

STAMFORD

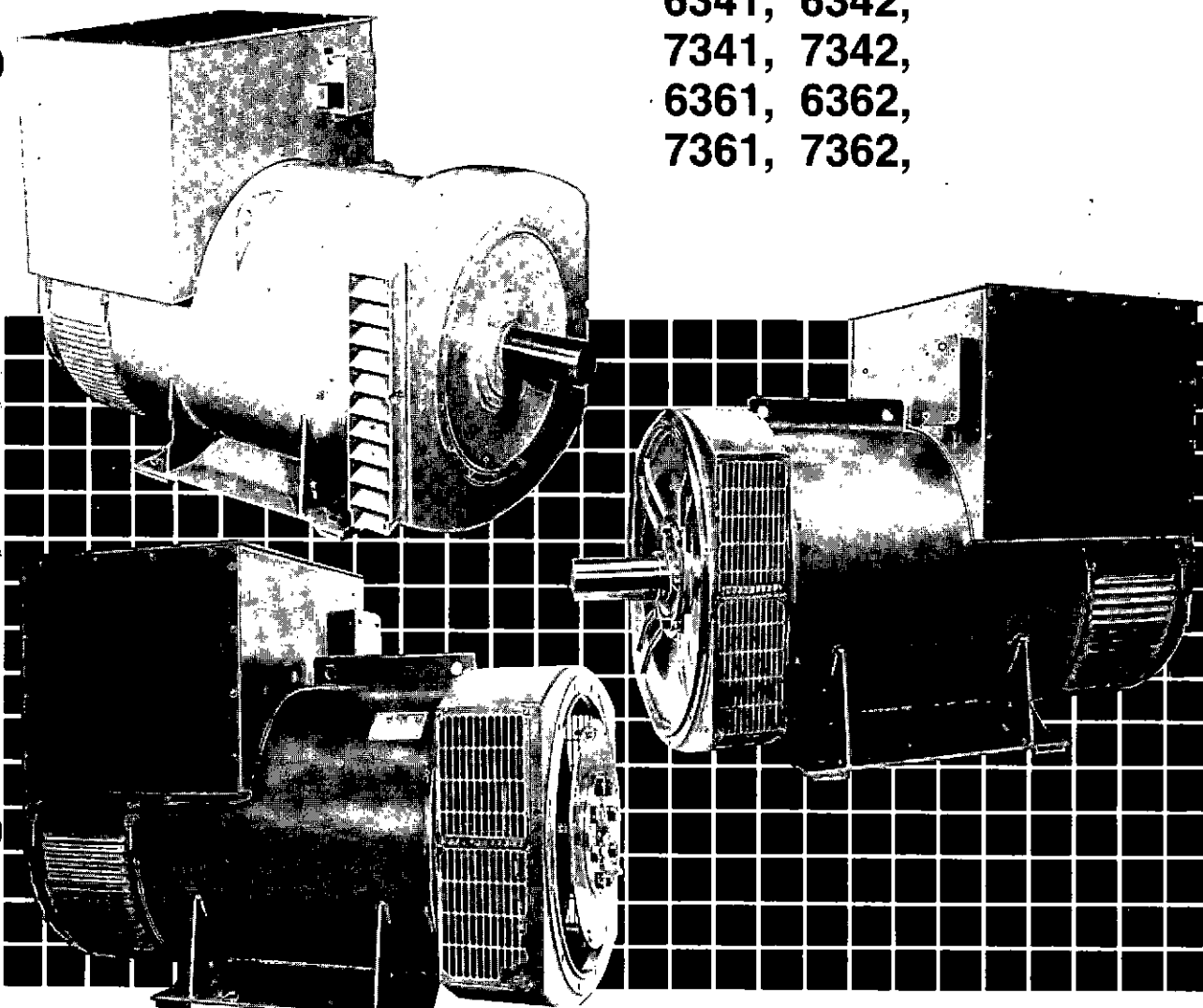
AC GENERATORS FROM
NEWAGE INTERNATIONAL

Publication No. 2H-056 7th Edition

Operation, Service and Maintenance Manual

For models

MHC and HC4341, 4342,
4441, 4442,
5341, 5342,
5441, 5442,
6341, 6342,
7341, 7342,
6361, 6362,
7361, 7362,



Safety Precautions

Before operating the generating set, read the Operation Manual and this Generator Manual and become familiar with it and the equipment.

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

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

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

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



WARNING

INCORRECT INSTALLATION, OPERATION, SERVICING OR REPLACEMENT OF PARTS CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND MECHANICAL SERVICE.

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SECTION ONE

INTRODUCTION

1.1 GENERAL DESCRIPTION

This new a.c. generator is a brushless, rotating field AVR-controlled high performance machine. The Series 4 machines are self-excited, deriving the Automatic Voltage Regulator (AVR) power from the output windings on the stator. The Series 3 machines use the MX341 or MX321 AVR powered by a permanent magnet pilot exciter which provides a source of constant excitation power independent of load changes or load current distortions.

Designation

The generator is described by a code using up to 9 digits:

All units are termed 'HC', with the prefix 'M' used to indicate a marine generator. Following these letters are 4 digits; the first indicates frame size (4 to 7)

the second indicates excitation system (3 or 4)

the third indicates number of poles (4 or 6)

the fourth indicates number of bearings (1 or 2)

A final letter, or letters following these numbers indicates core length within the frame (eg. 'A' or 'B').

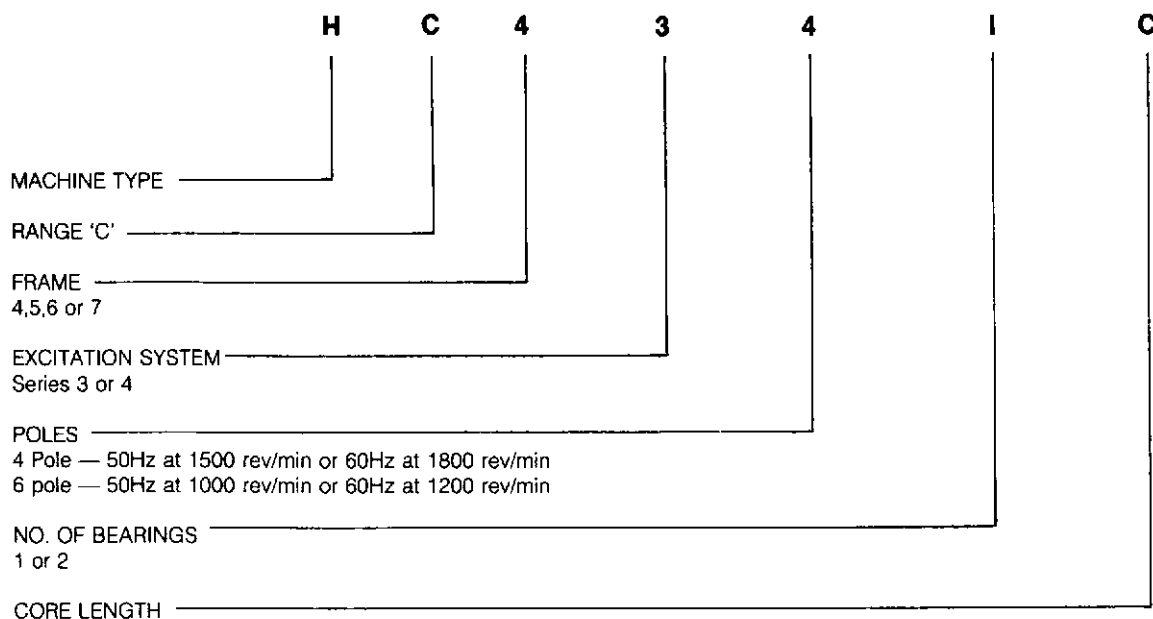


Fig. 1 shows an example of a frame code HC4341C

1.2 CONSTRUCTION

The machines are air-ventilated, screen-protected, and drip-proof to IP22 (NEMA 1), and can be in either two-bearing or single-bearing form.

The stator and rotor cores are produced from low-loss electrical-grade sheet-steel laminations, jig-built and welded under controlled pressure. All the wound components are insulated and impregnated to constitute a Class H (180°C) insulation system.

A high grade precision machined shaft carries the rotor assembly which comprises the generator rotating field system, incorporating a fully interconnected damper (amortisseur) winding, the exciter rotor/rotating rectifier system and cooling fan. The rotor is mechanically wedged and supported on the end winding. The whole rotor assembly, together with the permanent magnet rotor assembly, is dynamically balanced to within precision limits to ensure vibration-free running. The photograph overleaf shows a typical complete assembly (Fig.2).

