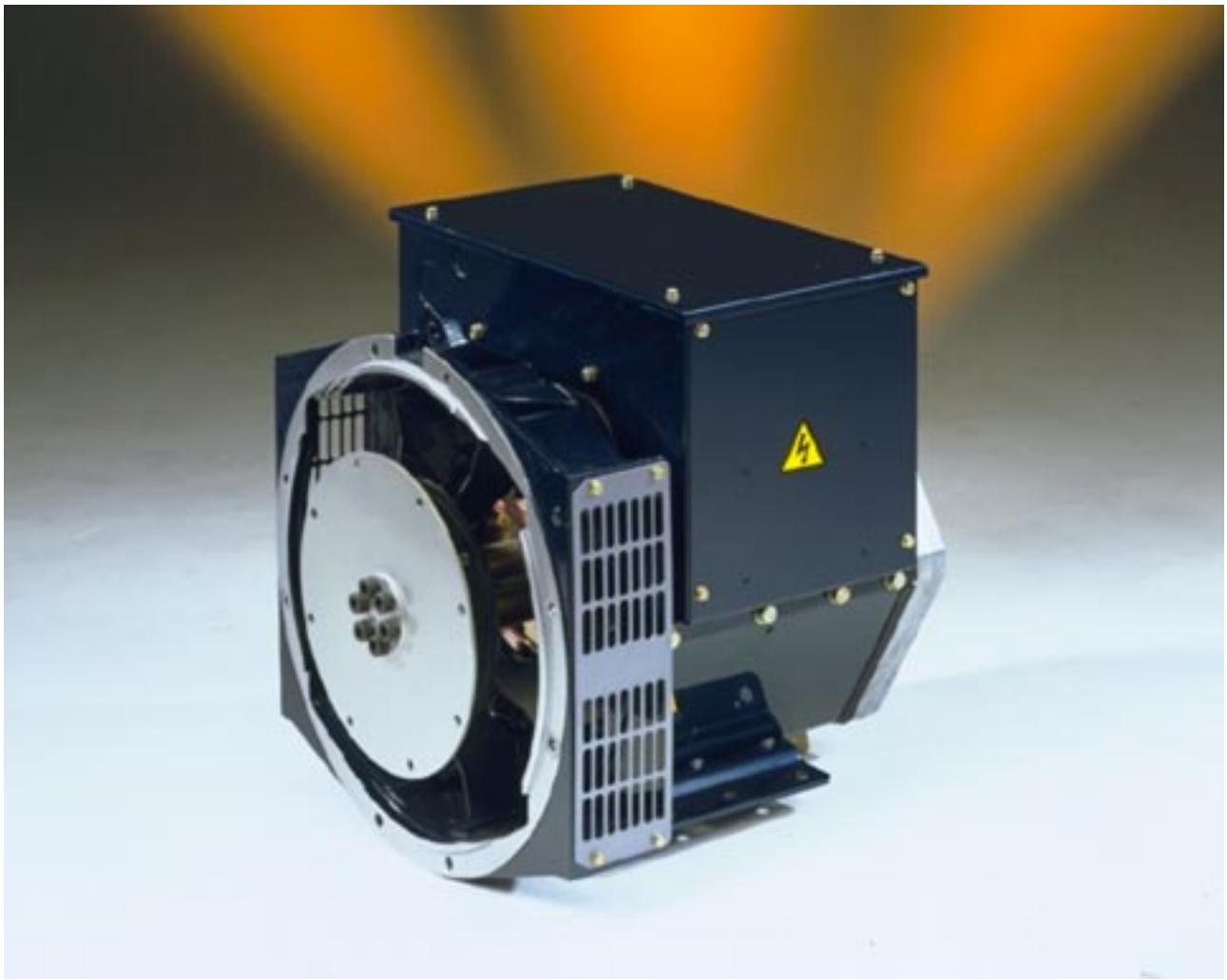
STAMFORD

AC GENERATORS FROM
NEWAGE INTERNATIONAL



Installation, Service & Maintenance Manual

For the BC Range of Generators.

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.

- 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.

Observe all **IMPORTANT, CAUTION, WARNING, and DANGER** notices, defined as:

Important ! **Important refers to hazard or unsafe method or practice which can result in product damage or related equipment damage.**

Caution ! **Caution refers to hazard or unsafe method or practice which can result in product damage or personal injury.**

Warning ! **Warning refers to a hazard or unsafe method or practice which CAN result in severe personal injury or possible death.**

Danger ! **Danger refers to immediate hazards which will result in severe personal injury or death.**

Due to our policy of continuous improvement, details in this manual which were correct at time of printing, may now be due for amendment. Information included must therefore not be regarded as binding.

Front Cover Photograph

This photograph is representative only. Several variations are available within the range of generators covered by this manual.

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, 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.

EC DECLARATION OF INCORPORATION

All Stamford generators are supplied with a declaration of incorporation for the relevant EC legislation, typically in the form of a label as below.

EC DECLARATION OF INCORPORATION

IN ACCORDANCE WITH THE SUPPLY OF MACHINERY (SAFETY) REGULATIONS 1992 AND THE SUPPLY OF MACHINERY (SAFETY) (AMENDMENT) REGULATIONS 1994 IMPLEMENTING THE EC MACHINERY DIRECTIVE 89/392/EEC AS AMENDED BY 91/368/EEC.

THIS **STAMFORD A.C. GENERATOR** WAS MANUFACTURED BY OR ON BEHALF OF
NEWAGE INTERNATIONAL LTD
BARNACK ROAD STAMFORD LINCOLNSHIRE ENGLAND.

THIS COMPONENT MACHINERY MUST NOT BE PUT INTO SERVICE UNTIL THE MACHINERY INTO WHICH IT IS TO BE INCORPORATED HAS BEEN DECLARED IN CONFORMITY WITH THE PROVISIONS OF THE SUPPLY OF MACHINERY (SAFETY) REGULATIONS 1995/MACHINERY DIRECTIVE.

FOR AND ON BEHALF OF NEWAGE INTERNATIONAL LIMITED

NAME: LAWRENCE HAYDOCK
POSITION: TECHNICAL DIRECTOR
SIGNATURE:

THIS COMPONENT MACHINERY CARRIES THE CE MARK FOR COMPLIANCE WITH THE STATUTORY REQUIREMENTS FOR THE IMPLEMENTATION OF THE FOLLOWING DIRECTIVES

WARNING! The EMC Directive 89/336/EEC
This Component Machinery shall not be used in the Residential, Commercial and Light Industrial environment unless it also conforms to the relevant standard (EN 50081 - 1) REFER TO FACTORY FOR DETAILS

ii) The Low Voltage Directive 73/23/EEC as amended by 93/68/EEC

When this manual is supplied to support a specific generator at point of sale, the generator identity is clearly displayed on the front cover of this book.

CE

ELECTROMAGNETIC COMPATIBILITY

Additional Information

European Union
Council Directive 89/336/EEC

For installations within the European Union, electrical products must meet the requirements of the above directive, and Newage ac generators are supplied on the basis that:

- They are to be used for power-generation or related function.
- They are to be applied in one of the following environments:

  Portable (open construction - temporary site supply)
  Portable (enclosed - temporary site supply)
  Containerised (temporary or permanent site supply)
  Ship-borne below decks (marine auxiliary power)
  Commercial vehicle (road transport / refrigeration etc)
  Rail transport (auxiliary power)
  Industrial vehicle (earthmoving, cranes etc)
  Fixed installation (industrial - factory / process plant)
  Fixed installation (residential, commercial and light industrial home / office / health)
  Energy management (Combined heat and power and/or peak lopping)
  Alternative energy schemes

- The standard generators are designed to meet the ‘industrial’ emissions and immunity standards. Where the generator is required to meet the residential, commercial and light industrial emissions and immunity standards reference should be made to Newage document reference N4/X/011, as additional equipment may be required.
- The installation earthing scheme involves connection of the generator frame to the site protective earth conductor using a minimum practical lead length.
- Maintenance and servicing with anything other than factory supplied or authorised parts will invalidate any Newage liability for EMC compliance.
- Installation, maintenance and servicing is carried out by adequately trained personnel fully aware of the requirements of the relevant EC directives

CONTENTS

CONTENTS

SECTION 1

INTRODUCTION

1.1 INTRODUCTION

The BC16/18 range of generators is of brushless rotating field design, available up to 660V/50Hz (1500 rpm, 4 pole and 3000 rpm, 2 pole) or 60Hz (1800 rpm, 4 pole and 3600 rpm, 2 pole), and built to meet B.S. 5000 Part 3 and international standards.

The BC16/18 range are self-excited with excitation power derived from the main output windings, using either the SX460/SA465 AVR or transformer controlled excitation system.
The BC184 may be supplied fitted with an auxiliary winding in the main stator, using the SA465 AVR.

Detailed specification sheets are available on request.

1.2 DESIGNATION

To provide standardisation of systems with minimal change to customers.

B	C	L	I	1	6	4	A	1
B	C	.	I	1	6	2	D	1
B	C	A	I	1	6	2	D	1
B	C	.	M	1	8	4	F	2

GENERATOR TYPE BC

SPECIFIC TYPE L = TS OR TR ENGINE
A = ALPHA ENGINE

INDUSTRIAL = (I) OR MARINE = (M)

SHAFT HEIGHT IN CM ON BC/UC

NUMBER OF POLES 2 or 4

CORE LENGTH

NUMBER OF BEARINGS 1 OR 2

1.3 PACKAGED LOOSE ADAPTOR HARDWARE

Several adaptors are only partially fitted to generators to simplify removal prior to engine-generator assembly. The remaining hardware is contained within a plastic bag located in the terminal box.

Adaptor Types

SAE2
SAE3
SAE5 Spacer Rings
SAE6
Coupling Plate Dowel Pins

1.4 SERIAL NUMBER LOCATION

Each generator has its unique serial number stamped into the upper section of the non-drive end frame.

Inside the terminal box two adhesive rectangular labels have been fixed, each carrying the generator's unique identity number. One to the inside of the terminal box sheet metal work, and the second label fixed to the main frame of the generator.

1.5 RATING PLATE AND CE MARK

The generator has been supplied with a self adhesive rating plate label to enable fitting after final assembly and painting. It is intended that this label will be stuck to the outside of the terminal box on the left hand side when viewed from the drive-end. To assist with squarely positioning the label, location protrusions have been made in the sheet metalwork.

A CE Mark label is also supplied loose for fitment after final assembly and painting. This should be attached to an external surface of the Generator at a suitable location where it will not be obscured by the customer's wiring or other fittings. Before fitting the CE Mark label the genset builder must address the requirements of the relevant EC legislation to ensure the compliance of the genset as a whole. CE compliance will also need to be addressed when installed on site.

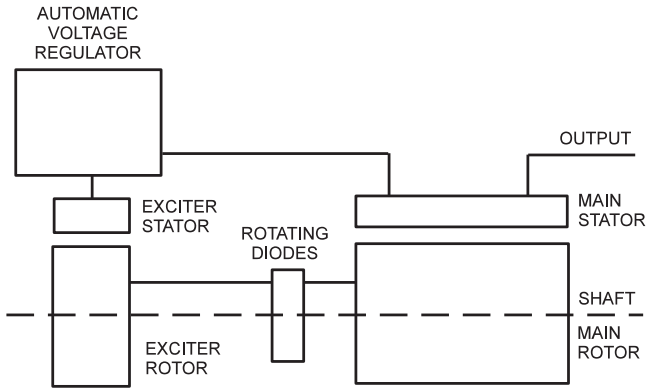
The surface on the area where a label is to be stuck must be flat, clean and any paint finish must be fully dry before attempting to attach label. Recommended method for attaching label is peel and fold back sufficient of the backing paper to expose some 20mm of label adhesive along the edge which is to be located against the sheet metal protrusions. Once this first section of label has been carefully located and stuck into position the backing paper can be progressively removed, as the label is pressed down into position. The adhesive will achieve a permanent bond in 24 hours.

SECTION 2

PRINCIPLE OF OPERATION

2.1 SELF-EXCITED AVR CONTROLLED GENERATORS

2.1.1 MAIN STATOR POWERED AVR



The main stator provides power for excitation of the exciter field via the SX460 (SA465) 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 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 AVR senses average voltage on two phases ensuring close regulation. In addition it detects engine speed and provides 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.

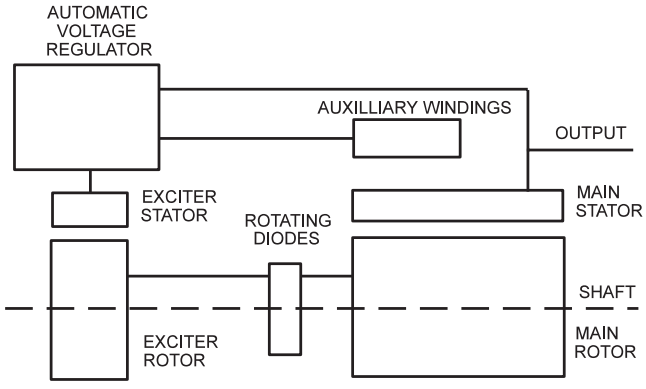
The detailed function of the AVR circuits and their adjustment are covered in the load testing section.

In addition the SA465 AVR incorporates circuits which, when used in conjunction with accessories, can provide for parallel operation either with 'droop' or 'astatic' control 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.

2.1.2 AUXILIARY WINDING POWERED AVR



The auxiliary winding provides power for excitation of the exciter field via the SA465 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 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 AVR senses average voltage on two phases ensuring close regulation. In addition, it detects engine speed and provides 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.

