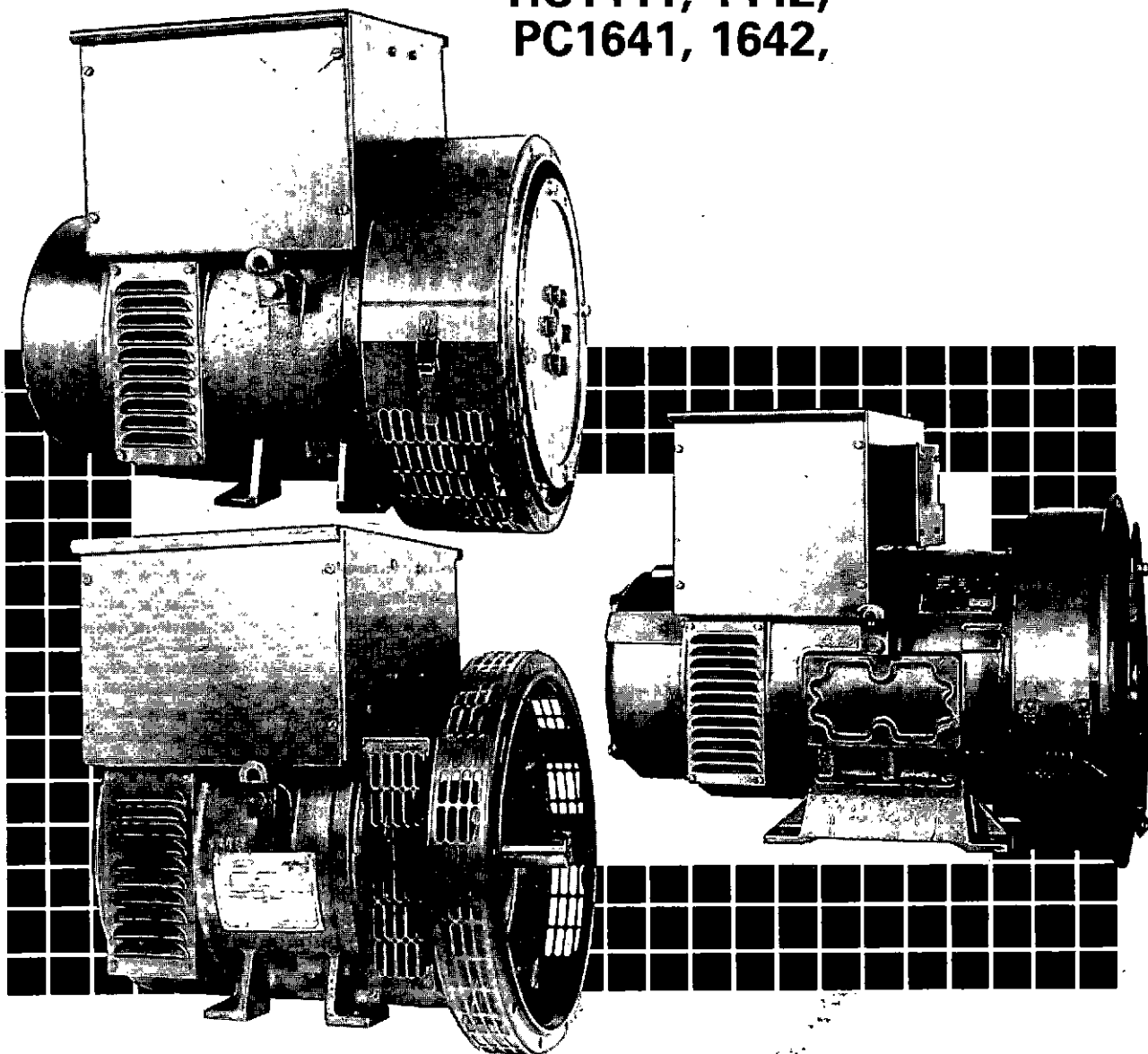




Operation, Service and Maintenance Manual

For models
MHC and HC1641, 1642,
HC1441, 1442,
PC1641, 1642,



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INTRODUCTION

1.1 GENERAL DESCRIPTION

This new Stamford a.c. generator is a brushless, rotating field AVR-controlled high-performance machine. It is self-excited, deriving the Automatic Voltage Regulator (AVR) power from the output windings on the stator.

Designation

The generator is described by a code using up to 8 digits:

All units are termed 'PC', with the prefix 'M' used to indicate a marine generator. Following these letters are 4 digits;
 the first indicates frame size (always 1)
 the second indicates excitation system (4 or 6)
 the third indicates number of poles (always 4)
 the fourth indicates number of bearings (1 or 2)

A final letter following these numbers indicates core length within the frame.