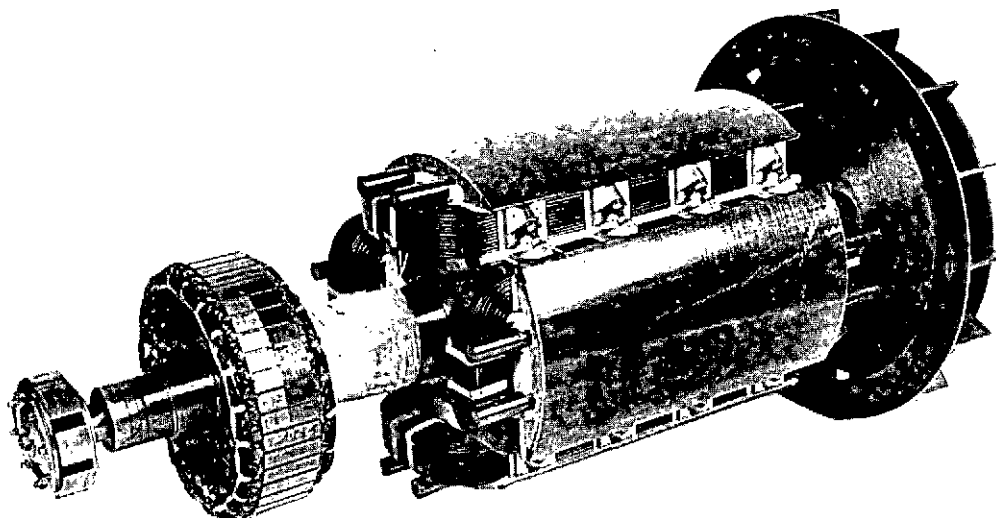


Fig. 2 Typical 4 Pole Rotor (Series 3)

The rotor is supported by liberally-rated long-life ball bearings. Cartridge housings allow the machine to be dismantled without disturbing the bearings.

The bearings are pre-packed with a lithium based grease for a calculated life of 40,000 hours in an ambient of 40°C.

The housing fitted to single bearing machines is designed to prevent bearing 'creep' and also to allow rotor 'end float' to avoid thrust created by tolerance variations in engines and couplings.

The Automatic Voltage Regulator (AVR) is mounted in the terminal box and an exciter/rotating rectifier assembly is mounted internally to the non-drive end bearing. Series 3 generators have, in addition, a permanent magnet pilot exciter overhung from the non-drive end bearing.

Removable access covers are provided at the drive end and non-drive end of the machine. Both side panels and top panel are removable on the terminal box to provide easy access to the output terminals and other ancillary equipment.

1.3 CABLE IDENTIFICATION

Hot foil printing is used to mark the cable wiring. This is resistant to diesel, carbon, grease and exhaust fumes.

Important

Solvents such as ACETONE or PETROL, or proprietary cleaners containing these solvents should not be used for cleaning cables as they can remove the markings.

SECTION TWO

INSTALLATION



WARNING

DURING INSTALLATION IT MAY BE NECESSARY TO REMOVE ACCESS COVERS TO ADJUST CONTROLS, EXPOSING LIVE TERMINALS OR COMPONENTS.

ONLY PERSONNEL QUALIFIED TO PERFORM ELECTRICAL SERVICE SHOULD CARRY OUT TESTING AND/OR ADJUSTMENTS.

2.1 HEALTH AND SAFETY NOTES

Important

It is necessary to draw your attention to the following.

On adaptors/flanges fitted between the a.c. generator and engine the opening must be guarded. Where integral guards are not provided an external protection cover must be fitted.

All a.c. generators are designed with screen-protected and drip-proof enclosures and should not be stored or run outdoors unless adequately protected. Electricity and water are not compatible and canopies/buildings should be well designed not to expose the generator to high degrees of moisture (ie. puddles of water) being drawn into the machine.

2.2 VENTILATION

When installed in a room without special ventilation arrangements it must be ensured that the ambient temperature of the normal operating conditions does not exceed the maximum value for which the machines are designed. (Normally a maximum of 40°C). Heat dissipation and cooling air requirements are available on request.

2.3 PRE-RUNNING CHECKS

If it is necessary to store the machine, the storage accommodation should be clean, dry, well-ventilated and free from any source of vibration. Periodic 90° rotation of the shaft is recommended to avoid bearing "Flat Spots". We recommend the use of anti-condensation heaters to ensure the winding insulation is kept in good condition if machines are stationary for long periods. These are available from our Nupart Department. Before installation of an a.c. generator which has been kept in storage the insulation resistance of the windings should be checked using a megger or similar instrument. It is essential that the automatic voltage regulator (AVR) is completely isolated before testing, otherwise damage to the electronic components may result. If the tests show that the insulation resistance is below 0.5 megohm, the machine should be dried out and the test made again. With a completely dry machine the resistance value should be at least 2 megohms. The machine windings can be dried out by applying warm air from a fan heater or similar apparatus into the machine opening. Alternatively, the main stator windings may be short circuited, and the generating set run with the exciter stator supplied from a d.c. source. A 12 volt 0.5 amp d.c. supply should be connected to the exciter stator leads, marked X and XX, or a Nupart Manual Voltage Regulator (MVR) will provide this excitation. The MVR may be used only with Series 3 — (MX321, MX341) Automatic Voltage Regulators.

WARNING:

The short circuit must not be applied with the AVR connected in circuit. The full load rated current must not be exceeded while drying process is carried out.

Normally no longer than half an hour will be required for drying out windings in this manner. After this period of time the insulation level should be checked and the drying out procedure repeated if necessary.

CAUTION NOTE:

Single bearing generator rotors are held in place with a transit bar. When removing this bar care should be taken to ensure that the rotor is positioned with the pole at the bottom centre line. This is to avoid any damage to the bearing or exciter by limiting the rotor movement to that of the air-gap.

2.4 VOLTAGE ADJUSTMENT

Adjustment to the pre-set level, within the permitted range, should be made as follows:

1. Remove AVR cover.
2. Adjust VOLTAGE RANGE control until the required value is obtained.
3. The stability control potentiometer should normally require no adjustment. If adjustment is necessary turn the control fully clockwise, then turn counter clockwise until stable operation results (ie. no flicker on a voltmeter needle).

Note: Adjustment of this control may change the voltage level and step 2 may need repeating.

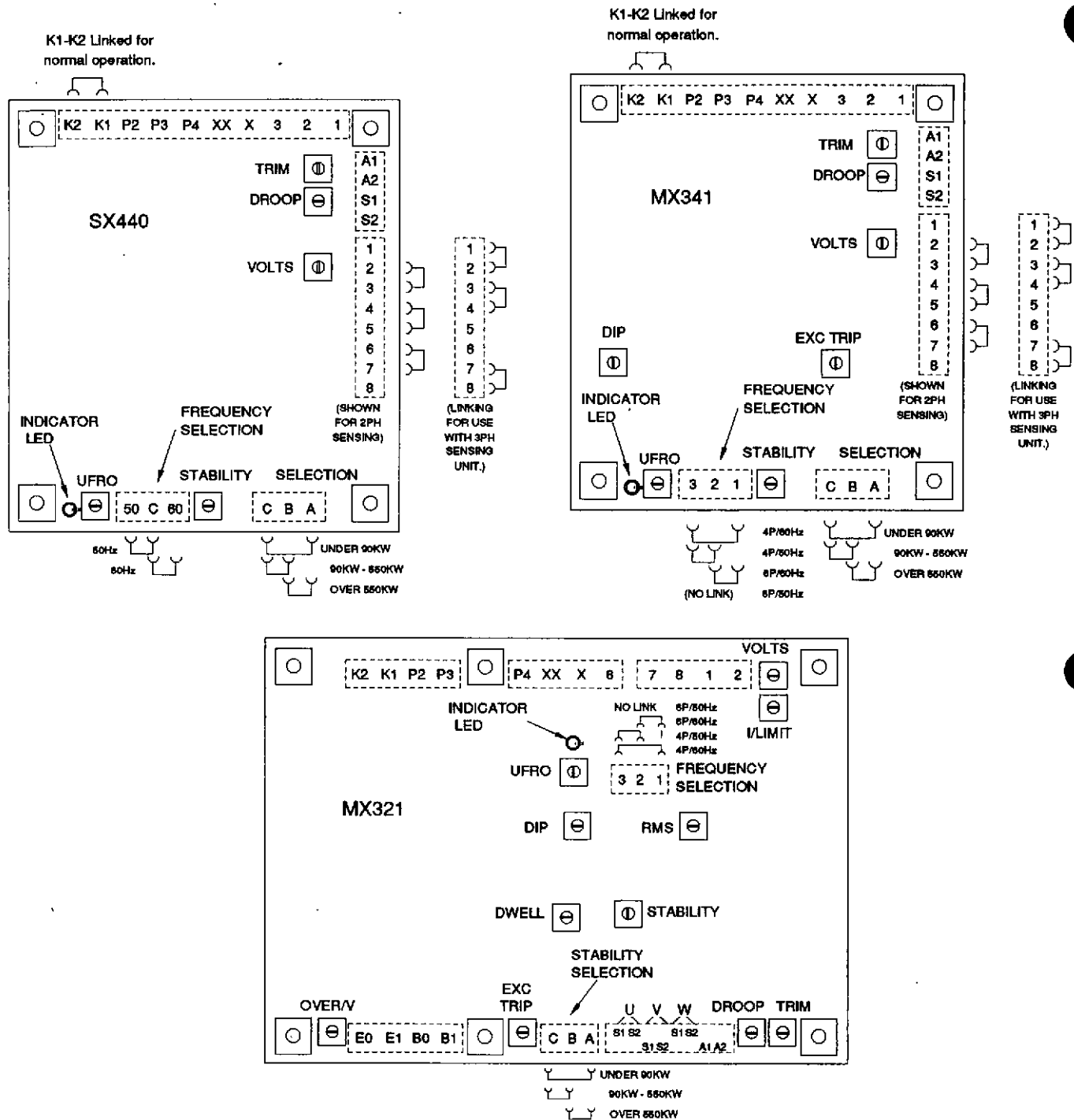
2.5 EARTHING (GROUNDING) ARRANGEMENT

On all star-connected machines a substantial neutral terminal is provided for connection to the distribution network, this is not connected to the frame of the machine. The a.c. generator frame should however, be solidly earthed to the generating set bedplate and connected to the common system earth. On generating sets used for mains failure standby special earthing arrangements may be necessary and the local area Electricity Authority or Company should be consulted.