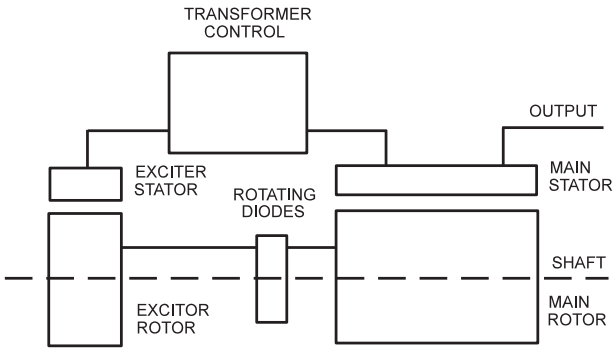
Under fault conditions on the main stator output the auxiliary winding continues to generate voltage from the harmonic content of the magnetic field in the main stator core providing the necessary power via the SA465 AVR, to maintain short circuit fault currents.

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

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.

2.2 TRANSFORMER CONTROLLED GENERATORS



The main stator provides power for excitation of the exciter field via a transformer rectifier unit. The transformer combines voltage and current elements derived from the main stator output to form the basis of an open-loop control system, which is self regulating in nature. The system inherently compensates for load current magnitude and power factor and provides short circuit maintenance in addition to a good motor starting performance.

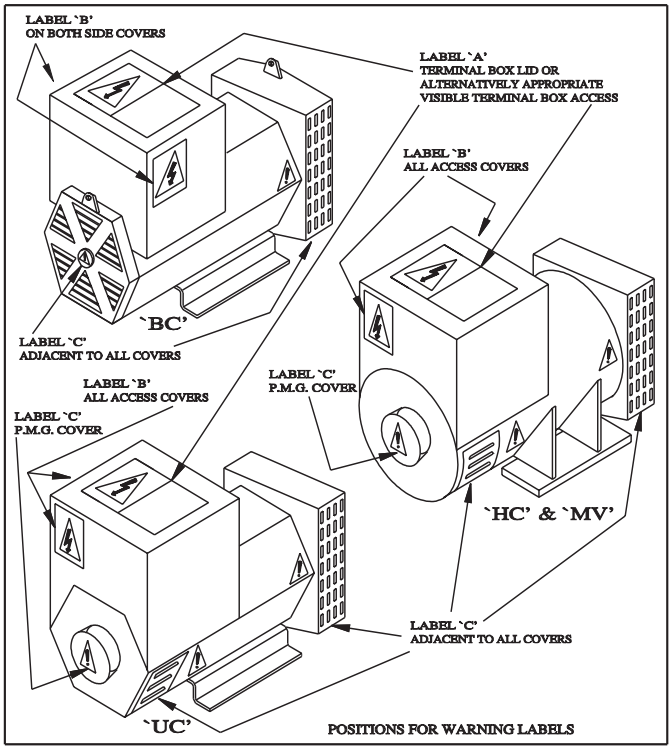
Three phase generators normally have a three phase transformer control for improved performance with unbalanced loads but a single phase transformer option is available.

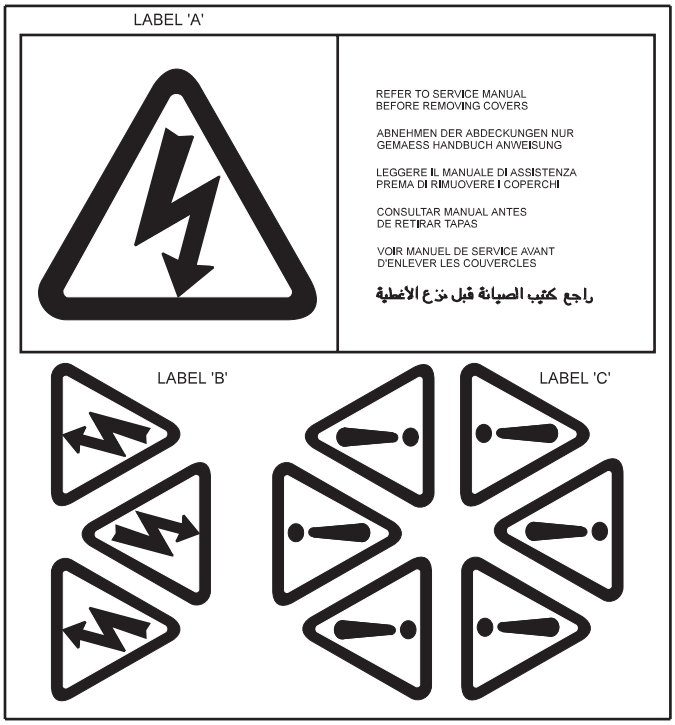
No accessories can be provided with this control system.

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.





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

The generators have been designed for use in a maximum ambient temperature of 40°C and altitude less than 1000 metres above sea level in accordance with BS 5000.

Ambients in excess of 40°C and altitudes above 1000 metres can be tolerated with reduced 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 2 stage filter.

The generator air intake is through the non drive end cover and the generating set and canopy design must be such that the intake is not restricted. It is recommended that a minimum clearance of 50mm is allowed between the generator air intake and any vertical flat surface.

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	
BC164	0.071 m³/sec	0.09 m³/sec	3mm water gauge (0.1")
	150 cfm	190 cfm	
BC184 EFG	0.095 m³/sec	0.119 m³/sec	
	200 cfm	250 cfm	
BC184 HJ	0.15 m³/sec	0.19 m³/sec	
	318 cfm	403 cfm	
BC162	0.19 m³/sec	0.23 m³/sec	
	403 cfm	487 cfm	
BC182	0.254 m³/sec	0.304 m³/sec	
	538 cfm	644 cfm	

If specified at the time of ordering, the generator itself may be fitted with air filters.

The BCL construction has no fan fitted to the generator. The engine flywheel fan draws air through the generator and additional restrictions on air flow such as filters on the generator or canopies are not permissible.

Important ! **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 r.p.m.	25 Hz
4 pole	1800 r.p.m.	30 Hz
2 pole	3000 r.p.m.	50 Hz
2 pole	3600 r.p.m.	60 Hz

However, vibrations induced by the engine are complex and contain frequencies of 1, 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 designer to ensure that the alignment and stiffness of the bedplate and mountings are such that the vibration limits of BS 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 BS 5000 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 125ft.lb. (17 kgm). A flexible coupling, designed to suit the specific engine/generator combination, is recommended to minimise torsional effects.

Belt driven applications of two bearing generators require the pulley diameter and design to be such that the side load or force applied to the shaft is central to the extension and does not exceed the values given in the table below:-

Frame 2/4 Pole	Side Load		Shaft extension mm
	kgf	N	
BC16	92	900	82
BC18	173	1700	82

In instances where shaft extensions greater than specified in the table have been supplied, reference must be made to the factory for appropriate loadings.

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 125ft.lb. (17 kgm).

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

It is expected that the generator will be incorporated into a generating set operating in an environment, where the maximum shock load experienced by the generator will not exceed 3g. in any plane. If shock loads in excess of 3g are to be encountered, anti-vibration mountings must be incorporated into the generating set to ensure they absorb the excess.

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

Important ! **Single bearing drive end brackets are designed to be bolted to the engine flywheel housing using cap head screws.**

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.

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

The terminal box 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. A hole is provided on the generator foot which may be tapped to give an additional earthing point.

The neutral is NOT connected to the frame.

The main stator winding has 12 leads brought out to the terminals in the terminal box.

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.**

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.

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.**

SECTION 4

INSTALLATION - PART 1

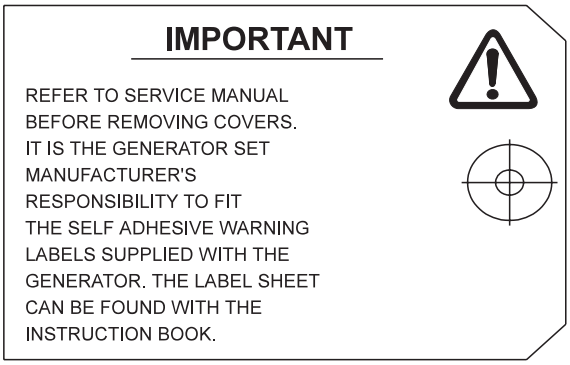
4.1 LIFTING

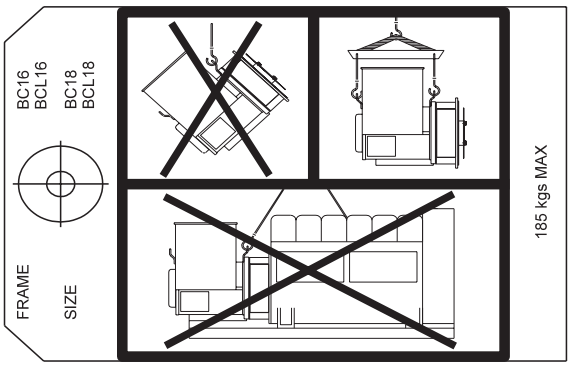
Warning !

Incorrect lifting or inadequate lifting capacity can result in severe personal injury or equipment damage. MINIMUM LIFTING CAPACITY REQUIRED IS 250kg. Generator lifting lugs should not be used for lifting the complete generator set.

Lifting lugs are provided at each end of the generator for use with a shackle and pin type lifting aid or lifting hooks. Chains of suitable length and lifting capacity, with spreader bar to avoid damage to the terminal box, must be used.

The correct lifting arrangement is shown on a label attached to the generator. A typical example is shown below.





BCL generators have no fan to support the drive end and are supplied fitted with a transit strap clamping the coupling hub to the drive end adaptor ring.

Once the transit strap is removed 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.

4.2 ASSEMBLY TO ENGINE

ENGINE TO GENERATOR COUPLING ASSEMBLY

During the assembly of the Generator to the Engine it will be necessary to firstly carefully align, then rotate, the combined Generator rotor - Engine crankshaft assembly, as part of the construction process, to allow location, insertion and tightening of the coupling bolts. This requirement to rotate the combined assemblies exists for both single and two bearing units.

During the assembly of single bearing units it is necessary to align the generator's coupling holes with the engine flywheel holes: it is suggested that two diametrically opposite location dowel pins are fitted to the engine flywheel, over which the generator coupling can slide into final location into the engine flywheel spigot recess. The dowels must be removed and replaced by coupling bolts before the final bolt tightening sequence.

While fitting and tightening the coupling bolts it will be necessary to rotate the Engine crankshaft - Generator rotor assembly. Care should be taken to ensure that rotation is carried out in an approved manner that ensures safe working practice when reaching inside the machine to insert or tighten coupling bolts, and that no component of the assembly is damaged by non-approved methods of assembly rotation.

Engine Manufacturers have available a proprietary tool designed to enable manual rotation of the crankshat assembly. This tool must always be used, having been engineered as an approved method of assembly rotation, by engaging the manually driven pinion with the engine flywheel starter ring-gear.

UNDER NO CIRCUMSTANCES SHOULD A LEVER BE USED AGAINST THE FAN BLADES OR BAFFLE TO ROTATE THE GENERATOR ROTOR / ENGINE CRANKSHAFT ASSEMBLY.

Danger !

Before working inside the generator, during the aligning and fitting of coupling bolts, care should be taken to lock the assembly to ensure there is no possibility of assembly rotational movement.

4.2.1 TWO BEARING GENERATORS

A flexible coupling should be fitted and aligned in accordance with the coupling manufacturer's instruction.

If a close coupling adaptor is used the alignment of machined faces must be checked by offering the generator up to the engine. Shim the generator feet if necessary. Ensure adaptor guards are fitted after generator/engine assembly is complete. Open coupled sets require a suitable guard, to be provided by the set builder.

In the case of belt driven generators, ensure alignment of drive end and driven pulleys to avoid axial load on the bearings. Screw type tensioning devices are recommended to allow accurate adjustment of belt tension whilst maintaining pulley alignment.

Belt and pulley guards must be provided by the set builder.

Important ! Incorrect belt tensioning will result in excessive bearing wear.

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

4.2.2 SINGLE BEARING GENERATORS

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

For transit and storage purposes the generator frame spigot and rotor coupling plates have been coated with a rust preventative. This MUST BE removed before assembly to engine.

A practical method for removal of this coating is to clean the mating surface areas with a de-greasing agent based on a petroleum solvent.

For coupling to the various engine flywheel housings, the

Caution !	**Care should be taken not to allow any cleaning agent to come into prolonged contact with skin.**

generators can be supplied with an endbracket-adaptor arrangement as outlined below.

EndBracket/Adaptor

SAE5
SAE4
SAE3
SAE2
SAE5 Plus SAE6 Adaptor Ring

Important ! Drive end adaptors are designed for use with cap head screws.
BC18 generators fitted with an SAE 5 drive end adaptor must also be fitted with a reduced diameter fan and must be operated at reduced output.
Fan securing screws should be tightened to 0.59kgm (6Nm 4.4lb. ft.)

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 a.c. generator bearing or engine bearing.
2. Check that the bolts securing the coupling disc to the coupling hub are tight and locked into position. Torque tightening is 7.6kgm (75Nm; 55 lb ft).
3. Remove covers from the drive end of the generator to gain access to coupling disc and adaptor bolts.
4. Check that coupling disc is concentric with adaptor spigot. This can be adjusted by suspending the rotor by means of a rope sling through the adaptor opening.
5. Offer the a.c. generator to engine and engage both coupling disc 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. Refer to engine manual for torque setting of disc to flywheel bolts.

Important ! When fitting drive disc ensure that flywheel fixing bolt holes fall between fan blades to allow access for flywheel bolts. Use engine pulley to turn rotor.

4.2.2.1 SINGLE BEARING 4-POLE & 2-POLE GENERATORS

Generators offered in the BCA range can be specified to suit different engine build configurations of specific flywheel and flywheel housing combinations.

Important ! It is most important that the appropriate generator build is ordered with prior knowledge of the intended engine flywheel/ housing arrangement.

Important ! During assembly, loss of residual voltage may occur. Refer to subsection 7.4.3 for field flashing.