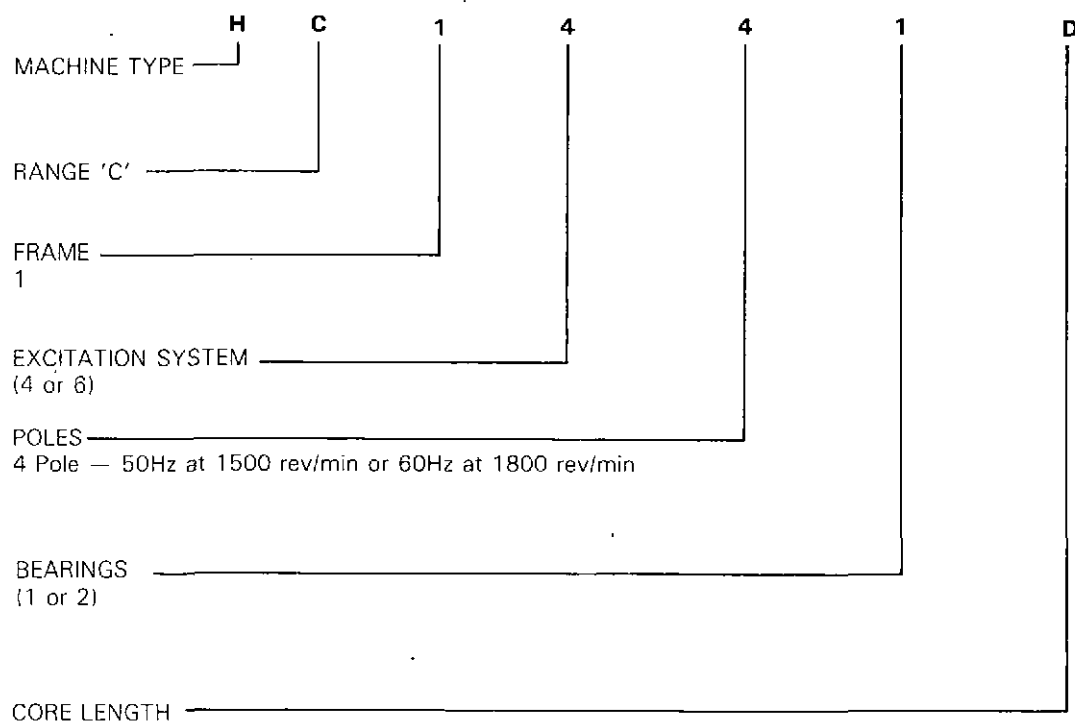


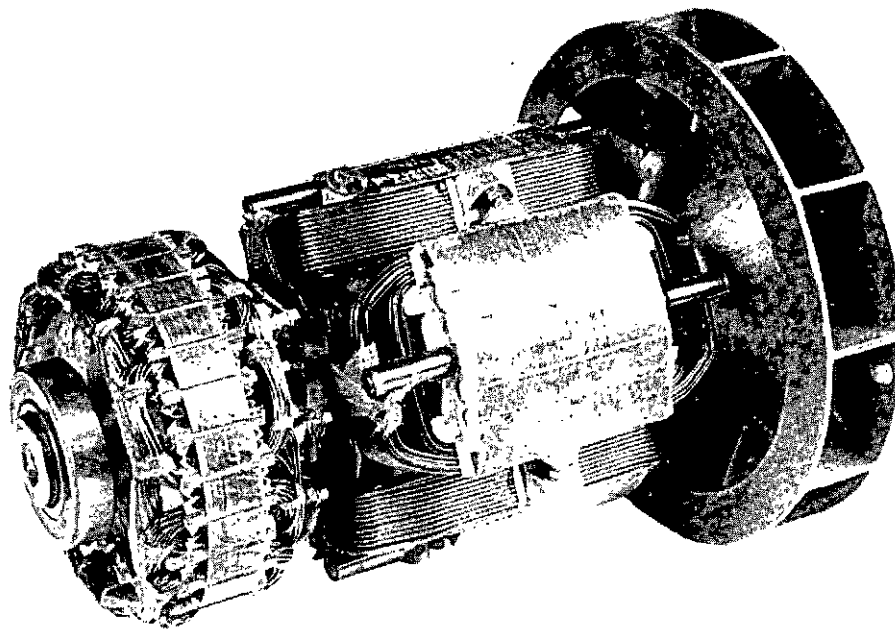
Fig. 1 Shows an example of a frame code HC1441D

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. IP23 versions are also available.