2.6 DIRECTION OF ROTATION

All machines are fitted with a radial bladed fan and are suitable for running in either direction of rotation. The standard machine is supplied to give a phase sequence U.V.W. with the machine running clockwise looking at the drive end unless otherwise specified at

Figure. 3 Automatic Voltage Regulator Adjustments



SUMMARY OF AVR CONTROLS

CONTROL	FUNCTION	DIRECTION
VOLTS	TO ADJUST GENERATOR OUTPUT VOLTAGE	CLOCKWISE INCREASES OUTPUT VOLTAGE
STABILITY	TO PREVENT VOLTAGE HUNTING	CLOCKWISE INCREASES THE STABILITY OR DAMPING EFFECT
STABILITY SELECTION	TO OPTIMISE TRANSIENT PERFORMANCE	LINK DEPENDING UPON KW OUTPUT
UFRO	TO SET UNDER FREQUENCY ROLL OFF KNEE POINT	CLOCKWISE REDUCES THE KNEE POINT FREQUENCY
FREQUENCY SELECTION	TO SELECT 'UFRO' CONTROL RANGE	LINK DEPENDING ON OPERATING FREQUENCY & NUMBER OF MACHINE POLES
DROOP	TO SET GENERATOR DROOP TO 5% AT FULL LOAD 0 PF	CLOCKWISE INCREASES THE DROOP
TRIM	TO MATCH AVR INPUT TO ACCESSORY OUTPUT	CLOCKWISE ALLOWS THE ACCESSORY MORE CONTROL OVER AVR
EXC TRIP	TO SET THE OVER EXCITATION CUT OFF LEVEL	CLOCKWISE INCREASES THE CUT OFF LEVEL
DIP	TO SET THE INITIAL FREQUENCY RELATED VOLTAGE DIP	CLOCKWISE INCREASES THE VOLTAGE DIP
OVER/V	TO SET THE OVERVOLTAGE PROTECTION CUT OFF LEVEL	CLOCKWISE INCREASES THE OVERVOLTAGE CUT OFF LEVEL
I/LIMIT	TO SET THE MAXIMUM SHORT CIRCUIT CURRENT	CLOCKWISE INCREASES THE SHORT CIRCUIT CURRENT
DWELL	TO SET THE VOLTAGE RECOVERY TIME AFTER BLOCK LOADING	CLOCKWISE INCREASES RECOVERY TIME
RMS	SET AND SEALED AT FACTORY	

2.7 OUTPUT TERMINALS

Output terminals are provided to accept cables rated to normal standard specifications for single or multicore cable and assume the use of crimped-type ring terminals.

2.8 PARALLEL OPERATION

2.8.1 DROOP KIT FOR PARALLEL OPERATION

If machines are required to operate in parallel with other a.c. generators, each should be provided with a quadrature droop current transformer (CT). These kits are available from our Nupart Department. When operating in parallel with the mains utility a Nupart VAR/PF controller must be fitted.

2.8.2 OPERATION THEORY

Two rules should be remembered.

1. It is the engine and its governor which control the kW load sharing.
2. It is the generator and its AVR which control the kVAr load sharing.

Assuming no electrical interconnection of governors or of generator excitation systems then:

1. A larger engine speed droop with load gives a more flexible and stable kW sharing.
2. A larger generator voltage droop with reactive current gives a more flexible and stable kVAr sharing.

All Stamford generators are fitted with fully interconnected damper (amortisseur) windings to ensure maximum stability for parallel operation.

2.8.3 CONNECTIONS

The enclosed wiring diagrams show the correct connections for the CT.

The neutrals of similar Stamford machines may be connected together in parallel operation, but when paralleling dissimilar generators we recommend that the neutrals are not connected since differences in waveforms may then cause harmonic currents.

2.8.4 SETTING THE DROOP CIRCUIT

Remember:

The generator droop kit can control only the kVAr sharing and circulating current. The sharing of kW load is determined by engine governors.

The droop CT on 3 phase machines is connected to the droop potentiometer which is mounted on the AVR circuit board. The droop can be increased by turning the potentiometer in a clockwise direction.

On single phase machines the droop CT is connected across a burden choke. The droop is varied by changing tapings on the burden choke.

For both two phase and three phase sensed machines the operation is the same in that any circulating current between machines produces a voltage across the burden resistor or choke which directly adds to or subtracts from the sensing voltage fed into the AVR. This makes the excitation system sensitive to circulating currents and ensures correct sharing of the kVAr load. The larger the droop voltage is set, the more flexible becomes the excitation system to reduce circulating currents and ensure kVAr load sharing. In most cases a 5% droop on the output voltage at full load zero p.f. (power factor) lag, is satisfactory. This droop is only measurable with the machine running alone (ie. not parallel). This setting increases the voltage regulation by approx. 1% at full load unity p.f. and approx. 3% at full load, 0.8 p.f. When a unity power factor load (kW) is applied the voltage produced across the burden resistor/choke adds vectorially at right angles to the sensing voltage and has a minimal effect. When the machines are run individually, the droop circuit can be switched out by short-circuiting auxiliary terminals S1 & S2 to obtain the normal close regulating characteristics of the machine.

2.8.5 PARALLEL OPERATION SETTING

Hand Trimmer

A separate hand trimmer available from our Nupart Department, is recommended for each machine so that fine output voltage adjustments may easily be made.

Voltmeter

This can be one voltmeter per machine, or one which is switchable to either. The latter is more accurate for initial voltage setting to ensure identical voltages. Another voltmeter may be fitted to the main bus-bars for monitoring the machine on load.

Ammeter

At least one ammeter per machine is required, preferably with phase to phase switching.

Frequency Meter

As with the voltmeter, this can be one per machine or preferably one which is switchable to either, and another registering the bus-bar frequency in the case of multiple parallel machines.

Synchronising Equipment

A purpose built synchronising meter or synchroscope indicates the correct moment for closing the breaker to bring the machines in parallel. Some sophisticated automatic versions are available which monitor the voltages frequencies and phase to ensure that incorrect paralleling attempts are not made. Alternatively, a 3 lamp system may be used as follows:

Cross-Connect lamps, eg. U-V, V-U, W-W between the machines. At the correct in phase moment 2 lamps will be bright and the third unlit. Each lamp must be rated for twice the line to neutral voltage. This is most simply achieved by connecting 2 lamps in series.

With the droop equipment set, polarity checked and synchronising equipment in place, the generators may now be synchronised as follows:

1. The speed of each set must be adjusted to the nominal frequency of the system, ie. 50Hz or 60Hz.
2. The voltage of each machine can now be set identically on the hand voltage trimmers.
3. The machine should only be paralleled when the difference in frequency (speed) between the two sets is small enough to enable the breaker to be closed when the in-phase condition is observed. This is achieved by adjusting the speed of the incoming set to match the set on the bus-bars and the easiest method of speed adjustment is with a governor motor control and a Raise/Lower speed control button

Care must be taken to ensure that the machines are exactly in phase before paralleling is attempted, as the forces set up by out of phase paralleling can create severe mechanical and electrical stresses in the sets.

4. As load is applied any discrepancy between the kW meters can be eliminated by slight adjustment of the throttle or governor on one of the machines.
5. With the kW meters sharing load correctly, any discrepancy between the ammeters can be eliminated with slight adjustment of the voltage trimmer on one of the machines.

NOTE: Current discrepancies are due to circulating currents which flow between the sets when there is a difference in excitation levels between the a.c. generators. High circulating currents may be due to a reversal of one of the droop transformers or incorrect adjustment of the droop setting on the burden resistor or choke. In general, when paralleling identical machines, the amount of droop should be approximately equal on all sets.

Astatic Paralleling Kit

This is used as an alternative to the quadrature droop kit for parallel operation, where voltage droop at the terminals is unacceptable. The system may only be used to parallel identical generators. It involves cross-connecting the droop kits so that each excitation system is still kVAr sensitive. Once again, this equipment cannot control kW load sharing; this is determined by the engine governors.

Connections for the kit are shown on the wiring diagrams

Setting is identical to that for the standard droop kit

Paralleling equipment and method are identical to that when using the standard droop kit.

2.9 CURRENT SENSING KIT (Cannot be used with droop CT)

This is an optional extra which adds an element of current sensing to the standard voltage sensed machine. This can be used to bias the setting circuit of the AVR, giving a rising voltage characteristic with load at the terminals, and so overcoming voltage drops through long cable runs to give a flat voltage characteristic at the load. Care should be taken not to set the rise too steep, or the terminal voltage will require excessive excitation current and the AVR will trip out to protect the windings.

Connections are shown in the wiring diagram.

A **Polarity Check** may be made simply by applying load and observing that terminal voltage rises gently with load increases. If the polarity is wrong, it may be corrected simply by reversing the leads on the burden resistor or CT.