GENERATOR TO ENGINE ASSEMBLY INSTRUCTIONS

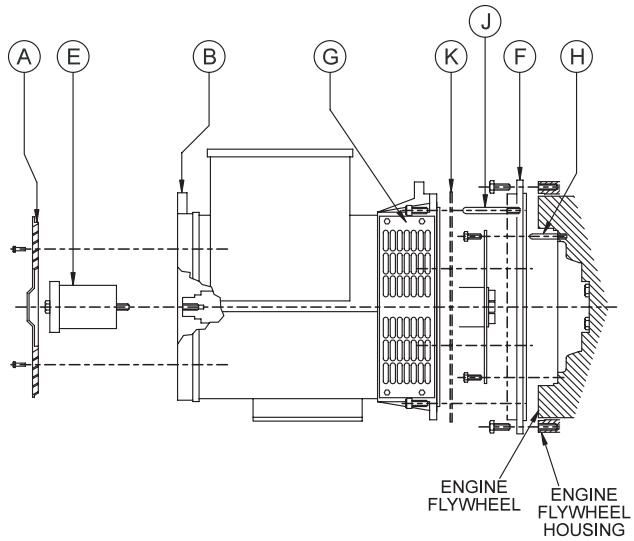
1. Remove louvered cover "A" from non-drive endbracket "B".
2. Assemble locating bar "E" (Newage No AF1609) by screwing into shaft.
3. Remove transit bar "K".
4. Remove side screens "G".
5. If the adaptor ring is an individual item, as indicated "F", bolted to the generator D.E. bracket, remove from generator and fit to engine flywheel housing.
6. Thread two locating pins "H" into two top flywheel holes.
7. Fit two locating pins "J" into two top holes of the engine flywheel housing/adaptor location holes.
8. Pick up generator by the cast lifting lugs on both ends with 1/2 ton shackles (TO BS3032) or lifting hooks (Newage No.LE130) using suitable lifting equipment.
9. Rotate generator rotor such that two top holes of coupling disc are in close axial alignment.
10. Push the generator rotor forward only half (50mm) the available movement provided by locating bar "E". It may be necessary to tap bar "E" with a hide mallet to ease the bearing out of housing.

Important ! Do not push the rotor forward too far. There is a risk that the rotor will rest on the stator winding outhang resulting in winding damage especially if any rotational movement occurs during alignment with pins "H".

11. Support the weight of the rotor at the coupling end whilst sliding the rotor forward to locate coupling disc holes over support pins "H". Locating bar "E" will allow the rotor to move forward a further 50mm, the total movement bar "E" allows being 100mm. With coupling discs positioned against flywheel location fit securing screws and washers. Remove pins "H" and fit two final securing screws and washers.
12. Push generator onto engine guiding adaptor over locating pins "J" and onto engine flywheel housing location, or ring "F", secure with screws and washers. Remove pins and replace with two screws and washers.

13. Remove locating bar "E". Replace M10 screw "C" for barring purposes.

14. Remove lifting tackle and replace side screens "G" and louvered cover "A".



4.2.2.2 SINGLE BEARING 2-POLE GENERATOR TO ENGINE ASSEMBLY INSTRUCTIONS (WITH DOWELED FLYWHEELS)

1-5. Follow steps 1-5 from 4 pole instruction procedure.

6. Fit the two location dowels pins into appropriate diametrically opposite holes in engine flywheel, leaving sufficient parallel diameter exposed to allow for positive location of the disc-spacer-ring and coupling discs.

7. Fit the disc-spacer-ring over the two dowel pins and position firmly against the flywheel face.

8. Follow steps 6-8 from 4 pole instruction procedure.

9. Rotate generator rotor such that the two coupling disc dowel holes align with flywheel dowel pins, and two top holes of coupling discs are in close axial alignment with the two flywheel location pins "H".

10. Follow step 10 from 4 pole instruction procedure.

11. Support the weight of the rotor at the coupling end whilst sliding the rotor forward to locate coupling disc holes over support pins "H".

Important ! **Ensure coupling disc dowel pin holes are in correct alignment.**

With the coupling disc positioned against flywheel location fit securing screws and washers.

Remove pins "H" and fit two final securing screws and washers.

12. Follow steps 12-14 from 4 pole instruction procedure.

4.2.3 TAPER SHAFT ARRANGEMENTS

This arrangement is used on the BCL style generators.

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

The following procedure should be adopted to assemble the generator to the engine:-

1. Remove louvred endcover "G" from non drive endbracket "H" and M10 Hex Nut "D" from shaft securing stud "AA"." Remove transit bar "E" and withdraw stub shaft/shaft securing stud "A/B" from rotor.

2. Ensure alternator, engine flywheel and flywheel housing locating spigots, faces and recesses are free from paint or preservatives.

3. Locate stub shaft/shaft securing stud assembly "A"/"B" on engine flywheel spigot and secure with studs "J", M12 hex. nut "L" or bolts. Refer to engine manual for torque settings.

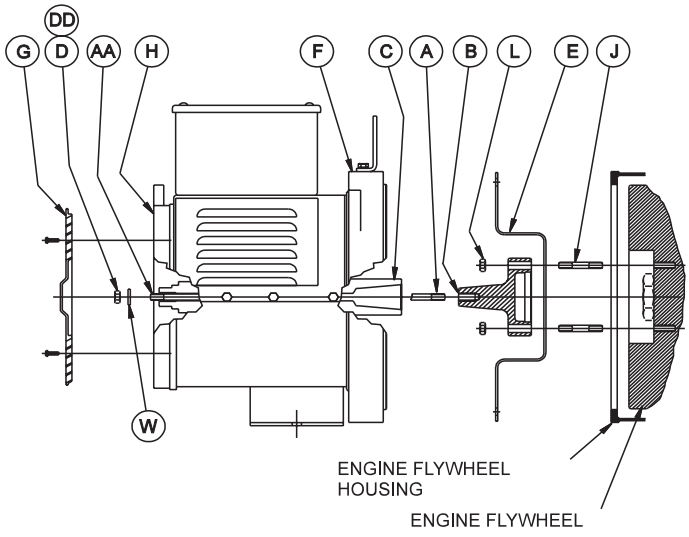
4. Ensure both tapers are clean and free of burrs, oil or grease. Slide alternator complete with rotor towards engine, ensuring that shaft securing stud "A" enters central hole in rotor shaft. Refer to engine manual for torque settings.

5. Secure alternator adaptor "F" to engine flywheel housing. Tap adaptor into place before tightening. Refer to engine manufacturer for torque setting.

6. Fit M10 Binx nut "DD" to protruding shaft securing stud "AA". M10 Binx nut tightening torque 45.0Nm (33.0 lbs.ft).

7. Fit louvred endcover "G" to non drive endbracket "H".

8. Check for excessive vibration at time of initial run-up.



Caution! **Incorrect guarding and/or generator alignment can result in personal injury and /or equipment damage**

4.3 EARTHING

The generator frame should be solidly bonded to the generating set bedplate. If anti vibration mounts are fitted between the generator frame and its bedplate a suitably rated earth conductor (normally one half of the cross sectional area of the main line cables) should bridge across the anti vibration mount.

Warning !

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

4.4 PRE-RUNNING CHECKS

4.4.1 INSULATION CHECK

Before starting the generating set, both after completing assembly and after installation of the set, test the insulation resistance of windings.

The AVR should be disconnected during this test.

A 500V Megger or similar instrument should be used. Disconnect any earthing conductor connected between neutral and earth and megger an output lead terminal U, V or W to earth. The insulation resistance reading should be in excess of 5MΩ to earth. Should the insulation resistance be less than 5MΩ the winding must be dried out as detailed in the Service and Maintenance section of this Manual.

Important ! **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)**

4.4.2 DIRECTION OF ROTATION & PHASE ROTATION

BC generators can rotate efficiently in either direction. However phase rotation is fixed for clockwise rotation as viewed from the drive end. If the generator is to be rotated in a counter-clockwise direction it will be necessary for the customers to adjust their cabling to the output terminals accordingly. Refer to the factory for a reverse wiring diagram.

4.4.3 VOLTAGE AND FREQUENCY

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

Three phase generators normally have a 12 ends out reconnectable winding. If it is necessary to reconnect the stator for the voltage required, refer to diagrams in the back of this manual.

4.4.4 AVR INITIAL SETTINGS

To make AVR selections remove the AVR cover and refer to the following sections depending upon type of AVR fitted.

Reference to the generator nameplate will indicate AVR type.

AVR type SX460 - Refer to Section 4.4.4.1
AVR type SA465 - Refer to Section 4.4.4.2

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

4.4.4.1 TYPE SX460 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.

Refer to Fig. 1 for location of selection links.

1. Frequency selection

50Hz operation	LINK C-50
60Hz operation	LINK C-60

2. External hand trimmer selection

No external hand trimmer - LINK 1-2
External hand trimmer required - REMOVE LINK 1-2 and connect trimmer across terminals 1 and 2.

3. AVR Input Selection

High Voltage (220/240V)	INPUT	No Link
Low Voltage (110/120V)	INPUT	LINK 3-4

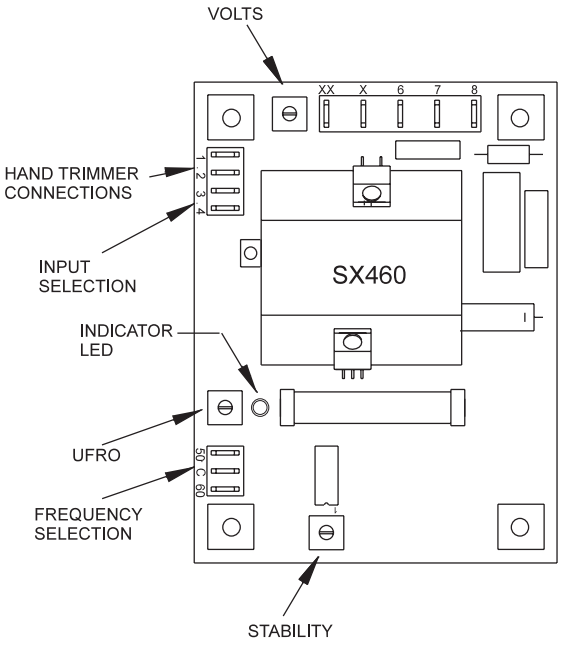


Fig. 1

4.4.4.2 TYPE SA465 AVR

The following switch and jumper connections on the AVR should be checked to ensure they are correctly set for the generating set application.
Refer to Fig. 2 for selector locations.

1. Frequency selection

50Hz operation	Set Switch SW1 to position 5
60Hz operation	Set Switch SW1 to position 6

2. External Hand Trimmer selection

No external hand trimmer	LINK 1-2
External hand trimmer required	REMOVE LINK 1-2 and connect trimmer across terminals 1 and 2.

3. AVR Input Selection

High Voltage	(220/240V)	INPUT	No Link
Low Voltage	(110/120V)	INPUT	LINK L-L

4. Stability selection

Set switch SW2 to position 4

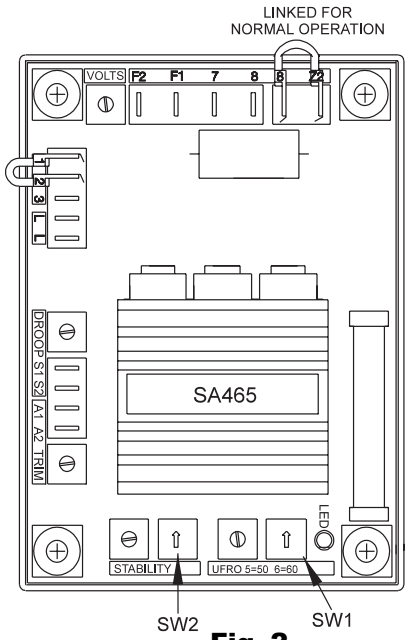


Fig. 2

4.4.5 TRANSFORMER CONTROLLED EXCITATION SYSTEM

This control system is identified by the word 'TRANSF' against AVR type on the nameplate.

The excitation control is factory set for the specific voltage shown on the nameplate and requires no adjustment.

4.5 GENERATOR SET TESTING

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.

4.5.1 TEST METERING/CABLING

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 - 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.

Important ! **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 with the nut provided.**

Caution! **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

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. Refit all access covers after adjustments are completed.

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.

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

In addition remove the AVR access cover (on AVR controlled generators) and turn VOLTS control fully anti-clockwise. 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. 1, 2 or 3 for control potentiometer location.

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

The STABILITY control potentiometer should be set to the midway position (refer to fig 1, 2 or 3 for its location) and with the stability selection correctly set should not normally require adjustment. Should adjustment be required, usually identified by oscillation of the voltmeter proceed as follows:-

On SA465 major adjustment of the stability can be made by selection on switch SW2.

Switch position 8 will give SLOW AVR response
Switch position 0 will give FAST AVR response

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

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. Refit all access covers after adjustments are completed.

4.7.1 AVR CONTROLLED GENERATORS - AVR ADJUSTMENTS

Refer to Fig. 1, 2 or 3 for control potentiometer locations.

Having adjusted VOLTS and STABILITY during the initial start-up procedure, the AVR control function UFRO should not normally need adjustment.

If however, poor voltage regulation on-load is experienced, refer to the following paragraph to a) check that the symptoms observed do indicate adjustment is necessary, and b) to make the adjustment correctly.