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 below shows a typical complete assembly. (Fig. 2)



(Fig. 2) Typical Rotor

The rotor is supported by liberally-rated long-life ball bearings with a calculated life expectancy of 40,000 hours in an ambient temperature 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 AVR is mounted from the terminal box and an exciter/rotating rectifier assembly is mounted internally to the non-drive-end bearing.

Removable access covers are provided at the D.E. and N.D.E. 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.

INSTALLATION

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 of a 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.

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:

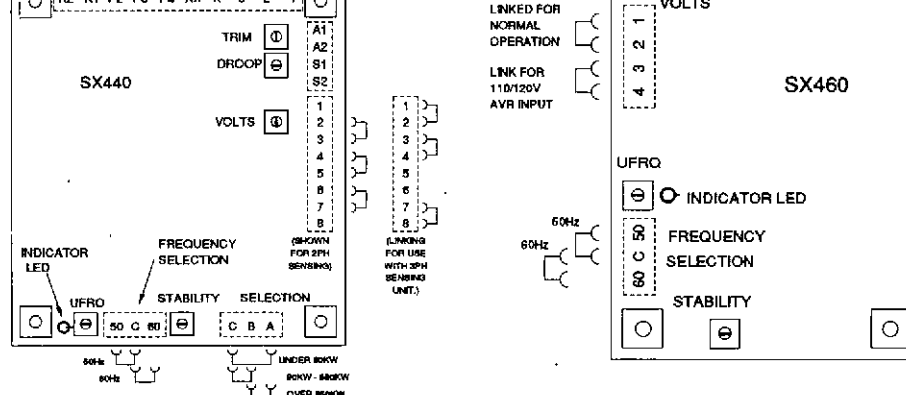
When dismantling a.c. generator from the engine, care should be taken to ensure that the rotor is positioned with the pole at the bottom centre line. This is to avoid any damage to the bearing or exciter by limiting the rotor movement to that of the air-gap.

2.4 VOLTAGE ADJUSTMENT

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

1. Remove AVR box lid.
2. Adjust VOLTAGE RANGE control until the required value is obtained.
3. The stability control potentiometer should normally require no adjustments. If adjustment is necessary turn the control fully clockwise, then turn counter clockwise until unstable operation results. (ie. flicker on voltmeter needle). Return adjustment 10% clockwise.

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



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

Fig. 3 (AVR) AUTOMATIC VOLTAGE REGULATOR ADJUSTMENTS

A hand trimmer, when fitted (optional extra), will allow a further finer adjustment of approximately $\pm 5\%$ improving the accuracy of the pre-determined voltage level.

2.5 UNDER FREQUENCY ROLL OFF PROTECTION ADJUSTMENT (UFRO)

This is set for 50Hz or 60Hz operation by means of a 'JUMPER' lead on the AVR. If it is necessary to change this setting appropriate instructions are given on a label fixed to the inside of the AVR box lid.

2.6 OVER EXCITATION PROTECTION

The correct level has been factory set and should not be changed.

2.7 OVERVOLTAGE PROTECTION

The Overvoltage Module (O.V.M.) is an optional feature which can be easily installed to provide additional security on the occurrence of a terminal overvoltage, protecting both the generator and the connected load.

This is not available with the SX460 AVR

Installations and adjustment details are not covered in this manual.

2.8 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.

2.9 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 the time of ordering. If machine rotation is reversed after the machine has been despatched apply to factory for appropriate wiring diagrams.

2.10 OUTPUT TERMINALS

Output terminals are provided to accept cables rated to normal standard specifications for single or multicore cable.

2.11 PARALLEL OPERATION

2.11.1 DROOP KIT FOR PARALLEL OPERATION

SX440 AVRs only (SX460 not applicable).

If machines are required to operate in parallel with other a.c. generators, each should be fitted with a quadrature droop current transformer (CT). Single phase generators require, additionally, a burden choke as the AVR-mounted burden resistor is not suitable. When operating in parallel with the mains utility a VAR/PF controller must be fitted. These accessories are available from our Nupart Department.

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.

2.11.3 CONNECTIONS

The enclosed wiring diagrams show fully the correct connections for the CT (and the burden choke if applicable).

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.

2.11.4 SETTING THE DROOP CIRCUIT

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.

2.11.5 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.

Wattmeter

At least one wattmeter per machine is essential to observe the load sharing of the prime movers, i.e. engines.

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 conditions 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.

2.12 CURRENT SENSING KIT

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 sensing 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.