2.10 FURTHER ACCESSORIES

A range of additional accessories is available. The connections for these are described in accompanying wiring diagrams. Any other installation and setting instructions accompany each item individually.

2.11 ASSEMBLY TO ENGINE

Torsional Vibration

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 a.c. 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, coupling details and rotor inertias are available for customers to forward to the engine supplier.

Linear Vibration

Failure will occur to virtually any component if it is subjected to high vibration for long periods.

In order to ensure trouble-free running the vibration levels have been laid down for bare generators and for generator sets.

BS4999 : Part 142 covers vibration levels for the bare generator and this is summarised as follows:

The radial vibration measured on the bearings of horizontal machines in both the vertical and lateral directions shall not exceed the following limits.

Quality Grade	Speed r.p.m.	Maximum r.m.s. values of the vibration velocity, in mm/s, for the shaft height, H, in mm.		
		$80 \leq H \leq 132$	$132 < H \leq 225$	$225 < H \leq 400$
N (normal)	$>600 \leq 3600$	1.8	2.8	4.5

For machines with centre heights in excess of 400mm, the limits of vibration amplitude (peak to peak, in mm) are 0.036mm at 1800 r.p.m. and 0.041mm at 1500 r.p.m.

The standard range of Stamford brushless generators in this book covers shaft heights from 315mm to 450mm.

In order to achieve the above limits **Newage** dynamically balance the complete rotor assembly in accordance with BS 5265 : Pt. 1 Grade 2.5. This means the complete rotor assembly has a maximum r.m.s. velocity of 2.5mm/s. The mechanical strengths of the frame and endbrackets are designed to ensure that the vibration levels measured at the bearing housing do not exceed the levels specified in BS 4999 : Part 142.

As far as the generating set is concerned the levels of vibration are laid down in BS 5000 : Part 3. This specifies that generators shall be capable of continuously withstanding linear vibration levels with amplitudes of 0.25mm between 5Hz and 8Hz and velocities of 9.0mm/s r.m.s. between 8Hz and 200Hz when measured at any point directly on the carcass or main frame of the machine and on separate pedestal bearing blocks, if fitted. These limits refer only to the predominant frequency of vibration of any complex waveform.

The generator set designer has to ensure that the alignment and stiffness of the bedplate are such that these levels of vibration are not exceeded.

Vibration can occur due to the flexing of the flanges between the engine and generator. As far as the generator is concerned the max. bending moment at this point must not exceed the following levels:-

Frames 4 and 5	—	1000 ft. lbs (140 kgm)
Frames 6 and 7	—	2000 ft. lbs (275 kgm)

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

The main vibration frequencies measured on a 6-pole or 4-pole set when operating at 1000 or 1500 r.p.m. are 25Hz and 50Hz and at 1200 or 1800 r.p.m. are 30Hz and 60Hz and if the vibration levels are kept below a velocity level of 9.0mm/s at the bearing housing then trouble-free operation over long periods can be expected with all Stamford generators.

Many sets today are for standby applications and the running time is limited. In these applications the vibration levels can be increased and **Newage** recommend that levels up to 18mm/s can be accepted without undue problems.

Two Bearing Machines

It is beyond the scope of this publication to give guidance on a.c. generator installation in great depth due to the many different designs of generating sets and engine configurations. However, it is recommended that the engine/a.c. generator is mounted on a substantial steel bedplate with machined pads to ensure accurate engine/a.c. generator alignment. Where machined faces cannot be accurately achieved, it is necessary to fit shims under the engine/a.c. generator feet to ensure alignment and avoid vibration.

If flexible mountings are used under the bedplate and their position is far removed from the corresponding engine/a.c. generator feet, a rigid bedplate becomes essential otherwise distortion during running will disturb the alignment or may create vibration.

Couplings

A good quality flexible coupling should be fitted and alignment carefully checked, preferably in accordance with the coupling manufacturer's recommendation, to avoid excessive shaft and bearing stresses. In addition a flexible coupling will ensure that in the majority of cases torsional vibration problems will not arise.

Single Bearing Machines

Alignment of single bearing a.c. generators is critical. If necessary, shims should be fitted under the feet to counteract any irregularities in the mounting surfaces.

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

1. Check on engine distance from the flywheel/coupling mating face to engine flywheel housing face. This should be within $\pm 0.5\text{mm}$ 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 flexible plates to the shaft are tight and locked into position. Torque tightening is 48kgf-m (476N-m; 352lbf-ft) for Frames 4 - 6; 84kgf-m (822N-m; 607lbf-ft) for Frame 7.
3. Remove drive end a.c. generator covers for access to coupling and adaptor bolts.
4. Check that coupling discs are central with adaptor spigot. This can be adjusted by the tapered wooden wedges supplied between the fan and adaptor for transit. Alternatively the rotor can be suspended by means of a rope sling through the adaptor opening.
5. Offer the a.c. generator to engine and engage both flexible plates and housing spigots at the same time, finally pulling home by using the housing and coupling bolts.
6. Tighten coupling to flywheel bolts.
7. Remove wooden wedges and check bearing housing gaps (see paragraph 1).
8. Replace covers, run the machine up to speed and check for excessive vibration.

CAUTION NOTE:

When dismantling a.c. generator from the engine, care should be taken to ensure that the rotor is positioned with the pole at the bottom centre line. This is to avoid any damage to the bearing or exciter by limiting the rotor movement to that of the air-gap.

SECTION THREE

OPERATION OF THE MACHINE

PERFORMANCE

This Stamford HC Range a.c. generator is a quality-engineered high performance product. Voltage regulation, waveform distortion, telephone interference and response are all to the highest standards. Specification sheets detailing performance are available on request for each generator.

3.1 AUTOMATIC VOLTAGE REGULATOR TYPES

Three AVR types are available

SX440 - (Series 4)

MX341 - (Series 3)

MX321 - (Series 3)

SX440 and MX341 AVRs are 2 phase sensed and derive a reference signal from a single voltage across 2 phases of the machine. They provide the high performance and flexibility needed for most applications.

The SX440 and MX341 AVRs may be modified to 3 phase sensing by the addition of our active 3 phase sensing unit. If severe load unbalance is anticipated the 3 phase sensing system, by deriving its reference signal from the average of the 3 output voltages, will centre any voltage unbalance around the nominal.

Due to the greater stability in having 3 sensed voltages this system also permits stable operation under a greater level of distorting, non-linear load.

The MX321 AVR is 3 phase rms sensed for the highest performance in voltage control.

3.2 OPERATION THEORY: Series 4 (SX440)

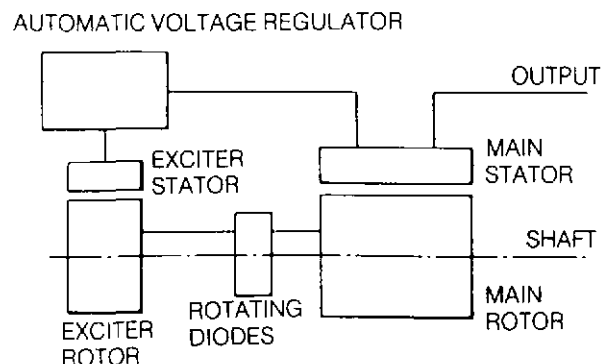
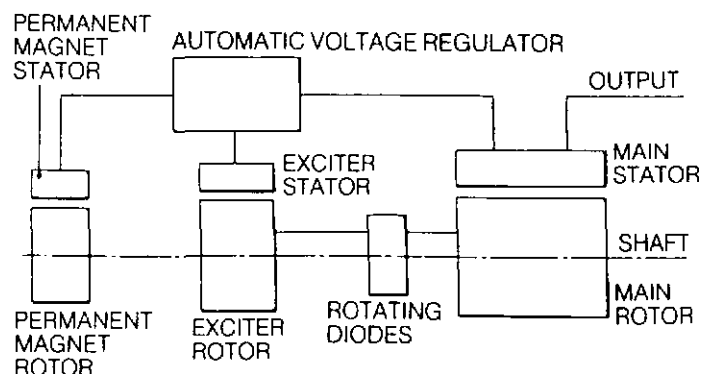


Fig. 4 Block Diagram of Excitation System (Series 4)

The block diagram above indicates the main electrical components and basic interconnections.

The main stator winding provides excitation power via the automatic voltage regulator (AVR) to the exciter. A circuit within the AVR ensures positive voltage build up, provided the residual magnetism level is sufficiently high. The AVR compares the main stator output with a reference value and feeds a controlled excitation current to the exciter stator. The exciter output is fed to the main rotor via a rectifier comprising 6 diodes mounted on 2 heatsinks to form positive and negative plates. The diodes are protected against harmful over voltages caused, for example, by switching surges or out-of-phase paralleling, by a metal oxide varistor (MOV). The d.c. output of the main rectifier provides the excitation onto the main rotor.

3.3 OPERATION THEORY: Series 3 (MX321, MX341)



The Series 3 system offers enhanced performance through improved motor-starting characteristics, sustained short circuit current, very low radio interference and a great tolerance to distorting non-linear loads. These characteristics are the result of the independent excitation provided by the permanent magnet pilot exciter (PMG).