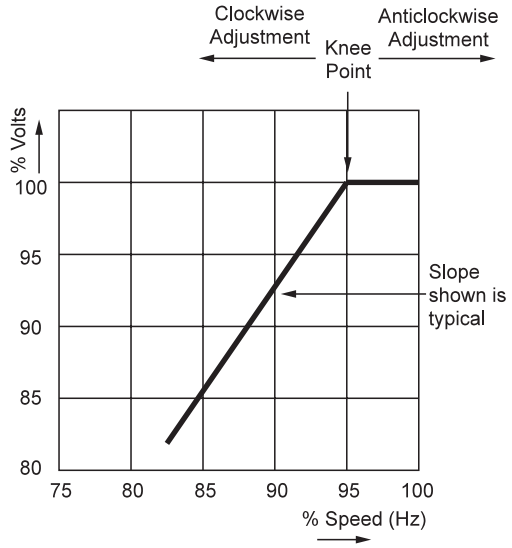
4.7.1.1 UFRO (Under Frequency Roll Off)

The AVR incorporates an underspeed protection circuit which gives a voltage/speed (Hz) characteristic as shown:

The UFRO control potentiometer sets the "knee point".

Symptoms of incorrect setting are a) the light emitting diode (LED) indicator, adjacent to 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 nominal frequency, i.e. 47Hz on a 50Hz generator or 57Hz on a 60Hz generator.



4.7.2 TRANSFORMER CONTROLLED GENERATORS - TRANSFORMER ADJUSTMENT

Normally no adjustment is required but should the no-load voltage and/or on-load voltage be unacceptable, adjustment of the transformer air gap can be made as follows.

Stop the generator. Remove transformer cover box. (Normally left hand side of the terminal box when viewed from the non drive end).

Slacken the three transformer mounting bolts along the top of the transformer, and the two bolts holding the mounting bracket to the base plate.

Start the set with a voltmeter connected across the main output terminals.

Adjust the air gap between the transformer top lamination section and the transformer limbs to obtain required voltage on no-load. Slightly tighten the three mounting bolts. Switch load 'on' and 'off' two or three times. Application of load will normally raise the voltage setting slightly. With the load 'off' recheck the no-load voltage.

Readjust air gap and finally tighten mounting bolts.

Refit the access cover.

Failure to refit covers can result in operator personal injury or death.

4.8 ACCESSORIES

Refer to the "ACCESSORIES" - Section 6 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.

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 will normally be supplied with the right hand side panel, viewed from the non drive end, available for cable exit. The side panel is removable for drilling/punching to suit glands or glanding boxes. Should the cable exit be required from the left hand side of the generator when viewed from the non drive end, the left and right hand panels may be interchanged. Sufficient length of wiring to the AVR has been provided for this purpose.

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.

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

A 500V Megger or similar instrument should be used. Should the insulation resistance be less than 5MW the windings must be dried out as detailed in the Service and Maintenance section of this manual.

When making connections to the terminals the incoming cable termination should be placed on top of the winding lead termination(s) and clamped with the nut provided.

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

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. A hole is provided on the generator foot which may be tapped to give an additional earthing point. The feet 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 ! **Reference to local electricity regulations or safety rules should be made to ensure correct earthing procedures have been followed.**

5.4 PROTECTION

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.

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.

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.

The generator AVR controls will have been adjusted during the generating set manufacturer's tests and should normally not require further adjustment. Should adjustment on site be necessary refer to Section 4 for AVR details and/or Section 6 for paralleling adjustments.

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

SECTION 6

ACCESSORIES

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.

Accessories available are droop transformer for parallel operation applicable to generators with SA465 AVR, and remote voltage adjust (hand trimmer). The latter being available for all AVR types but not fitted on the generator.

NOTE:
None of the accessories can be fitted with a transformer controlled generator.

6.1 REMOTE VOLTAGE ADJUST (all AVR types).

A remote voltage adjust can be fitted to the control panel.

Remove link 1-2 on the AVR and connect adjuster to terminals 1 and 2.

6.2 PARALLEL OPERATION

Understanding of the following notes on parallel operation is useful before attempting the fitting or setting of the droop kit 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.

Important ! **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, watt meter (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

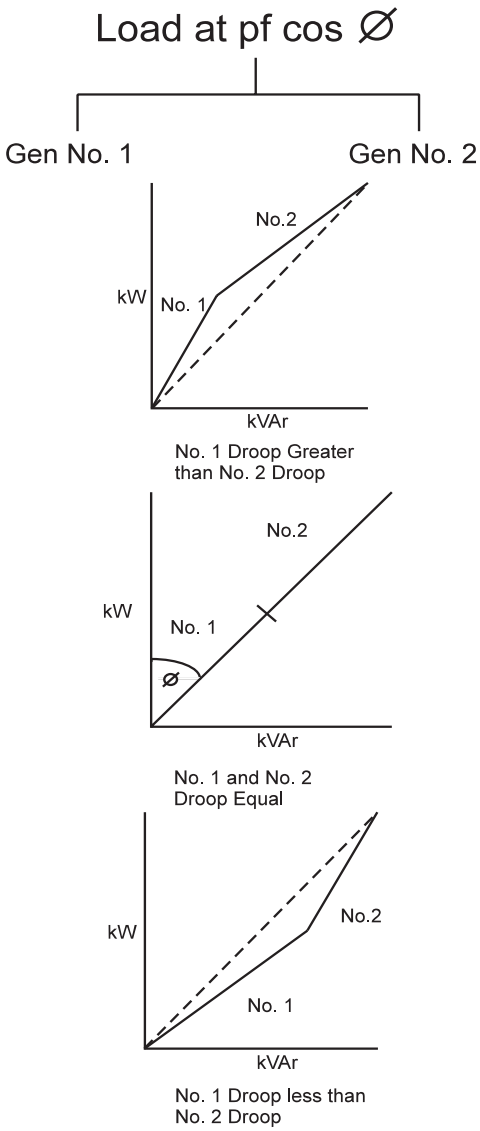
1. kW are derived from the engine, and speed governor characteristics determine the kW sharing between sets**.**

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.

6.2.1 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 (C.T.) which provides a signal dependent on current phase angle (i.e. power factor) to the AVR. 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.

The diagrams below indicate the effect of droop in a simple two generator system:-



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

If the droop accessory has been supplied with the generator it will have been tested to ensure correct polarity and set to a nominal level of droop. The final level of droop will be set during generating set commissioning.

The following setting procedure will be found to be helpful.

6.2.1.1 SETTING PROCEDURE

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

0.8 P.F. LOAD	(at full load current)	SET DROOP TO 3%
0 P.F. 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 potentiometer to give droop in line with above table. Clockwise rotation increases amount of droop. Refer to Fig 2, Fig 3, for potentiometer location. After adjustment check NO LOAD voltage level and adjust if necessary.

Note 1) Reverse polarity of the C.T. 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 operated as a single unit with a droop circuit set at rated load 0.8 power factor is unable to maintain the usual % regulation. A shorting switch can be connected across S1-S2 to restore regulation for single running.

Important ! 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 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 secondary.

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. (Subsection 6.2.1.1).

Important ! 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.

SECTION 7

SERVICE AND MAINTENANCE

7.1 WINDING CONDITION

Service and fault finding procedures present hazards which can result in severe personal injury or death. Only 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.

Guidance of Typical Insulation Resistance [IR] Values

The following is offered as general information about IR values and is aimed at providing guidance about the typical IR values for generators from new through to the point of refurbishment.

New Machines

The generators Insulation Resistance, along with many other critical factors, will have been measured during the alternator manufacturing process. The generator will have been transported with an appropriate packaging suitable for the method of delivery to the Generating Set assemblers works. Where we expect it to be stored in a suitable location protected from adverse environmental conditions.

However, absolute assurance that the generator will arrive at the Gen-set production line with IR values still at the factory test levels of above 100 MΩ cannot be guaranteed.

At Generating Set Manufacturers Works

The generator should have been transported and stored such that it will be delivered to the assembly area in a clean dry condition. If held in appropriate storage conditions the generator IR value should typically be 25 MΩ.

If the unused/new generators IR values fall below 10 MΩ then a drying out procedure should be implemented by one of the processes outlined below before being despatched to the end customer's site. Some investigation should be undertaken into the storage conditions of the generator while on site.

Generators in Service

Whilst It is known that a generator will give reliable service with an IR value of just 1.0 MΩ. For a relatively new generator to be so low it must have been subjected to inappropriate operating or storage conditions.

Any temporarily reduction in IR values can be restored to expected values by following one of the drying out procedures.

7.1.1 WINDING CONDITION ASSESSMENT

CAUTION! **The AVR should be disconnected and the Resistance Temperature Detector (R.T.D.) leads grounded during this test.**

The condition of the windings can be assessed by measurement of insulation resistance [IR] between phase to phase, and phase to earth.

Measurement of winding insulation should be carried out: -

1. As part of a periodic maintenance plan.
2. After prolonged periods of shutdown.
3. When low insulation is suspected, e.g. damp or wet windings.

Care should be taken when dealing with windings that are suspected of being excessively damp or dirty. The initial measurement of the [IR] Insulation Resistance should be established using a low voltage (500V) megger type instrument. If manually powered the handle should initially be turned slowly so that the full test voltage will not be applied, and only applied for long enough to very quickly assess the situation if low values are suspected or immediately indicated.

Full megger tests or any other form of high voltage test should not be applied until the windings have been dried out and if necessary cleaned.

Procedure for Insulation Testing

Disconnect all electronic components, AVR, electronic protection equipment etc. Ground the [RTD's] Resistance Temperature Detection devices if fitted. Short out the diodes on the rotating diode assembly. Be aware of all components connected to the system under test that could cause false readings or be damaged by the test voltage.

Carry out the insulation test in accordance with the 'operating instructions for the test equipment.

The measured value of insulation resistance for all windings to earth and phase to phase should be compared with the guidance given above for the various 'life stages' of a generator. The minimum acceptable value must be greater than 1.0 MΩ.

If low winding insulation is confirmed use one or more of the methods, given below, for drying the winding should be carried out.

7.1.2 METHODS OF DRYING OUT GENERATORS

Cold Run

Consider a good condition generator that has not been run for some time, and has been standing in damp, humid conditions. It is possible that simply running the gen set unexcited - AVR terminals K1 K2 open circuit - for a period of say 10 minutes will sufficiently dry the surface of the windings and raise the IR sufficiently, to greater than 1.0 MΩ , and so allow the unit to be put into service.

Blown Air Drying

Remove the covers from all apertures to allow the escape of the water-laden air. During drying, air must be able to flow freely through the generator in order to carry off the moisture.

Direct hot air from two electrical fan heaters of around 1 – 3 kW into the generator air inlet apertures. Ensure the heat source is at least 300mm away from the windings to avoid over heating and damage to the insulation.

Apply the heat and plot the insulation value at half hourly intervals. The process is complete when the parameters covered in the section entitled, 'Typical Drying Out Curve', are met.

Remove the heaters, replace all covers and re-commission as appropriate.

If the set is not to be run immediately ensure that the anti-condensation heaters are energised, and retest prior to running.

Short Circuit Method

NOTE: This process should only be performed by a competent engineer familiar with safe operating practices within and around generator sets of the type in question.

Ensure the generator is safe to work on, initiate all mechanical and electrical safety procedures pertaining to the genset and the site.

Bolt a short circuit of adequate current carrying capacity, across the main terminals of the generator. The shorting link should be capable of taking full load current.

Disconnect the cables from terminals “X” and “XX” of the AVR.

Connect a variable dc supply to the “X” (positive) and “XX” (negative) field cables. The dc supply must be able to provide a current up to 2.0 Amp at 0 - 24 Volts.

Position a suitable ac ammeter to measure the shorting link current.

Set the dc supply voltage to zero and start the generating set. Slowly increase the dc voltage to pass current through the exciter field winding. As the excitation current increases, so the stator current in the shorting link will increase. This stator output current level must be monitored, and not allowed to exceed 80% of the generators rated output current.

After every 30 minutes of this exercise:
Stop the generator and switch off the separate excitation supply, and measure and record the stator winding IR values, and plot the results. The resulting graph should be compared with the classic shaped graph. This drying out procedure is complete when the parameters covered in the section entitled 'Typical Drying Out Curve' are met.

Once the Insulation Resistance is raised to an acceptable level - minimum value 1.0 MΩ – the dc supply may be removed and the exciter field leads “X” and “XX” re-connected to their terminals on the AVR.

Rebuild the genset, replace all covers and re-commission as appropriate.

If the set is not to be run immediately ensure that the anti-condensation heaters are energised, and retest the generator prior to running.

TYPICAL DRYING OUT CURVE

Whichever method is used to dry out the generator the resistance should be measured every half-hour and a curve plotted as shown. (fig 6.)

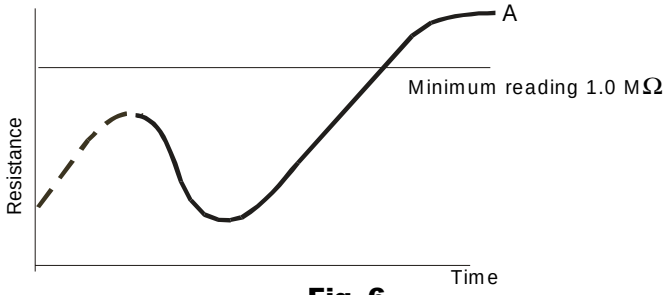


Fig. 6

The illustration shows a typical curve for a machine that has absorbed a considerable amount of moisture. The curve indicates a temporary increase in resistance, a fall and then a gradual rise to a steady state. Point ‘A’, the steady state, must be greater than 1.0 MΩ. (If the windings are only slightly damp the dotted portion of the curve may not appear).

For general guidance expect that the typical time to reach point 'A' will be:

1 hour for a BC16/18,
2 hours for a UC22/27
3 hours for an HC4,5,6&7
Drying should be continued after point “A” has been reached for at least one hour.

It should be noted that as winding temperature increases, values of insulation resistance may significantly reduce. Therefore, the reference values for insulation resistance can only be established with windings at a temperature of approximately 20°C.

If the IR value remains below 1.0 MΩ, even after the above drying methods have been properly conducted, then a Polarisation Index test [PI] should be carried out.