The main excitation components comprising diodes, MOV, and main exciter are identical to those of the standard Series 4 machine. Output voltage is compared with a reference voltage to feed a controlled current to the (main) exciter stator in the same way. The fundamental difference is that the excitation power is now derived from the PMG, mounted on the main shaft, rather than from the main stator winding. Excitation power is thereby independent of output voltage, and a positive voltage build-up is ensured, without reliance on residual magnetism.

3.4 PROTECTION

On Series 3 generators the high forcing capabilities could have harmful effects on the generator if misused or misapplied in the absence of any protective mechanism. The Series 3 generator has inbuilt overexcitation protection within the AVR, which acts following a time delay, to de-excite the machine in the event of excessive exciter field voltage. The MX321 has, in addition, inbuilt over-voltage protection which de-excites the generator in the event of excessive output voltage. Once the protection circuit has operated it latches, so that the generator remains de-energised until the prime mover stops, when the circuit automatically resets.

Series 4 generators do not have the strong forcing capabilities of their Series 3 counterparts and are not therefore provided with the same degree of protection.

All AVRs, however, incorporate some overexcitation protection due to a frequency sensitive circuit (Under Frequency Roll Off Protection). This functions, normally if shaft speed falls below 95% of rated speed, to reduce the voltage linearly with speed, so preventing the excitation from reaching levels which may cause damage.

On MX321 and MX341 Series 3 AVRs, this Under Frequency Roll Off has an adjustable slope and roll-off point. This permits optimised adjustment to enable the engine generator set to accept a heavier level of block loading than would otherwise be possible.

A number of other Nupart accessories are available from our Nupart Department. These offer various facilities from condition monitoring to load protection.

3.5 MARINE GENERATORS

The standard Series 3 Industrial Unit is electrically suitable for operation (generally at a reduced output) to meet the requirements of most marine classifying societies. First it is necessary to modify the standard industrial enclosure to meet marine drip-proofing requirements by adding louvered air outlets (available from our Nupart Department).

However, most classifying societies require the machine to include a pre-inspected shaft made from approved material. If it is required to convert an industrial generator to marine specification, it is important to ensure that approval of the relevant marine classifying authority is obtained.

SECTION FOUR

SERVICE AND MAINTENANCE



WARNING

SERVICE AND FAULT FINDING PROCEDURES PRESENT HAZARDS WHICH CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH. ONLY PERSONNEL QUALIFIED TO PERFORM ELECTRICAL AND MECHANICAL SERVICE SHOULD CARRY OUT THESE PROCEDURES.

ENSURE ENGINE STARTING CIRCUITS ARE DISABLED BEFORE COMMENCING SERVICE OR MAINTENANCE PROCEDURES.

4.1 ROUTINE

Routine servicing is confined to drive end bearing lubrication on Frames 6 and 7, and insulation resistance checks following a long period without running.

NB. Dismantling procedures are referred to on page 13.

Insulation Test

This is detailed on Page 3 of this manual. (Pre-running checks).

4.2 LUBRICATION

Recommended lubricant: Lithium based grease, Mobilux number 2 or Shell Alvania R3.

Only the drive end bearings on Frames 6 and 7 normally require re-greasing. The service interval is 4000 hours or 6 months. Care should be taken not to mix dissimilar greases and not to grease too liberally or overheating may result. Total grease quantity should be 110ml.

The non-drive end bearings on Frame 4-7 and drive end bearings on Frame 4-5 do not normally require regreasing. If regreasing is necessary the bearings must be dismantled.

Temperature range for the grease is -30°C to $+120^{\circ}\text{C}$.

4.3 BEARING CHECKS

Frame 4 and 5 drive end and all non-drive end bearings are packed and sealed suitable for 40,000 hours running under normal operating conditions.

We recommend periodic checks for over heating or noise (using a stethoscope) during the life of the bearing, and when re-greasing or replacement of the bearing if necessary.

After 40,000 hours running the bearing should be changed. The grease should be occasionally checked for signs of emulsification (milky coloured grease). If present the grease should be flushed out and replaced, and the bearing checked for signs of corrosion.

Excessive vibration which develops after a period of time may be due to bearing wear, the bearing should then be examined for damage or loss of grease.

4.4 FAULT FINDING

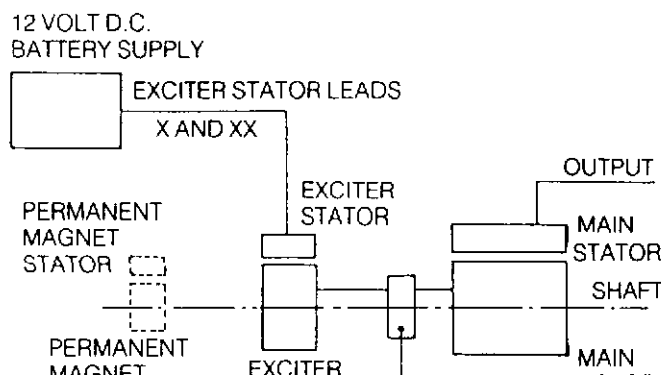
1) Overexcitation Protection (Series 3 generators only)

If the generator has been overloaded or misapplied such that this protection has been triggered, the set must be stopped. If there is no output voltage from the generator, first check that this protection has not tripped by stopping the set, whereupon resetting is automatic. If there is still no output on re-running the set, proceed to the following fault-finding method.

In practice fault-finding is greatly simplified by dividing the machine, for check test purposes into 2 parts, namely:

- The exciter and main machine windings plus main rectifier.
- The electronic control assembly, wiring, and permanent magnet generator.

4.4.1 SECTION A) WINDING AND MAIN RECTIFIER ASSEMBLY



The principle is the same for Series 3 and Series 4 generators. The positive terminal of the d.c. supply is connected to the exciter stator lead marked X and the negative terminal to the lead marked XX. These leads must be removed from the AVR terminals X and XX respectively. It is also advisable to remove the rest of the push-on terminals from the AVR prior to this test.

With the battery connected to the stator leads, the machine is now run up to full speed (it is essential that the speed is correct for this test), and with a multimeter or voltmeter the following tests are made on the output from the main stator terminals.

Voltage Balanced and within + 10% - 15% of the Nominal (6 Pole generators are towards lower limit)

This indicates that the exciter windings, main windings and main rectifier diodes are in good working order, and it is therefore not necessary to carry out the following tests up to and including "Main Excitation Windings". Fault finding should continue with test "4.4.2 Sensing and Power Supplies".

Voltage Balance between Phases

The voltages between the three phases, and each phase to neutral, should be balanced, and if an unbalance is shown on any phase of more than 1%, this indicates that a fault exists in the main stator windings. This test should be carried out with all of the customer's external connections removed to eliminate the possibility of external shorts between the machine and the main isolator. Further tests can be made on the resistance values of the stator windings (see Winding Resistance Chart, at the end of this section). Should unbalanced voltages occur, the short circuit currents generated in the stator will tend to load the engine, and may be detected as hot spots on the stator windings.

Voltage Balanced but Reading Low when Separately Excited

This indicates that a fault exists in either the main rotating rectifier assembly, or one of the excitation windings i.e. the main rotor and/or the exciter stator and rotor. **First check that the d.c. separate excitation supply is not lower than 12 volts, and that the speed is correct.**

Rectifier Diodes

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

On an electronic digital meter a healthy diode will give a reading in one direction, and infinity in the other, which will be in opposite polarity to a moving coil multimeter.

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 - 4.74 Nm (36-42lbf-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 (normally visible by inspection, since signs of burning will be apparent) it will normally give a full-deflection (short circuit) reading.

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 X and XX. The exciter rotor is connected to six studs which also carry the diode lead terminals. The main rotor winding is connected across the two rectifier plates. The respective leads must be disconnected before taking the readings.

4.4.2 SENSING AND POWER SUPPLIES

AVR Sensing Supply

The final test which can be made in the externally excited condition is to ensure that the sensing and power supplies to the AVR are correct.

2 Phase Sensing

With rated output voltage on the main terminals, the voltage across AVR leads 2 and 3 should be between 170 and 250 volts a.c. This supply may be via quadrature drop burden resistor and/or dropper transformer. These should be checked for continuity.

3 Phase Sensing

3 phase sensing is via a separate sensing unit on MX341 and SX440 AVRs. With rated output voltage on the main terminals the reference supplies to this unit should be between 170 and 250v a.c. across 6-7, 7-8 and 8-6. This supply may be via transformers.

AVR Power Supply

Series 4 (SX440)

The Series 4 machine derives power from the output windings. With rated output voltage on the main terminals the voltage across AVR leads P2-P3 should be between 170-250v a.c.

Series 3 (MX341, MX321)

The Series 3 machine derives power from the permanent magnet pilot exciter (PMG) located on the non-drive end of the generator and isolated from all other windings. Its output leads are connected to AVR terminals P2, P3, P4. These must first be disconnected.

With the machine at rated speed the output voltage between leads P2-P3, P3-P4 and P4-P2 should be balanced with values approximately as follows:

60Hz (1800 rev/min) 180v 50Hz (1500 rev/min) 150v	]	4 Pole	60Hz (1200 rev/min) 120v 50Hz (1000 rev/min) 100v	]	6 Pole
--	---	--------	--	---	--------

These voltage levels are approximate and measured values may be $\pm 15\%$ of the figures given, depending upon the magnetic field strength produced by the permanent magnet rotor. Variations of this magnitude are unimportant to the operation of the control system.