If the minimum value of 1.0 MΩ for all components cannot be achieved rewinding or refurbishment of the generator will be necessary.

The generator must not be put into service until the minimum values can be achieved.

Important ! The short circuit must not be applied with the AVR connected in circuit. Current in excess of the rated generator current will cause damage to the windings.

After drying out, the insulation resistances should be rechecked to verify minimum resistances quoted above are achieved.
On re-testing it is recommended that the main stator insulation resistance is checked as follows:-
Separate the neutral leads

Ground	V and W	phase and megger		U phase to ground
Ground	U and W	phase and megger		V phase to ground
Ground	U and V	phase and megger		W phase to ground

If the minimum value of 1.0MΩ is not obtained, drying out must be continued and the test repeated.

7.2 BEARINGS

All bearings are supplied sealed for life and are, therefore, not regreasable.

Important ! The life of a bearing in service is subject to the working conditions and the environment.

Important ! Long stationary periods in an environment where there is vibration can cause false brinnelling which puts flats on the ball and grooves on the races.
Very humid atmospheres or wet conditions can emulsify the grease and cause corrosion.

Important ! High axial vibration from the engine or misalignment of the set will stress the bearing.

The bearing, in service, is affected by a variety of factors that together will determine the bearing life. We recommend that the health of the bearings be monitored, using ‘spike energy’ vibration monitoring equipment. This will allow the timely replacement of bearings, that exhibit a deteriorating trend, during a major engine overhaul.

If excessive heat, noise or vibration is detected, change the bearing as soon as practicable. Failure to do so could result in bearing failure.

In the event that ‘spike energy’ vibration monitoring equipment is not available, it is strongly recommend that consideration be given to changing the bearing during each ‘major engine overhaul’.

Belt driven application will impose an additional load on bearings. The bearing life will therefore be significantly affected. It is important that the side load limits given in SECTION 3 are not exceeded and the health of the bearing is monitored more closely.

7.3 AIR FILTERS

Removal of filter elements enables access to LIVE parts. Only remove elements with the generatorout 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.

Alternatively, after removing the filter elements 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) hoding 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

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

Three excitation control systems can be fitted to the range of generators covered by this manual, identified by the last digit of the generator frame size designation. Refer to the nameplate then proceed to the appropriate subsection as indicated below:-

SERIES	EXCITATION CONTROL	SUBSECTION
4	SA465 AVR	7.4.1
5	Transformer control	7.4.2
6	SX460 AVR	7.4.1

7.4.1 ALL AVR TYPES - FAULT FINDING

No voltage build-up when starting set	1. Check speed 2. Check residual voltage. - Refer to subsection 7.4.3. 3. Follow separate excitation test procedure to check generator and AVR. Refer to subsection 7.5.
Unstable voltage either on no-load or with load	1. Check speed stability. 2. Check stability setting. Refer to subsection 4.6.
High voltage either on no-load or with load	1. Check speed. 2. Check that generator load is not capacitive (leading power factor).
Low voltage no-load	1. Check speed. 2. Check link 1-2 or external hand trimmer leads for continuity.
Low voltage on-load	1. Check speed. 2. Check UFRO setting. Refer to subsection 4.7.1.1. 3. Follow separate excitation procedure to check generator and AVR. Refer to subsection 7.5.

7.4.2 TRANSFORMER CONTROL - FAULT FINDING

No voltage build-up when starting set	1. Check transformers rectifiers. 2. Check transformer secondary winding for open circuit.
Low voltage	1. Check speed. 2. Check transformer air gap setting. Refer to subsection 4.7.2.
High voltage	1. Check speed. 2. Check transformer air gap setting. Refer to subsection 4.7.2. 3. Check transformer secondary winding for short circuited turns.
Excessive voltage drop on-load	1. Check speed drop on-load. 2. Check transformer rectifiers. Check transformer air gap setting. Refer to subsection 4.7.2.

7.4.3 RESIDUAL VOLTAGE CHECK (Field Flashing)

This procedure applies to all generators fitted with AVR control. With the generator set stationary remove AVR access cover and leads F1 and F2 from the AVR.

Start the set and measure voltage across AVR terminals 7-8. A minimum level of 5 volts is required at these terminals. If the voltage is less than 5 volts stop the set,because it will be necessary to carry out the following **Field Flashing** procedure. Replace leads F1 and F2 on the AVR terminals. Using a 12 volt d.c. battery as a supply, clip leads from battery negative to AVR terminal F2, and from battery positive through a diode to AVR terminal F1. See Fig 5.

Important ! A diode must be used as shown below to ensure the AVR is not damaged.

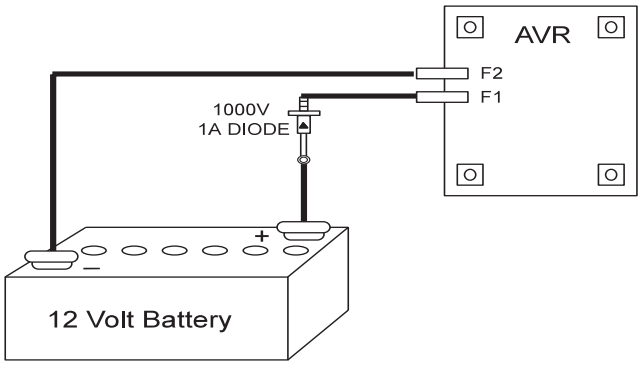


Fig. 5

Important ! If the generating set battery is used for field flashing, the generator main stator neutral must be diconnected from earth.

Restart the set and note output voltage from the main stator, which should be approximately nominal voltage, or voltage at AVR terminals 7 and 8 which should be between 170 and 250 volts.

Stop the set and unclip battery supply from terminals F1 and F2. Restart the set. The generator should now operate normally. If no voltage build-up is obtained it can be assumed a fault exists in either the generator or the AVR circuits. Follow the SEPARATE EXCITATION PROCEDURE to check generator windings, rotating diodes and AVR. Refer to subsection 7.5.

7.5 SEPARATE EXCITATION TEST PROCEDURE

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

1. With the generating set stationary remove AVR access cover and leads F1 and F2 from the AVR. On transformer controlled generators remove the terminal box lid for access and remove leads F1 and F2 from the control rectifier bridge.

2. Connect a 60W 240 volt household lamp (or two 120V lamps in series) to AVR terminals F1 and F2. (Only required for section 7.5.2.1). On transformer controlled generators refer to sub section 7.5.2.2 for transformer checks.
3. Connect a 0-12 volt, 1.0 Amp d.c. supply to leads F1 and F2. The positive of the d.c. supply is connected to the lead marked F1 and the negative to the lead marked F2.

The procedure is simplified by dividing into two sections:

7.5.1 GENERATOR WINDINGS AND ROTATING DIODES, and

7.5.2 EXCITATION CONTROL TEST.

7.5.1 GENERATOR WINDINGS AND ROTATING DIODES

Important! The resistances quoted apply to a standard winding. For generators having windings or voltages other than those specified refer to factory for details. Ensure all disconnected leads are isolated and free from earth.

This procedure is carried out with leads F1 and F2 disconnected at the AVR or transformer control rectifier bridge and using a 12 volt d.c. supply to leads F1 and F2.

Start the set and run at rated speed, on no-load.

Measure the voltages at the main output terminals U, V and W. These should be balanced and within 10% of the generator nominal voltage.

On generators fitted with an auxiliary winding in the main stator, applicable only with the SA665 AVR, the voltage at AVR terminals 8 and Z2 should be approximately 150 volts a.c.

7.5.1.1 BALANCED MAIN TERMINAL VOLTAGES

If all voltages are balanced within 1% at the main terminals, it can be assumed that all exciter windings, main windings and main rotating diodes are in good order, and the fault is in the AVR or transformer control. Refer to subsection 7.5.2 for test procedure.

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.

Replacement of Faulty Diodes

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), as the fault must be in one of these windings. The exciter stator resistance is measured across leads F1 and F2. 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.

Resistance values should be within 10% of the values given in the table below:-

Frame Size	Main Rotor	Exciter Stator			Exciter Rotor
		Type 1	Type 2*	Type 3**	
BC164A	0.44	19	26	110	0.26
BC164B	0.48	19	26	110	0.26
BC164C	0.52	19	26	110	0.26
BC164D	0.56	19	26	110	0.26
BC184E	0.64	20	27	115	0.21
BC184F	0.74	22	30	127	0.23
BC184G	0.83	22	30	127	0.23
BC184H	0.89	24	-	-	0.24
BC184J	0.96	24	-	-	0.24
BC162D	0.81	18	-	-	0.26
BC162E	0.89	18	-	-	0.26
BC162F	0.95	18	-	-	0.26
BC162G	1.09	19	-	-	0.27
BC182H	1.17	20	-	-	0.21
BC182J	1.28	20	-	-	0.21
BC182K	1.4	20	-	-	0.21
BCA162L	1.55	20	-	-	0.21

* Used with 1 phase transformer controlled 3 phase or 1 phase generators

** Used with 3 phase transformer controlled 3 phase generators.

Generators fitted with auxiliary stator windings.

Frame Size	Main Rotor	Exciter Stator	Exciter Rotor
BC184E	0.64	8	0.21
BC184F	0.74	8	0.23
BC184G	0.83	8	0.23
BC184H	0.89	8	0.24
BC184J	0.96	8	0.24

Incorrect resistances indicate faulty windings and component replacement is necessary. Refer to removal and replacement of component assemblies, subsection 7.5.3.

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 winding leads U1-U2, U5-U6, V1-V2, V5-V6, W1-W2, W5-W6 to isolate each winding section.

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

AVR CONTROLLED GENERATORS			
Frame Size	SECTION RESISTANCES		
	Winding 311	Winding 05	Winding 06
BC164A	0.81	0.41	0.31
BC164B	0.51	0.30	0.19
BC164C	0.36	0.21	0.13
BC164D	0.3	0.32	0.21
BC184E	0.20	0.20	0.13
BC184F	0.13	0.14	0.09
BC184G	0.11	0.11	0.07
BC184H	0.085	0.041	0.029
BC184J	0.074	0.034	0.024
BC162D	0.68	0.30	0.25
BC162E	0.42	0.21	0.15
BC162F	0.31	0.17	0.11
BC162G	0.21	0.10	0.095
BC182H	0.16	0.075	0.055
BC182J	0.13	0.06	0.042
BC182K	0.10	0.047	0.030
BCA162L	0.65	0.03	0.02

Generators fitted with auxiliary stator windings.

AVR CONTROLLED GENERATORS		
Frame Size	AVR CONTROLLED GENERATORS	
	Main Stator Winding 71	Auxilliary
BC184E	0.19	1.88
BC184F	0.13	1.44
BC184G	0.1	1.32
BC184H	0.08	-
BC184J	0.066	-

TRANSFORMER CONTROLLED GENERATORS							
SECTION RESISTANCES							
Frame Size	3 Phase Windings					1 Phase Windings	
	380V	400V	415V	416V	460V	240V	240V
BC164A	2.4	2.56	2.62	1.98	2.36	0.37	0.25
BC164B	1.68	1.75	1.81	1.36	1.7	0.26	0.17
BC164C	1.16	1.19	1.21	0.91	1.16	0.17	0.12
BC164D	0.83	0.84	0.87	0.74	0.93	0.28	0.22
BC184E	0.59	0.60	0.63	0.48	0.61	0.16	0.12
BC184F	0.41	0.43	0.45	0.35	0.43	0.15	0.08
BC184G	0.33	0.34	0.36	0.26	0.33	0.09	0.07
BC184H	-	-	-	-	-	-	-
BC184J	-	-	-	-	-	-	-

Measure insulation resistance between sections and each section to earth.

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 subsection 7.5.3.

7.5.2 EXCITATION CONTROL TEST

7.5.2.1 AVR FUNCTION TEST

All types of AVR'S can be tested with this procedure:

1. Remove exciter field leads X &XX (F1 & F2) from the AVR terminals X & XX (F1 & F2).

2. Connect a 60W 240V household lamp to AVR terminals X & XX (F1 & F2).

3. Set the AVR VOLTS control potentiometer fully clockwise.

4. Connect a 12V, 1.0A DC supply to the exciter field leads X & XX (F1 & F2) with (F1) to the positive.

5. Start the generating set and run at rated speed.

6. Check that the generator output voltage is within +/- 10% of rated voltage.

Voltages at AVR terminals 7-8 on SX460 AVR or P2-P3 on SX421 AVR SHOULD BE BETWEEN 170 AND 250 VOLTS. If the generator output voltage is correct but the voltage on 7-8 (or P2-P3) is low, check auxiliary leads and connections to main terminals.

The lamp connected across X-XX should glow. In the case of the SX460 and SA465 AVRs the lamp should glow continuously. Failure to turn off indicates faulty protection circuit and the AVR should be replaced. Turning the "VOLTS" control potentiometer fully anti-clockwise should turn off the lamp with all AVR types.

Should the lamp fail to light the AVR is faulty and must be replaced.

Important ! **After this test turn the VOLTS control potentiometer fully anti-clockwise.**

7.5.2.2 TRANSFORMER CONTROL

The transformer rectifier unit can only be checked by continuity, resistance checks and insulation resistance measurement.

Rectifier Diodes

Separate primary leads T1-T2-T3-T4 and secondary leads 10-11. Examine windings for damage. Measure resistances across T1-T2 and T3-T4. These will be a low value but should be balanced. Check that there is resistance in the order of 5 ohms between leads 10 and 11. Check insulation resistance of each winding section to earth and to other winding sections.

Low insulation resistance, unbalanced primary resistance, open or short circuited winding sections, indicates the transformer unit should be replaced.

Three phase transformer

Separate primary leads T1-T2-T3 and secondary leads 6-7-8 and 10-11-12.

Examine windings for damage. Measure resistances across T1-T2, T2-T3, T3-T1. These will be low but should be balanced. Check that resistances are balanced across 6-10, 7-11 and 8-12 and in the order of 8 ohms.

Check insulation resistance of each winding section to earth and to other winding sections.

Low insulation resistance, unbalanced primary or secondary winding resistances, open or short circuited winding sections indicates the transformer unit should be replaced.

Rectifier units - Three phase and single phase

With the leads 10-11-12-F1 and F2 removed from the rectifier unit (lead 12 is not fitted on single phase transformer rectifier units), check forward and reverse resistances between terminals 10-F1, 11-F1, 12-F1, 10-F2, 11-F2 and 12-F2 with a multimeter.

A low forward resistance and high reverse resistance should be read between each pair of terminals. If this is not the case the unit is faulty and should be replaced.

7.5.3 REMOVAL AND REPLACEMENT OF COMPONENT ASSEMBLIES

Important ! **The following procedures assume that the generator has been removed from the generating set.**
On single bearing generators before removal from the engine, position the rotor such that a full pole face is at bottom dead centre. Use engine pulley to turn rotor.
Metric threads are used throughout.

Caution ! **When lifting single bearing generators, care is needed to ensure the generator frame is kept in the horizontal plane. The rotor is free to move in the frame and can slide out if not correctly lifted. Incorrect lifting can cause serious personal injury.**

7.5.3.1 REMOVAL OF BEARINGS

Important ! **Position the main rotor so that a full pole face of the main rotor core is at the bottom of the stator bore.**

Removal of bearings may be effected either after the rotor assembly has been removed or simply by removal of endbracket(s).

Refer to main rotor assembly section 7.5.3.2.
The bearings are pre-packed with grease and sealed for life.

1. The bearing(s) 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 circlip from shaft at non drive end (only fitted on single bearing machines).

When fitting new bearings use a bearing heater to expand the bearing before fitting to the shaft. Tap the bearing into place ensuring that it contacts the shoulder on the shaft.

Refit the retaining circlip on single bearing generators.

7.5.3.2 MAIN ROTOR ASSEMBLY

Single Bearing Generator

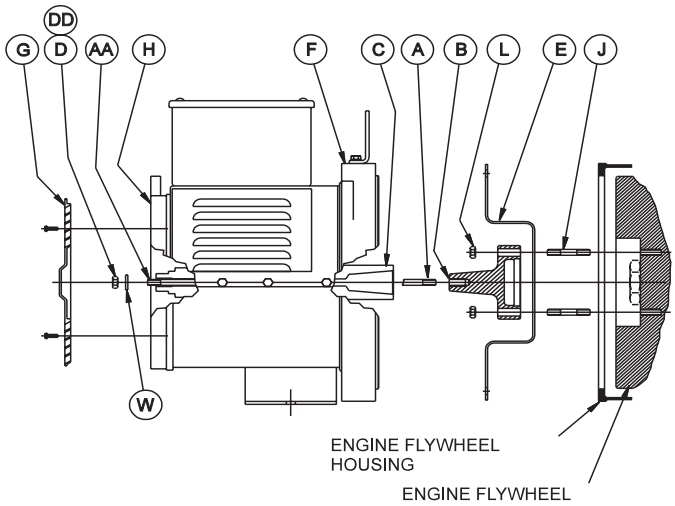
1. Remove four screws securing louvred cover at non drive end and remove cover.
2. Remove the screws and covers on each side of adaptor.
3. Ensure that rotor is supported at D.E. on a sling.
4. Tap the rotor from non-drive end bearing housing to push the bearing clear of the endbracket and its retaining 'O' ring.
5. Continue to push rotor through stator bore, gradually moving sling along rotor as it is withdrawn, to ensure full support at all times.

Important ! When re-assembing position the rotor such that full pole face is at bottom dead centre.

Two Bearing Generator

1. Remove eight bolts securing the close coupling adaptor to the drive endbracket.
2. Tap off adaptor after supporting weight with sling.
3. Remove the screens and louvres (if fitted) on either side of drive end adaptor. Turn rotor until a full pole face is at bottom dead centre.
4. Remove eight cap head screws securing the drive end bracket to the drive end adaptor.
5. Tap off drive end bracket from drive end adaptor.
6. Support rotor at drive end with a sling.
7. Remove four screws securing louvred cover at non-drive end and remove cover.
8. Tap the rotor from non-drive end bearing housing to push the bearing clear of the endbracket and its retaining 'O' ring.
9. Continue to push rotor through stator bore, gradually moving sling along rotor, as it is withdrawn, to ensure full support at all times.

Tapered Shaft Generator (BCL)



1. Remove louvred endcover 'G' from non drive endbracket 'H'.
2. Remove M10 "BINX" self locking nut "DD".
3. The shaft securing stud "AA" has been treated with a thread locking agent before being screwed into the stub shaft "B". This may make removal of shaft securing stud "AA" difficult.
4. If the shaft securing stud "AA" can be removed follow steps 5 to 12 to remove generator from engine.

   If the shaft securing stud "AA" cannot be removed follow steps 13 to 18 to remove complete generator from engine.
5. Locate a steel rectangular bar (or similar), with a central 15mm. hole, flush with rear vertical face of non-drive endbracket 'H'. Ensure that hole is aligned with tapped hole in shaft end.
6. Insert M14 X 25 hex. bolt through bar hole and screw into shaft end.

   The rotor will be drawn towards non-drive end thus releasing contact with engine taper stub shaft.
7. Remove M14 X 25 hed. hd. bolt.
8. Remove 10 bolts securing adaptor to engine.
9. Withdraw generator from engine.
10. Ensure rotor is supported at D.E. on a sling.
11. Tap the rotor from non-drive end bearing housing to push the bearing clear of the endbracket and a retaining 'O' ring.
12. Continue to push rotor through stator bore, gradually moving sling along rotor as it is withdrawn, to ensure full support at all times.
13. If it has not been possible to remove the shaft securing stud the following procedure is necessary.
14. Remove the 10 bolts securing adaptor to engine.
15. Using a hide mallet tap the sides of the non drive end bracket in order to release the generator adaptor from engine fly wheel housing spigot.
    Sometimes it is possible that the action of taping the sides of the non drive end bracket with the hide mallet will in fact free the taper-lock of the rotor shaft to stub shaft.
16. If stator frame assembly is freed from the engine flywheel housing, yet the rotor is still firmly fixed to the stub shaft the stator frame assembly should be supported by a crane and carefully pulled back over the rotor assembly, taking care not to damage any winding outhangs.
17. With the rotor now exposed it will be possible to apply a sharp blow to the rotor pole face with a hide mallet to shock the rotor free of the taper stub shaft.

    It may be necessary to apply the sharp blow to more than just one rotor pole.

    To ensure the rotor when released cannot fall and do damage, the M10 binx nut should be re-fitted finger tight to the shaft securing stud leaving at least some 2 mm clearance between nut and rotor shaft end face.
18. With the "Taper Lock" now broken the rotor can be removed from the stub-shaft, once the binx nut has been removed.

Care should be taken to ensure the rotor weight can be supported during removal in a manner which ensures no damage will occur to the rotor assembly.

Replacement of rotor assemblies is a reversal of the procedures above.

7.5.3.3 RE-ASSEMBLY OF GENERATOR ENGINE

Before commencing re-assembly, components should be checked for damage and bearing(s) examined for loss of grease.

Fitting of new bearing(s) is recommended during major overhaul.

Before re-assembling to the engine drive shafts and couplings or drive disc shold be checked for damage or wear.

Where fitted the drive disc should be examined for cracks, signs of fatigue or elongation of fixing holes.

Ensure that the disc to shaft end fixing bolts are fitted with the pressure plate and are torque tightened to 7.6Kgm (75Nm 55lbs.ft).

Taper shaft drive end arrangements should be checked for damage to the taper on both shaft and coupling hub. Ensure both tapers are free from oil before refitting.

Refer to 4.2.3. for assembly to engine.

NOTE:
The M10 "BINX" nut should always be renewed. Tightening torque 4.6Kgm; (45Nm; 33lbs.ft.)

Damaged or worn components must be replaced.

7.6 RETURNING TO SERVICE

After rectification of any faults found, remove all test connections and reconnect all control system leads.

Restart the set and adjust VOLTS control potentiometer on AVR by slowly turning clockwise until rated voltage is obtained.

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

Caution!	**Failure to refit all guards, access covers and terminal box covers can result in personal injury or death.**

SECTION 8

SPARES AND AFTER SALES SERVICE

8.1 RECOMMENDED SPARES

Service parts are conveniently packaged for easy identification. Genuine parts may be recognised by the Nupart name.

We recommend the following for Service and Maintenance. In critical applications a set of these service spares should be held with the generator.

8.1.1 AVR CONTROLLED GENERATORS

1.	Diode Set (6 diodes with surge suppressor)	**RSK**	**1101**
2.	SA465 AVR	**E000**	**24650**
	SX460 AVR	**E000**	**24602**
3.	Non drive end Bearing	**051**	**01058**
4.	BC16 & BC18 Drive end Bearing	**051**	**01032**

8.1.2 TRANSFORMER CONTROLLED GENERATORS

1.	Diode Set (6 diodes with surge suppressor)	**RSK**	**1101**
2.	Diode Assembly	**E000**	**22006**
3.	Non drive end Bearing	**051**	**01058**
4.	BC16 & BC18 Drive end Bearing	**051**	**01032**

When ordering parts the machine serial number or machine identity number and type should be quoted, together with the part description. For location of these numbers see paragraph 1.4.

Orders and enquiries for parts should be addressed to:

Newage International Limited
Nupart Department
PO Box 17, Barnack Road
STAMFORD
Lincolnshire
PE9 2NB
ENGLAND

Telephone: 44 (0) 1780 484000
Fax: 44 (0) 1780 766074

Or any of our subsidiary companies listed on the back cover.

8.1.3 ASSEMBLY TOOLS

Locating Bar (Single Bearing)	AF1609.
8mm Rachet Box Wrench (for M10 socket screws)	AF1599.

8.2 AFTER SALES SERVICE

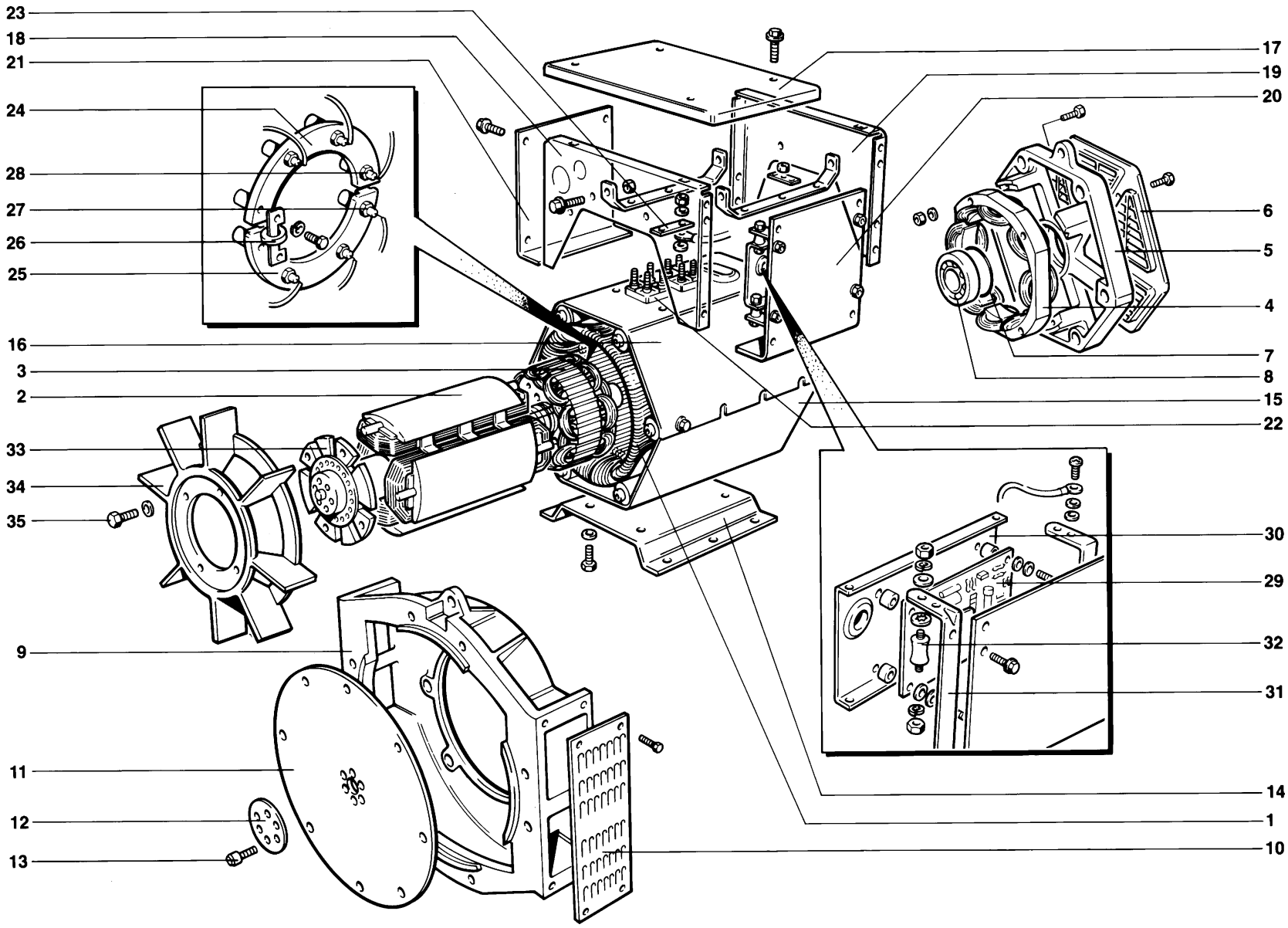
A full technical advice and on-site service facility is available from our Service Department at Stamford or through our Subsidiary Companies. A repair facility is also available at our Stamford Works.