4.4.3 SECTION B) THE ELECTRONIC CONTROL SYSTEM

AVR

Should the previous tests prove successful, any faults can now be assumed to be within the voltage control system and its respective wiring. This system can be affected by bad connections, therefore, the wiring between the auxiliary terminals and the AVR push-on terminals should be carefully examined for broken, loose or corroded connections. The sensing circuit leads have been covered in a previous section.

Protection Circuits

The MX341 AVR has inherent overexcitation protection.

The MX321 AVR has inherent overexcitation and overvoltage protection.

If these protective circuits have operated a red LED will illuminate on the AVR board. This should be checked before replacing the AVR.

If no defects are found and the fault still exists, the AVR can be assumed to be faulty. It must be exchanged for a replacement unit. Repairs to the circuit board are not possible (See 'Removal of the AVR' under 'Dismantling the Machine' below).

4.5 DISMANTLING THE MACHINE

Metric threads are used throughout.

NOTE: On SINGLE BEARING MACHINES before removal from the prime mover, if possible, position the rotor such that a full pole face is at the bottom of the main stator core.

Removal of the AVR

1. Remove AVR cover complete with 4 captive screws.
2. Disconnect all cables to AVR.
3. Remove 4 threaded pillars securing AVR.

Removal of the Permanent Magnet Exciter (Series 3 only)

1. Mark the position of the stator housing and remove access cover.
2. Disconnect leads P1 (if fitted) P2, P3 and P4 from the AVR inside terminal box. These leads have in-line connectors making it unnecessary to disconnect at AVR.
3. Remove the 4 bolts and clamps retaining the stator housing.
4. Tap the stator housing out of its spigot; and carefully guide the stator leads through the access hole in the non-drive endbracket. As the highly magnetic rotor will attract the stator core, care must be taken to avoid a contact which may damage the windings.
5. Remove the SMALL hexagon nut from the rotor shaft and firmly pull the complete rotor assembly from its location. Keep the rotor clean by avoiding contact with metal dust or particles.
6. Remove the rotor shaft stud from the main shaft to avoid possible damage when handling the main rotor assembly.

IMPORTANT:

The rotor assembly should under no circumstances be dismantled, or the magnetic properties will be destroyed.

Removal of the Main Rotor Assembly (Two Bearing machines only)

1. Remove all access covers and terminal box lid.
2. Disconnect exciter leads X+ and XX- at the inline spade connectors inside the terminal box.
3. Remove permanent magnet assembly as described previously.
4. **Frames 4 and 5.** Remove the 4 bolts retaining the drive end bearing cartridge housing in the drive endbracket (outer 4 bolts).

Frames 6 and 7. Remove the 4 bolts retaining the drive end bearing caps.

5. Remove the 8 bolts holding the drive endbracket to frame.
6. Position the rotor such that a full pole face is at the bottom of the main stator core.
7. With rope sling around shaft, supporting rotor weight tap the drive endbracket out of its spigot.
8. Lower rotor onto stator core.
9. **Frames 4 and 5.** With rope sling around drive endbracket withdraw endbracket leaving bearing cartridge housing in position.

Frames 6 and 7. With rope sling around drive endbracket, withdraw endbracket over drive end bearing.

10. See continuation under heading "All Machines".

Single Bearing Machines only

1. Remove all access covers and terminal box lid.
2. Disconnect exciter leads X+ and XX- at the inline spade connectors inside the terminal box.
3. Remove permanent magnet assembly as described previously.
4. Remove the 8 bolts holding the drive endbracket to frame.
5. With rope sling around drive endbracket tap endbracket out of its spigot.
6. See continuation under following heading "All Machines".

All Machines

1. Disconnect leads X and XX from the AVR (inside terminal box) and draw leads back into non-drive endbracket. These leads have inline connectors making it unnecessary to disconnect at the AVR.
2. Remove the 4 bolts retaining the non-drive end bearing cartridge housing in the non-drive endbracket (outer 4 bolts).
3. Dismantle terminal box by removing side/top covers and support bracket.
4. Remove the 8 bolts holding the non-drive endbracket (4 of these bolts also hold the non-drive end panel of the terminal box).
5. Remove non-drive end panel of terminal box.
6. Insert 2 bolts (M10) in the 2 holes provided for 'jacking' purposes, on the endbracket centre line. Screw bolts in until endbracket spigot is clear of locating recess.
7. Carefully tap the whole assembly off the bearing cartridge housing ensuring the endbracket is supported, to prevent the exciter stator from fouling the windings on the exciter rotor.
8. To withdraw the rotor from the stator the rotor must be supported by means of a rope sling at the drive end and eased out of the stator core until half of the main rotor core is protruding out of the stator. At this point it is safe to release the weight from the rope sling.
9. Tightly bind a rope sling around the rotor core and take the weight on the sling.

10. With the rope sling around the rotor core manually guide the rotor assembly out of the stator bore. Care should be taken during this operation to prevent damage to the windings and rectifier assembly by manually guiding the non-drive end of the rotor

WARNING

The rope sling may not be at the centre of gravity of the rotor, and guidance at the ends of the rotor is essential.

As the rotor is fully withdrawn from the stator core, THE FULL WEIGHT OF THE ROTOR MUST BE SUPPORTED BY THE CRANE. If the rotor core is allowed to drop more than a few millimetres at this point, it will make contact with the stator windings, and may damage them.

Removal of the Bearings**IMPORTANT:**

The bearings are enclosed in pre-packed cartridge housings (except the drive end frames 6 and 7) and must not be dismantled unless absolutely necessary, such as for: re-lubrication, replacement of bearings or when a major overhaul is carried out on the prime mover.

NOTE:

Removal of the bearings can be carried out after the removal of the main rotor assembly or by removing the endbrackets only. (See instructions previously described).

The bearings are a press fit and can be removed from the shaft with the correct standard tooling ie. 3 leg or 2 leg manual or hydraulic bearing pullers.

Drive End Bearing — Frames 4 and 5

1. Remove the 4 screws holding bearing cap.
2. Remove cap and "wave" washer.
3. Remove bearing cartridge housing complete with bearing.

Drive End Bearing — Frames 6 and 7

This bearing is re-greasable and enclosed between standard bearing caps.

Non-drive End Bearing — All Machines

1. Remove the 4 screws holding bearing cap.
2. Remove cap
3. Remove circlip (single bearing machines only).
4. Remove bearing cartridge housing complete with bearing.

When replacing bearings they must be flushed out and refilled as follows:

Recommended Lubricant: Lithium based grease — Mobilux No. 2 or Shell Alvania R3.

Temperature Range: -30°C to +120°C.

Quantity:

Frame 4 — 108ml Drive End — 81ml Non-drive End.

Frame 5 — 81ml Drive End or Non-drive End.

Frames 6 and 7 — 110ml Drive End or Non-drive End.

About a third of the above quantities should be inserted in the bearing, the bearing cap cavity, and the bearing cartridge cavity.

Re-Assembly of the Machine.

In general re-assembly is the reverse of the dismantling process detailed above.

WINDING RESISTANCE TABLES

FIG. 7a. 4 POLE

Frame Size	Exciter		Stator Winding (per phase: Star or Series Star)		Rotor
	Stator	Rotor L-L			
			311 & 312	17 & 07	
4C	25	0.14	0.017	0.023	0.91
4D	25	0.14	0.014	0.020	1.04
4E	25	0.14	0.011	0.015	1.17
4F	25	0.14	0.010	0.010	1.35
5C	25	0.17	0.0068	0.0090	1.55
5D	25	0.17	0.0058	0.0080	1.77
5E	25	0.17	0.0043	0.0069	1.96
5F	25	0.17	0.0038	0.0042	2.16
6AS	28	0.16	0.0041	0.0046	1.26
6A/G	28	0.16	0.0037	0.0053	1.37
6B/H	28	0.16	0.0025	0.0033	1.47
6C/J	28	0.16	0.0024	0.0028	1.66
6D/K	28	0.16	0.0018	0.0023	1.89
7A/E	28	0.20	0.0017	0.0023	1.20
7B/F	28	0.20	0.0012	0.0018	1.34
7C/G	28	0.20	0.0010	0.0014	1.58
7H	28	0.20	0.0008	0.0011	1.70

FIG. 7b. 6 POLE

Frame Size	Exciter		Stator Winding (per phase: Star or Series Star)		Rotor
	Stator	Rotor L-L	311 & 312	17 & 07	
6A/G	28	0.20	0.0088	0.015	1.06
6B/H	28	0.20	0.0060	0.010	1.27
6C/J	28	0.20	0.0046	0.0061	1.43
6D/K	28	0.20	0.0037	0.0058	1.67
7A/E	28	0.24	0.0025	0.0043	2.20
7B/F	28	0.24	0.0016	0.0029	2.69
7C/G	28	0.24	0.0012	0.0018	3.18

NOTES:

1. All figures are approximate only.
2. Resistances are in ohms and 'cold' (20°C).
3. Pilot exciter stator resistance is 4.4 ohms line-to-line (all frame sizes).

SECTION FIVE

RECOMMENDED SPARES/SECTIONAL ARRANGEMENTS/PARTS LISTS

5.1 RECOMMENDED SPARES

Replaceable items are conveniently packaged for easy identification and replacement. Genuine spares may be recognised by the Nupart name.