PARTS LIST
TYPICAL SINGLE BEARING GENERATOR

Plate Ref.	Description	Plate Ref.	Description
1	Stator	25	Main Rectifier Assembly - Reverse
2	Rotor	26	Varistor
3	Exciter Rotor	27	Diode Reverse Polarity
4	Exciter Stator	28	Diode Forward Polarity
5	N.D.E. Endbracket	29	AVR
6	Cover N.D.E.	30	AVR Mounting Plate
7	Bearing 'O' Ring N.D.E.	31	AVR Mounting Bracket
8	Bearing N.D.E.	32	AVM
9	D.E. Adaptor	33	Fan Hub
10	D.E. Screen	34	Fan
11	Coupling Hub	35	Fan Securing Screw
12	Pressure Plate		
13	Coupling Bolt		
14	Foot		
15	Frame Cover Bottom		
16	Frame Cover Top		
17	Terminal Box Lid		
18	Endpanel D.E.		
19	Endpanel N.D.E.		
20	Side Panel (AVR)		
21	Side Panel		
22	Main Terminal Panel		
23	Terminal Link		
24	Main Rectifier Assembly - Forward		

N.D.E.	Non Drive End
D.E.	Drive End
AVR	Automatic Voltage Regulator
AVM	Anti-Vibration Mount

Fig. 6
TYPICAL SINGLE BEARING GENERATOR

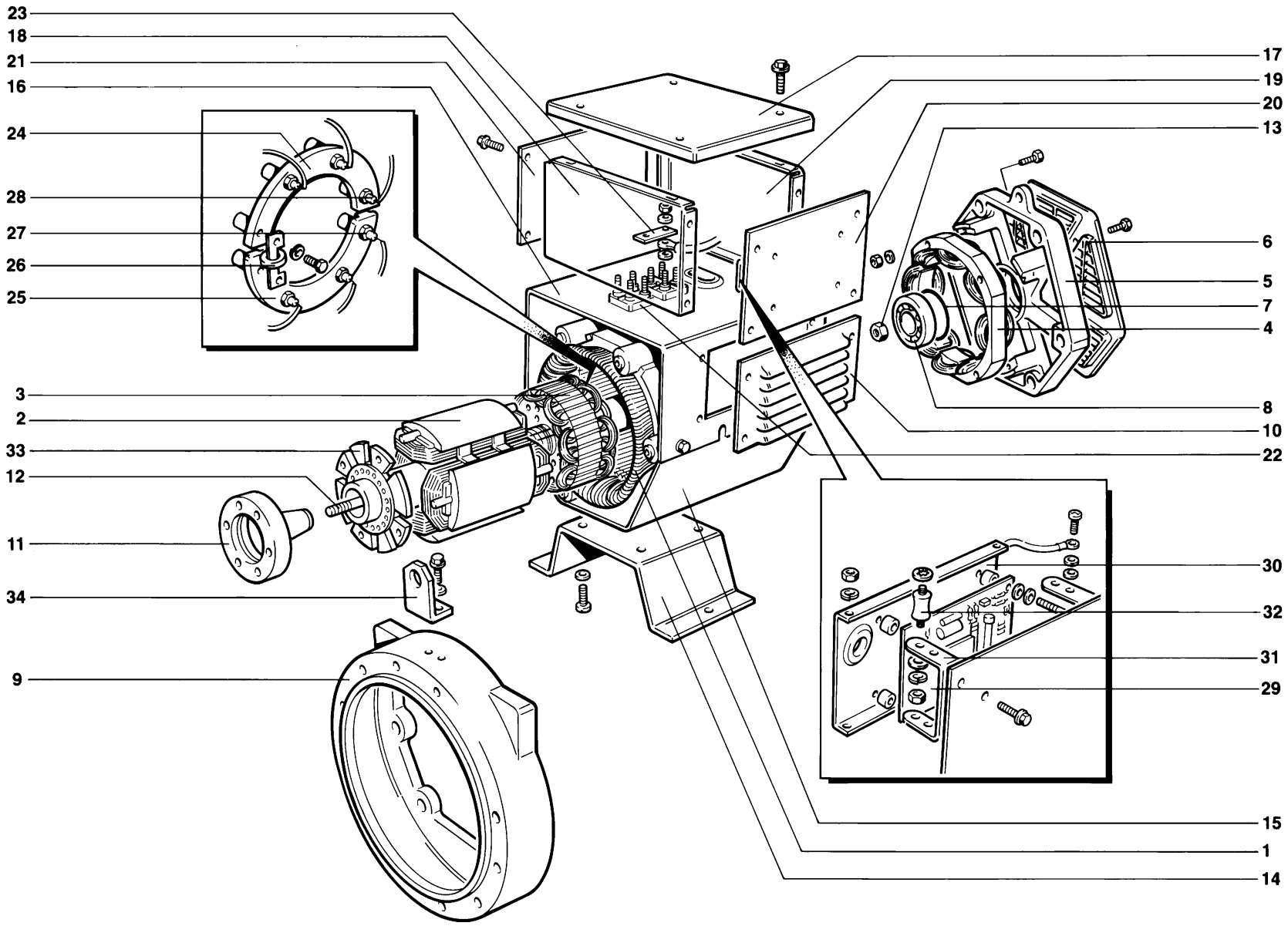


PARTS LIST
TYPICAL SINGLE BEARING GENERATOR - TAPER SHAFT ARRANGEMENT (BCL)

Plate Ref.	Description	Plate Ref.	Description
1	Stator	25	Main Rectifier Assembly - Reverse
2	Rotor	26	Varistor
3	Exciter Rotor	27	Diode Reverse Polarity
4	Exciter Stator	28	Diode Forward Polarity
5	N.D.E. Endbracket	29	AVR
6	Cover N.D.E.	30	AVR Mounting Plate
7	Bearing 'O' Ring N.D.E.	31	AVR Mounting Bracket
8	Bearing N.D.E.	32	AVM
9	D.E. Adaptor	33	Fan Hub (For Balancing Purposes Only)
10	Air Intake Side Panel	34	Lifting Lug
11	Coupling Hub		
12	Rotor Shaft Stud		
13	Binx Nut		
14	Foot		
15	Frame Cover Bottom		
16	Frame Cover Top		
17	Terminal Box Lid		
18	Endpanel D.E.		
19	Endpanel N.D.E.		
20	Side Panel (AVR)		
21	Side Panel		
22	Main Terminal Panel		
23	Terminal Link		
24	Main Rectifier Assembly - Forward		

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

Fig. 7.
TYPICAL SINGLE BEARING GENERATOR - TAPER SHAFT ARRANGEMENT (BCL)

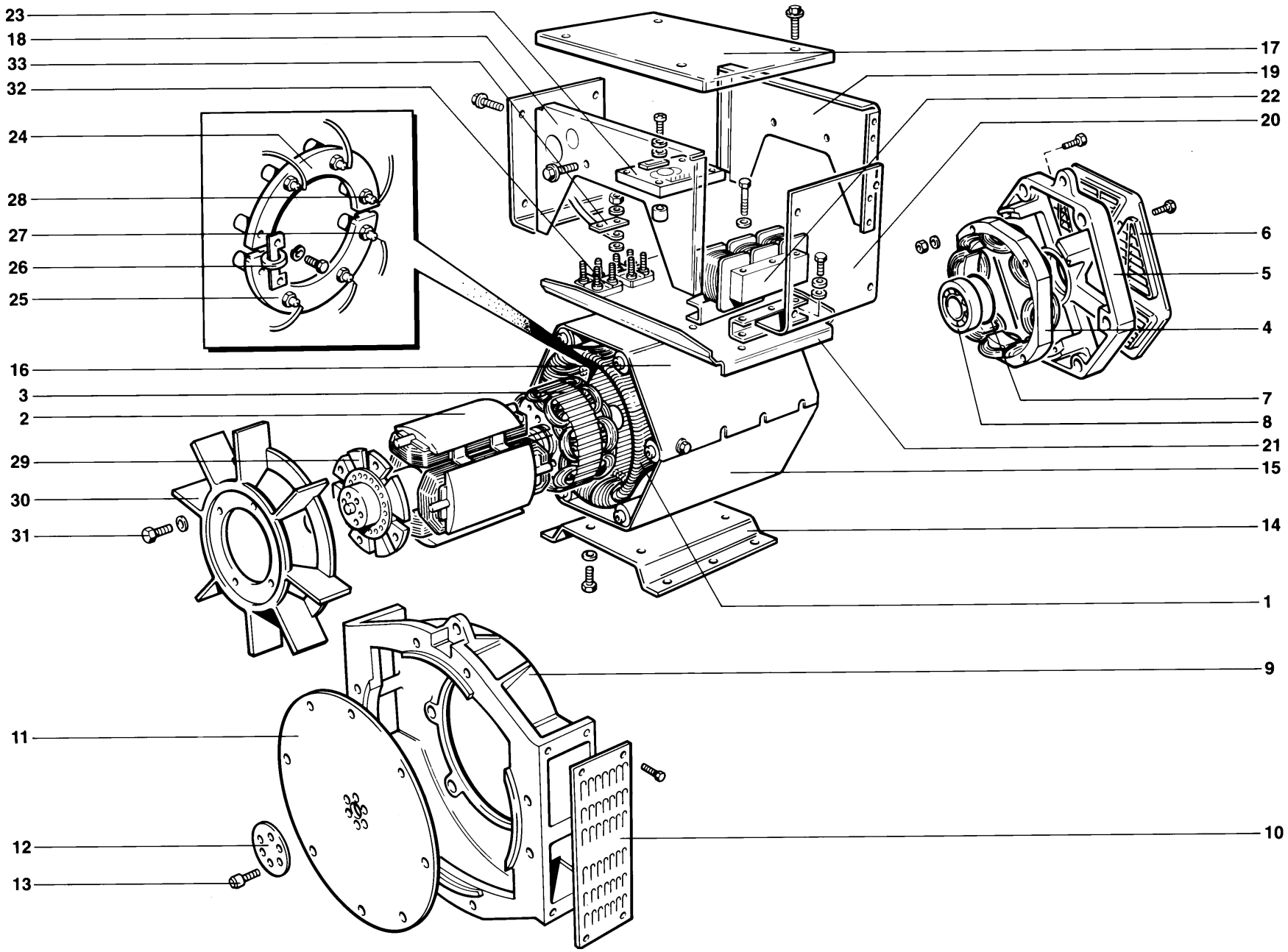


PARTS LIST
TYPICAL SINGLE BEARING (SERIES 5) TRANSFORMER CONTROLLED GENERATOR

Plate Ref.	Description	Plate Ref.	Description
1	Stator	25	Main Rectifier Assembly - Reverse
2	Rotor	26	Varistor
3	Exciter Rotor	27	Diode Reverse Polarity
4	Exciter Stator	28	Diode Forward Polarity
5	N.D.E. Endbracket	29	Fan Hub
6	Cover N.D.E.	30	Fan
7	Bearing 'O' Ring N.D.E.	31	Fan Securing Screw
8	Bearing N.D.E.	32	Main Terminal Panel
9	D.E. Adaptor	33	Terminal Link
10	D.E. Screen		
11	Coupling Disc		
12	Pressure Plate		
13	Coupling Bolt		
14	Foot		
15	Frame Cover Bottom		
16	Frame Cover Top		
17	Terminal Box Lid		
18	Endpanel D.E.		
19	Endpanel N.D.E.		
20	Side Panel		
21	Mounting Plate (Series 5)		
22	Transformer Control Assembly (Series 5)		
23	Control Rectifier Assembly		
24	Main Rectifier Assembly - Forward		

N.D.E. Non Drive End
D.E. Drive End

Fig. 8.
TYPICAL SINGLE BEARING (SERIES 5) TRANSFORMER CONTROLLED GENERATOR



PARTS LIST
TYPICAL TWO BEARING GENERATOR

Plate Ref.	Description	Plate Ref.	Description
1	Stator	25	Main Rectifier Assembly - Reverse
2	Rotor	26	Varistor
3	Exciter Rotor	27	Diode Reverse Polarity
4	Exciter Stator	28	Diode Forward Polarity
5	N.D.E. Endbracket	29	AVR
6	Cover N.D.E.	30	AVR Mounting Plate
7	Bearing 'O' Ring N.D.E.	31	AVR Mounting Bracket
8	Bearing N.D.E.	32	AVM
9	Bearing D.E.	33	Fan Hub
10	Bearing Wave Washer D.E.	34	Fan
11	D.E. Screen	35	Fan Securing Screw
12	D.E. Adaptor		
13	D.E. Endbracket		
14	Foot		
15	Frame Cover Bottom		
16	Frame Cover Top		
17	Terminal Box Lid		
18	Endpanel D.E.		
19	Endpanel N.D.E.		
20	Side Panel (AVR)		
21	Side Panel		
22	Main Terminal Panel		
23	Terminal Link		
24	Main Rectifier Assembly - Forward		

N.D.E.	Non Drive End
D.E.	Drive End
AVR	Automatic Voltage Regulator
AVM	Anti-Vibration Mount