We recommend the following items for Service and Maintenance:

	HC444	HC434	HC544	HC534	HC634/6	HC734/6
1. Diode set (6 diodes) with Varistor (Suppressor)	RSK3001	RSK3001	RSK3001	RSK3001	RSK3001	RSK3001
2. Automatic Voltage Regulator	E000 24030	E000 23410(MX341) E000 23210(MX321)	E000 24030	E000 23410(MX341) E000 23210(MX321)	E000 23210	E000 23210
3. Bearing non-drive end	051 01036	051 01036	051 01036	051 01036	051 01025	051 01025
4. Bearing drive-end	051 01025	051 01025	051 01035	051 01035	051 01034	051 01040
5. 3 phase sensing unit (when applicable)	E000 22035	E000 22035	E000 22035	E00022035	—	—

When ordering parts the machine serial number and type should be quoted, together with the part description. The serial number is stamped on the nameplate and on the drive-end of the shaft.

Orders and enquiries for parts should be addressed to:

Newage International Limited
Nupart Department
P.O. Box 17, Barnack Road
Stamford
Lincolnshire, PE9 2NB, England

Telephone: (0)780 62552, Telex: 32268, Fax: (0)780 66074
or any of our subsidiary companies list on the back cover.

5.2 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.

FIG. 8a SINGLE BEARING MACHINE PARTS LIST

Plate Ref	Description	Plate Ref	Description
1	Non-Drive Endbracket	27	Main Terminal Board
2	Cover Non-Drive End	28	Auxiliary Terminal Board
3	Drive Endbracket/Adaptor	29	Fan Key
4	Main Rotor Key (Not illustrated)	30	Exciter Rotor Key
5	Main Frame	31	Drive End Cover
6	Wound Main Stator Assembly	32	Coupling Disc
7	Wound Main Rotor Assembly	33	Coupling Pressure Plate
8	Fan	34	Coupling Spacer
9	Shaft	35	Coupling Bolt
10	Wound Exciter Stator Assembly	36	Circlip Non-Drive End
11	Wound Exciter Rotor Assembly	37	Permanent Magnet Rotor Stud
12	Main Rectifier Assembly		
13	Permanent Magnet Cover		
14	Permanent Magnet Wound Stator Assembly		
15	Permanent Magnet Rotor Assembly		
16	Bearing Non-Drive End		
17	Bearing Cap Non-Drive End		
18	Bearing Cartridge Non-Drive End		
19*	Terminal Box Side Panel		
20	Terminal Box Lid		
21	Automatic Voltage Regulator		
22	A.V.R. Mounting Bracket		
23	A.V.R. Cover Plate		
24	Overvoltage Module		
25	Excitation Switch		
26	Three Phase Sensing Unit (Not illustrated)		

* Later HC6 and HC7 generators (with core length designations "E" onwards) have a welded saddle at the non-drive end. The terminal box is mounted on top of this saddle.

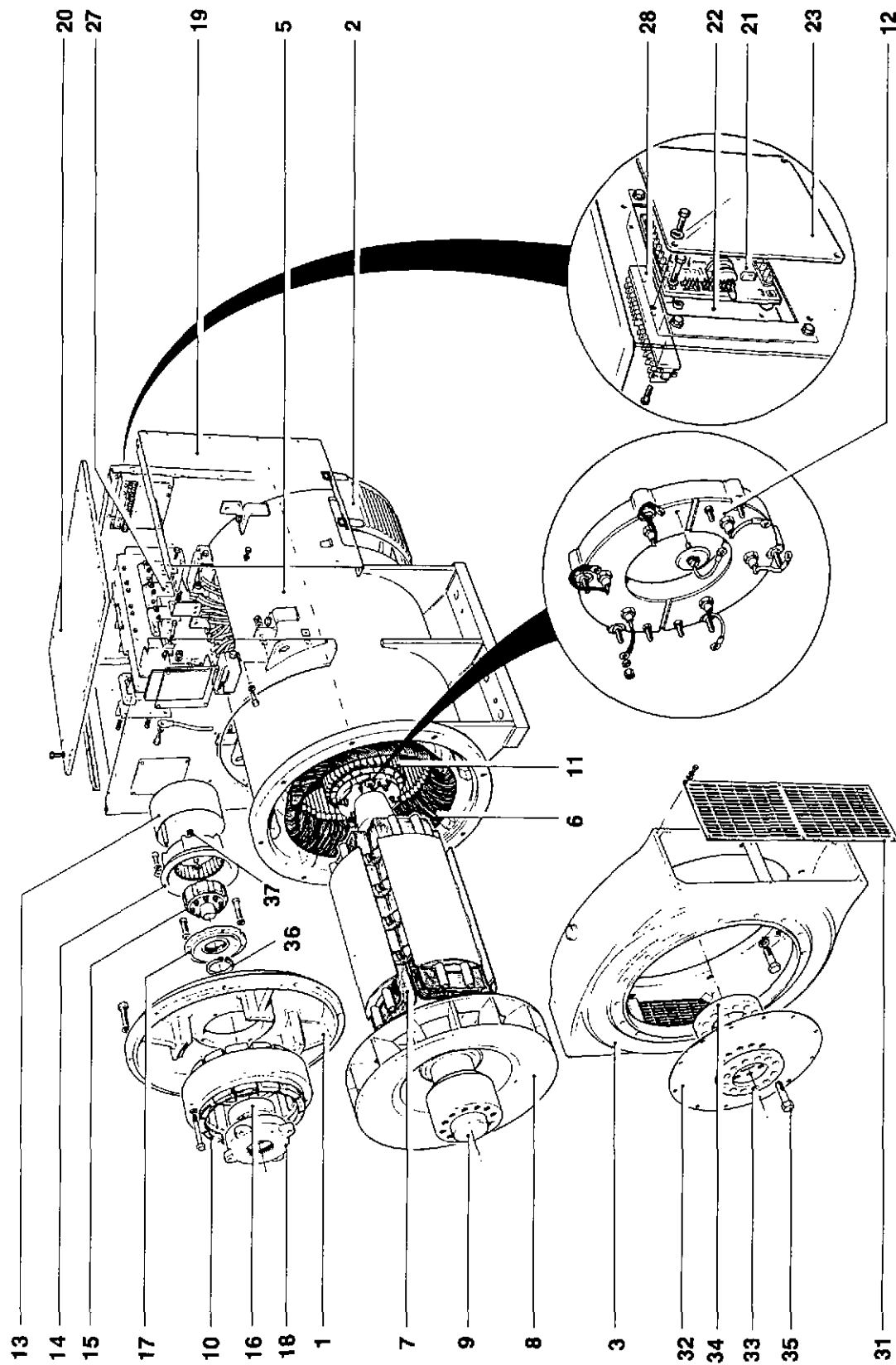


FIG. 8b TYPICAL HC SINGLE BEARING MACHINE GENERAL ARRANGEMENT

FIG. 9a TWO BEARING MACHINE PARTS LIST

Plate Ref	Description	Plate Ref	Description
1	Non-Drive Endbracket	30	Fan Key
2	Cover Non-Drive End	31	Exciter Rotor Key] (Not Illustrated)
3	Drive Endbracket	32	Bearing Drive-End
4	Main Rotor Key (Not illustrated)	33	Wave Washer (Bearing Drive-End)
5	Main Frame	34	Bearing Cap Inner Drive End
6	Wound Main Stator Assembly	35	Bearing Cap Outer Drive End
7	Wound Main Rotor Assembly	36	Screen Drive End
8	Fan	37	Grease Nipple Drive End (Not Illustrated)
9	Shaft	38	Drip Proof Louvres
10	Wound Exciter Stator Assembly	39	Gasket
11	Wound Exciter Rotor Assembly	40	Lifting Lug
12	Main Rectifier Assembly		
13	Permanent Magnet Cover		
14	Permanent Magnet Rotor Stud		
15	Permanent Magnet Wound Stator Assembly		
16	Permanent Magnet Rotor Assembly		
17	Bearing Non-Drive End		
18	Bearing Cap Non-Drive End		
19	Bearing Cartridge Non-Drive End		
20*	Terminal Box Side Panel		
21	Terminal Box Lid		
22	Automatic Voltage Regulator		
23	A.V.R. Mounting Bracket		
24	A.V.R. Cover Plate		
25	Overvoltage Module] (Not Illustrated)		
26	Excitation Switch		
27	Three Phase Sensing Unit (Not Illustrated)		
28	Main Terminal Board		
29	Auxiliary Terminal Board		

* Later HC6 and HC7 generators (with core length designations "E" onwards) have a welded saddle at the non-drive end.
The terminal box is mounted on top of this saddle.

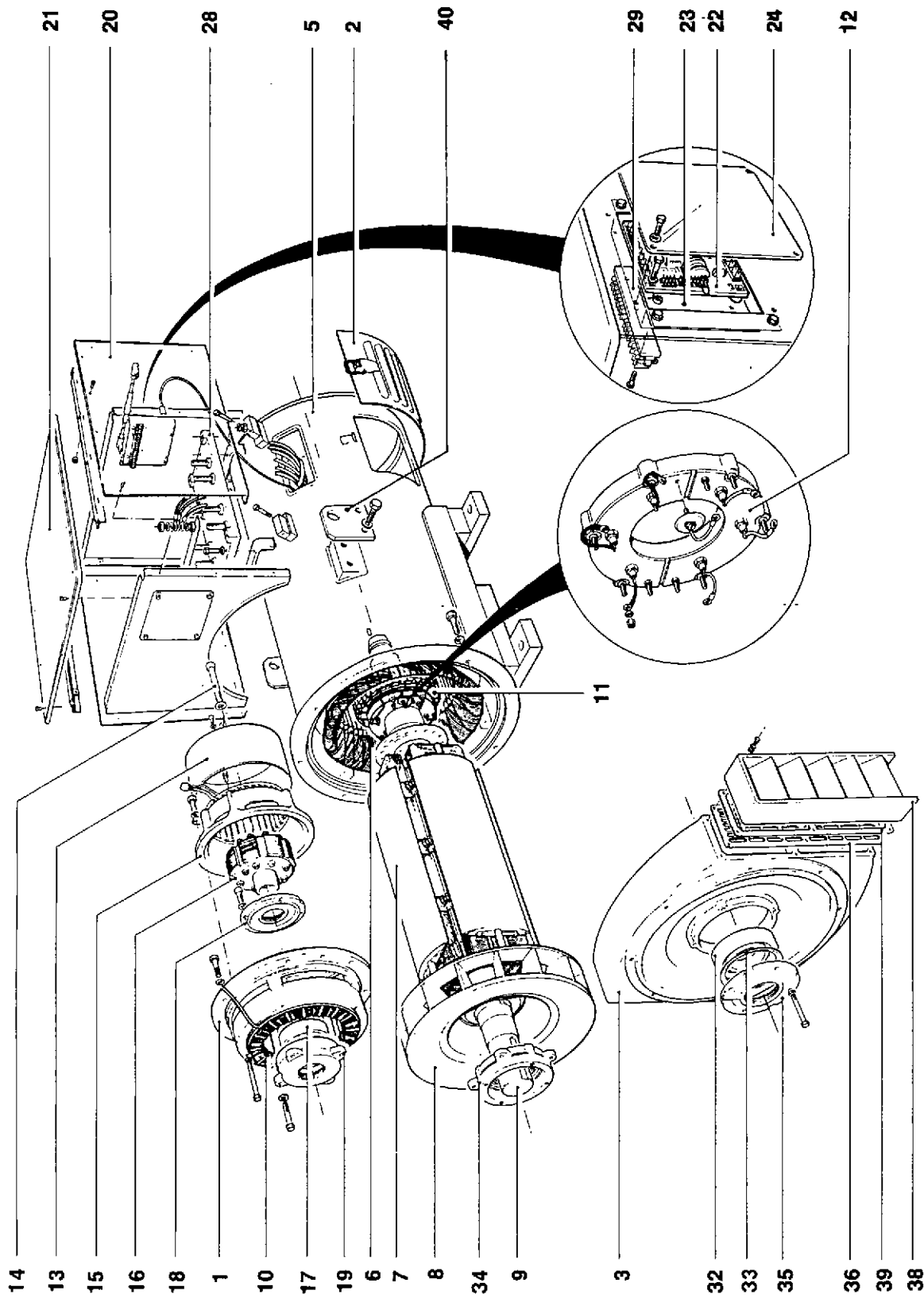


FIG. 9b TYPICAL HC TWO BEARING MACHINE GENERAL ARRANGEMENT

ER ROTOR CORE

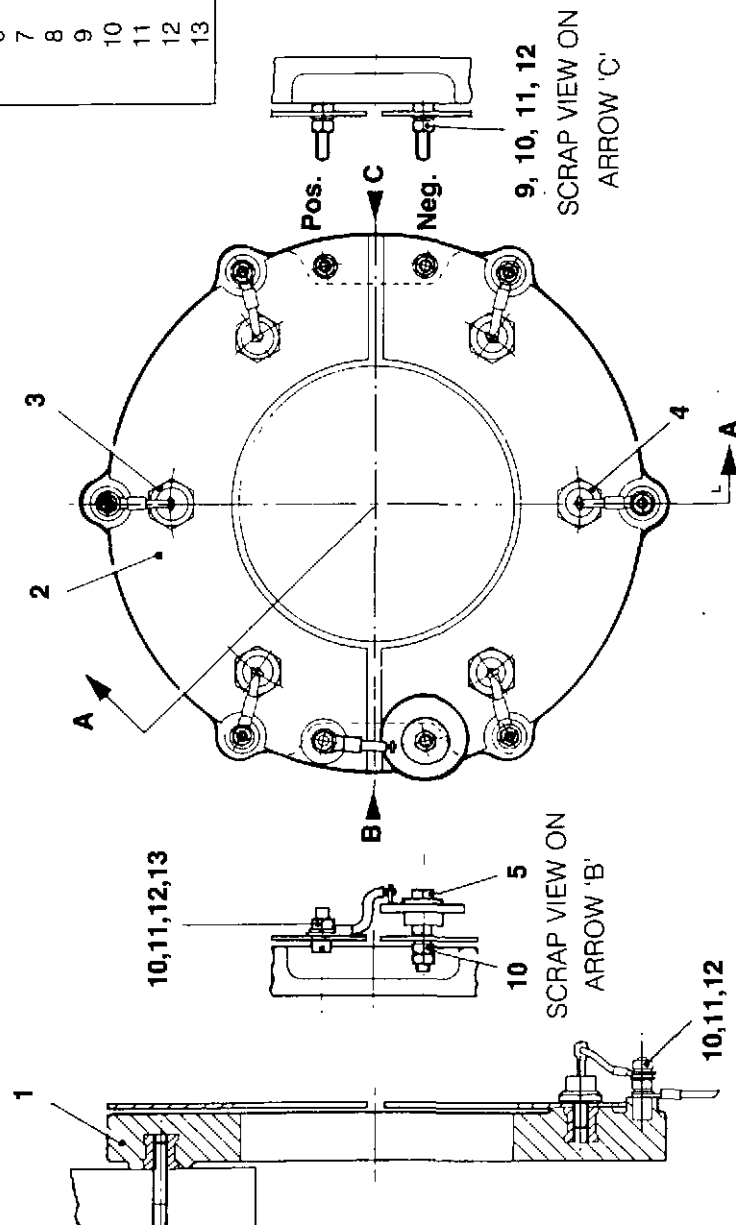


Plate Ref.	Description	Qty
1	Moulded Base	1
2	Fin	2
3	Diode (Forward)	3
4	Diode (Reverse)	3
5	Varistor	1
6	Hexagonal Head Bolt M6 x 65	4
7	Plain Washer M6	4
8	S.C. Lockwasher M6	4
9	Hexagonal Head Screw M5 x 20	2
10	Hexagonal Nut M5	17
11	Plain Washer M5	21
12	S.C. Lockwasher M5	15
13	CH. HD. Screw	1

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

Rotating Rectifier Assembly

SECTION ON 'AA'

A.C. GENERATOR WARRANTY

WARRANTY PERIOD:

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

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

DEFECTS AFTER DELIVERY:

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

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

nor 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.

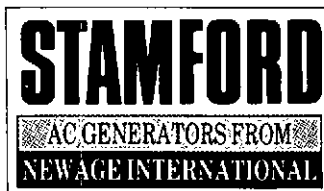
- (c) Our liability shall be fully discharged by either repair or replacement as above, and in any event our liability shall not exceed the current list price of the defective goods.
- (d) Our liability under this clause shall be in lieu of any warranty or condition implied by law as to the quality or 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 any defect in goods delivered or for any damage or loss (whether direct or consequential resulting from such defect or from any work done in connection therewith).
- (e) Any claim under this clause must contain full particulars of the alleged defect, the description of the goods, the serial number (as shown on the manufacturers identification plate) or, for spares, the order reference, the date of purchase and the name and address of the vendor.
- (f) Our judgement in all cases of claims shall be final and conclusive and the claimant shall accept our decision on all questions as to defects and the exchange of a part or parts. The repaired or replacement part will be delivered by us free of charge ex-Works. We shall not be liable for any expense which may be incurred in removing or replacing any part sent to us for inspection or in fitting any replacement supplied by us.

MACHINE SERIAL NUMBER

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SUBSIDIARY COMPANIES

Australia:	NEWAGE ENGINEERS PTY. LIMITED 29 Victoria Avenue, Castle Hill, PO Box 746 New South Wales 2154 Telephone: Sydney (02) 680 2299 Fax: (02) 680 1545		
Canada:	NEWAGE EQUIPMENT LIMITED P.O. Box 427, Islington, Ontario. M9A 4X4 Telephone: Toronto (416) 259 3741 Fax: (416) 259 7167		
Germany:	NEWAGE ENGINEERS G.m.b.H. Archenholzstr 69, 2000 Hamburg 74. Telephone: Hamburg (040) 712 2044/45 Fax: (040) 712 5544 Telex: 2174397		
Indonesia:	P.T. NEWAGE ENGINEERS INDONESIA, P.O. Box 70/JAT, Jl. Pulogadung 21, Kawasan Industri Pulogadung, Jakarta 13001, Telephone: (21) 4713043/4601685/4601687 Fax: (21) 4896654 Telex: 49204		
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