Fig. 9.
TYPICAL TWO BEARING GENERATOR

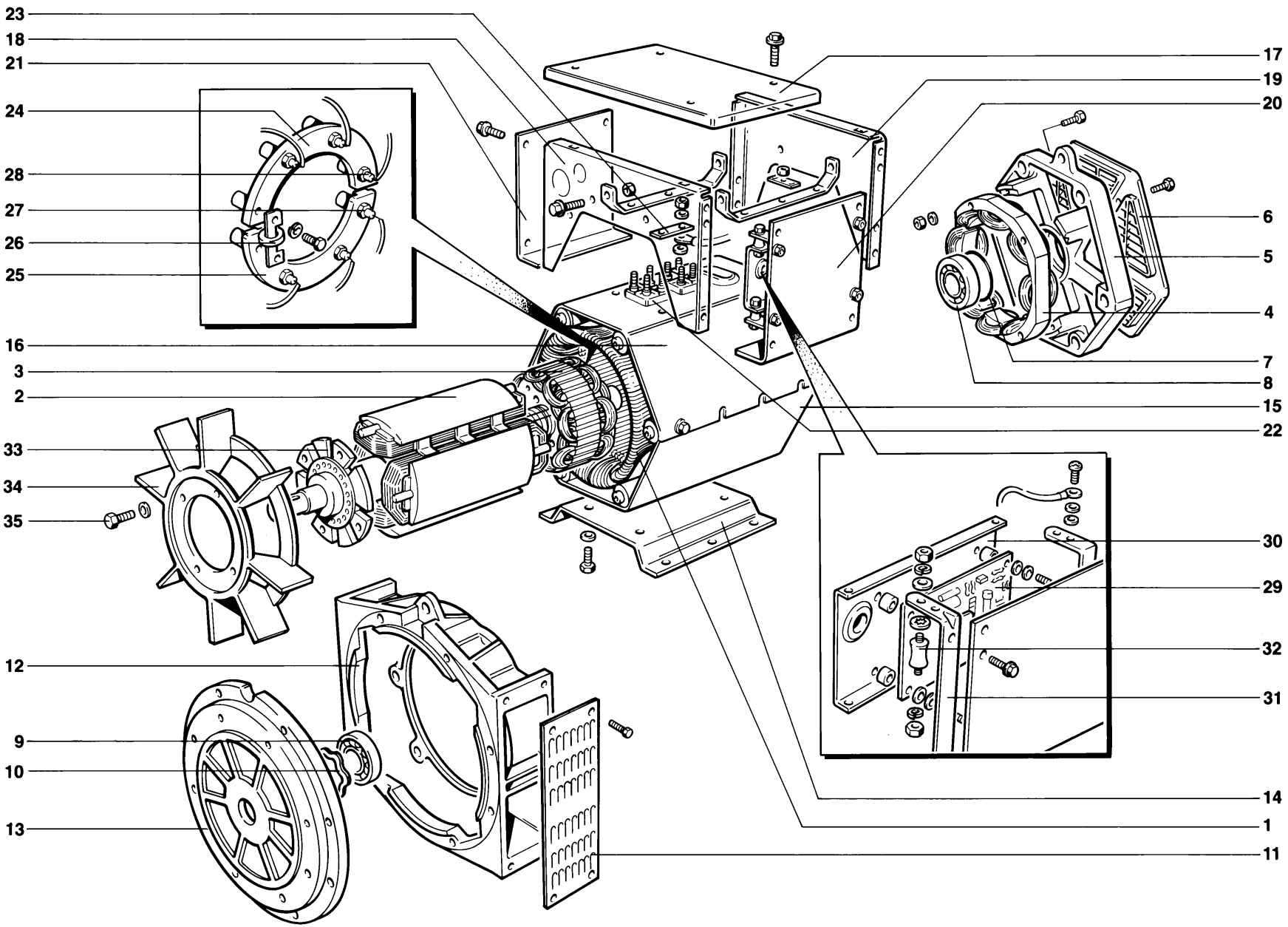


Fig. 10.
ROTATING RECTIFIER ASSEMBLY

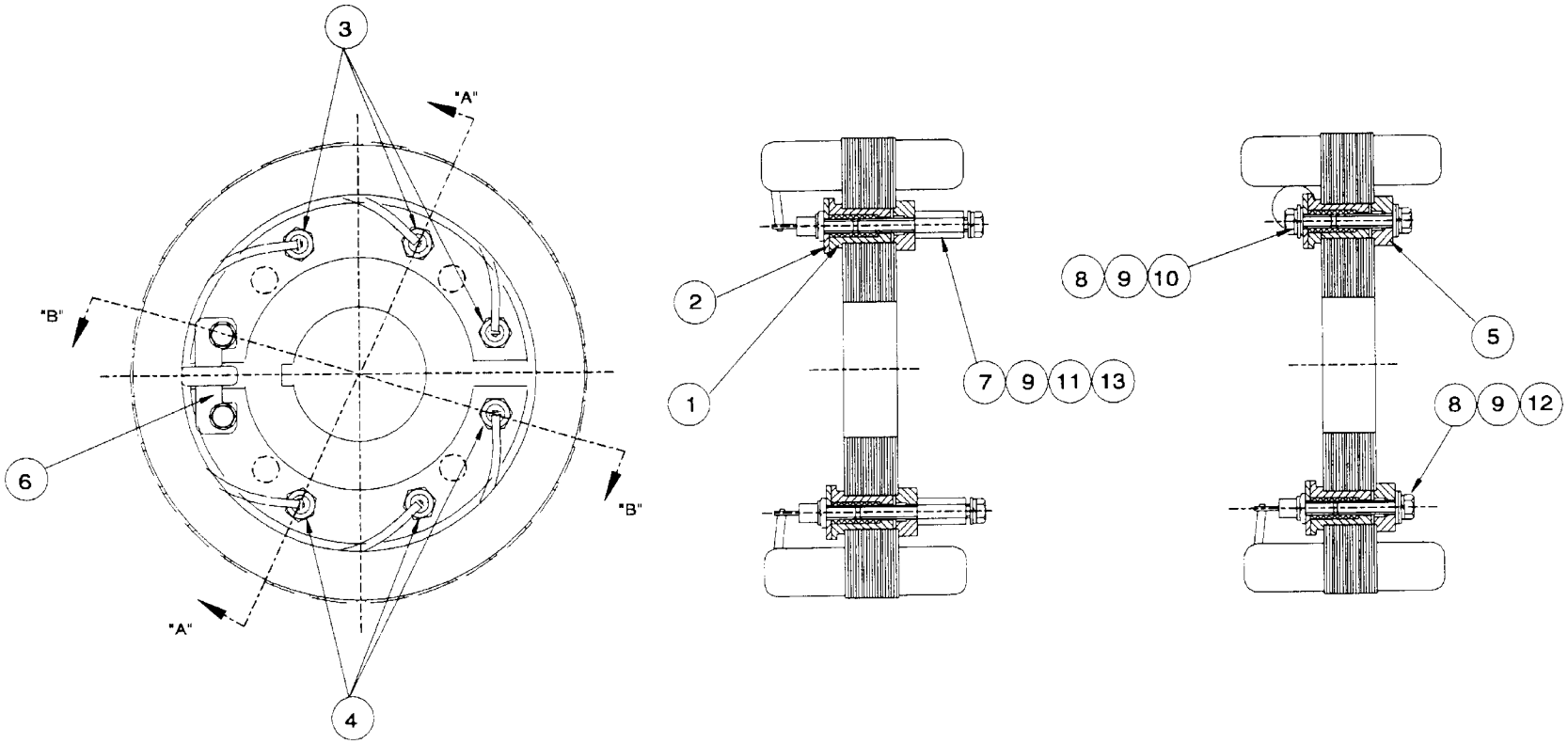


Plate Ref.	Description	Quantity
1	Diode Hub	2
2	Rectifier Fin	2
3	Forward Diode	3
4	Reverse Diode	3
5	Insulating Washer	4
6	Varistor	1
7	M5 Plain Washer	2
8	M5 Plain Washer (Large)	6
9	M5 Lockwasher	6
10	Tornillo hex.	2
11	No. 10 UNF Brass Screw	2
12	No. 10 UNF Brass Screw	2
13	Spacer	2

NOTE:
Underside of diodes to be smeared with Midland Silicons Heat Sink compund type MS2623 Newage Code No 030-02318. This compound must not be applied to diode thread.

Diodes to be tightened to a torque load of 2.03\2.37Nm.

Strip insulation for 10mm from end of cable. If conductor is un-tinned this section should be tinned before threading through hole in diode tag solder in accordance with DD15500.

This manual is available in the following languages on request:
English, French, German, Italian and Spanish.

Denne manual er til rådighed på følgende sprog: engelsk, fransk, tysk, italiensk og spansk.

Denne håndboken er tilgjengelig på de følgende språkene: engelsk, fransk, tysk, italiensk og spansk.

Sur simple demande, ce manuel vous sera fourni dans l'une des langues suivantes: anglais, français, allemand, italien, espagnol.

Dieses Handbuch ist auf Anfrage in den folgenden Sprachen erhältlich: Englisch, Französisch, Deutsch, Italienisch, Spanisch.

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Este manual pode também ser obtido nas seguintes línguas: inglês, francês, alemão, italiano e espanhol.

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Este manual también puede solicitarse en los siguientes idiomas: inglés, francés, alemán, italiano e español.

Αυτό το εγχειρίδιο οδηγιών χρήσεως διατίθεται στις ακόλουθες γλώσσες κατόπιν αιτήσενς: Αγγλικά, Γαλλικά Γερμανικά, Ιταλικά, Ισπανικά.

A.C. GENERATOR WARRANTY

WARRANTY PERIOD

A.C. Generators

In respect of a.c. generators the Warranty Period is eighteen months from the date when the goods have been notified as ready for despatch by N.I. or twelve months from the date of first commissioning (whichever is the shorter period).

DEFECTS AFTER DELIVERY

We will make good by repair or, at our option, by the supply of a replacement, any fault which under proper use appears in the goods within the period specified on Clause 12, and is found on examination by us to be solely due to defective material and workmanship; provided that the defective part is promptly returned, carriage paid, with all identification numbers and marks intact, or our works or, if appropriate to the Dealer who supplied the goods.

Any part repaired or replaced, under warranty, will be returned by N.I. free of charge (via sea freight if outside the UK).

We shall not be liable for any expenses which may be incurred in removing or replacing any part sent to us for inspection or in fitting any replacement supplied by us. We shall be under no liability for defects in any goods which have not been properly installed in accordance with N.I. recommended installation practices as detailed in the publications 'N.I. Installation, Service and Maintenance Manual' and 'N.I. Application Guidelines', or which have been improperly stored or which have been repaired, adjusted or altered by any person except ourselves or our authorised agents, or in any second-hand goods, proprietary articles or goods not of our own manufacture although supplied by us, such articles and goods being covered by the warranty (if any) given by the separate manufacturers.

Any claim under this clause must contain fully particulars of the alleged defect, the description of the goods, the date of purchase, and the name and address of the Vendor, the Serial Number (as shown on the manufacturers identification plate) or for Spares the order reference under which the goods were supplied.

Our judgement in all cases of claims shall be final and conclusive and the claimant shall accept our decision on all questions as to defects and the exchange of a part or parts.

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.

Our liability under this clause shall be in lieu of any warranty or condition implied by law as to the quality or fitness for any particular purpose of the goods, and save as expressly provided in this clause we shall not be under any liability, whether in contract, tort or otherwise, in respect of defects in goods delivered or for any injury, damages or loss resulting from such defects or from any work undone in connection therewith.

MACHINE SERIAL NUMBER

NEWAGE INTERNATIONAL LIMITED

REGISTERED OFFICE AND ADDRESS:
PO BOX 17
BARNACK ROAD
STAMFORD
LINCOLNSHIRE
PE9 2NB ENGLAND

Telephone: 44 (0) 1780 484000
Fax: 44 (0) 1780 484100
Web site: www.newagestamford.com

SUBSIDIARY COMPANIES

1 AUSTRALIA: NEWAGE ENGINEERS PTY. LIMITED
PO Box 6027, Baulkham Hills Business Centre,
Baulkham Hills NSW 2153.
Telephone: Sydney (61) 2 9680 2299
Fax: (61) 2 9680 1545

2 CHINA: WUXI NEWAGE ALTERNATORS LIMITED
Plot 49-A, Xiang Jiang Road
Wuxi High - Technical Industrial Dev. Zone
Wuxi, Jiangsu 214028
PR of China
Tel: (86) 51 027 63313
Fax: (86) 51 052 17673

3 GERMANY: NEWAGE ENGINEERS G.m.b.H.
Rotenbrückenweg 14, D-22113 Hamburg.
Telephone: Hamburg (49) 40 714 8750
Fax: (49) 40 714 87520

4 INDIA: C.G. NEWAGE ELECTRICAL LIMITED
C33 Midc, Ahmednagar 414111, Maharashtra.
Telephone: (91) 241 778224
Fax: (91) 241 777494

5 ITALY: NEWAGE ITALIA S.r.l.
Via Triboniano, 20156 Milan.
Telephone: Milan (39) 02 380 00714
Fax: (39) 02 380 03664

6 JAPAN: NEWAGE INTERNATIONAL JAPAN
8 - 5 - 302 Kashima
Hachioji-shi
Tokyo, 192-03
Telephone: (81) 426 77 2881
Fax: (81) 426 77 2884

7 NORWAY: NEWAGE NORGE A/S
Økern Naeringspark, Kabeigt. 5
Postboks 28, Økern, 0508 Oslo
Telephone: Oslo (47) 22 97 44 44
Fax: (47) 22 97 44 45

8 SINGAPORE: NEWAGE ASIA PACIFIC PTE LIMITED
10 Toh Guan Road #05-03
TT International Tradepark
Singapore 608838
Telephone: Singapore (65) 794 3730
Fax: (65) 898 9065
Telex: RS 33404 NEWAGE

9 SPAIN: STAMFORD IBERICA S.A.
Ctra. Fuenlabrada-Humanes, km.2
Poligono Industrial "Los Linares"
C/Pico de Almanzor, 2
E-28970 HUMANES DE MADRID (Madrid)
Telephone: Madrid (34) 91 604 8987/8928
Fax: (34) 91 604 81 66

10 U.S.A.: NEWAGE LIMITED
4700 Main St, N.E.
Fridley
Minnesota 55421
Telephone: (1) 800 367 2764
Fax: (1) 800 863 9243