The components are identical to those for the quadrature droop kit, but positioned so to be most sensitive to loads from unity to 0.8 p.f. (lag).

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.

2.13 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.

2.14 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.

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/min	Max. 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 .036mm at 1800 r.p.m. and .041mm at 1500 r.p.m.

The standard range of Stamford brushless generators covers shaft heights from 160mm to 450mm.

In order to achieve the above limits Newage dynamically balance the complete rotor assembly in accordance with BS5265: 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 as measured at the bearing housing do not exceed the levels specified in BS 4999: Part 142.

The permitted levels of vibration for generator sets are laid down in BS5000: 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. For trouble free generator operation, the bending moment at this point must not exceed the following levels:-

Frame 1 500 ft. lb (70kgm)

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

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

Many applications today are for standby operation 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 problems.

Two Bearing Machines

It is beyond the scope of this publication to give guidance on ways and means of 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 manufacturers' 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.

If there is any doubt about the alignment, the covers at the non-drive end should be removed and the air gap checked with long feeler gauges to ensure uniformity around the periphery of the rotor.

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 ± 0.5 mm of nominal dimension. This is necessary to ensure that the a.c. generator bearing does not thrust against the bearing caps.

2. Check that the bolts securing the flexible plates to the shaft hub are tight and locked into position. Torque tighten M12 bolts to 10 kgf-m (98N-m) (72 lbf-ft).
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. These 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.

PERFORMANCE

This Stamford a.c. generator is a quality-engineered and built 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 OPERATION THEORY

Series 4 and Series 6 systems have the same principles of operation.

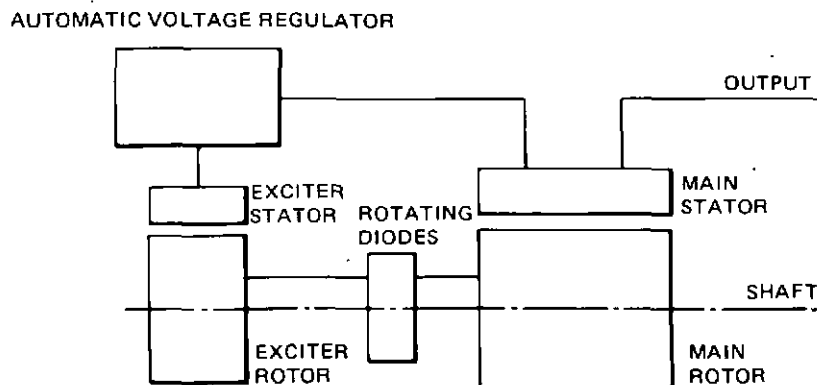


Fig. 4 Block Diagram of Excitation System

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

The control system is based on the main stator winding providing excitation power via the automatic voltage regulator (AVR) to the main exciter. Residual magnetism of the machine is utilised via a circuit within the AVR to provide a positive voltage build up. A reference signal is fed into the AVR from the main stator through a high source impedance which is rectified and smoothed to maintain the voltage regulation to within fine limits. The main exciter output is fed into the main rotor windings via a rotating 3 phase bridge rectifier unit incorporating a surge suppressor to protect the diodes against voltage transients during heavy load surges, i.e. short circuits or out of phase paralleling.

A frequency sensitive circuit is incorporated into the AVR which functions only when the shaft speed falls below approximately 90% of the rated speed. The voltage then reduces proportionally to any further reduction in speed, thus assisting the prime mover to recover after application of high starting torque motor loads or high kilowatt load changes. This also provides low speed protection to the main rotor by ensuring the excitation does not exceed the safe operating level at all speeds.

3.2 PROTECTION

Some overexcitation protection is inherent due to a frequency sensitive circuit (Under frequency Roll Off Protection). This functions if shaft speed falls below about 95% of rated value, to reduce the voltage linearly with speed, so preventing the excitation from reaching levels which may cause damage. The further advantage of this reduction is that it offers assistance to the prime mover to recover speed following heavy load acceptance.

Settings for the protection elements are described in Section 2.

A number of other Nupart Accessories are available from our Nupart Department. These offer various facilities from condition monitoring to load protection. Some of these are not available for use with the Series 6 system which is normally fitted to PC1 machines.

3.3 AUTOMATIC VOLTAGE REGULATOR TYPES

Two AVR types are available – a) SX460
b) SX440

machine. They provide the high performance and flexibility needed for most applications.

The SX440 AVR 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.

3.4 MARINE GENERATORS

Marine generators are available to meet the requirements of most marine classifying societies. These are termed MHC units and must be specified at the time of order. Generally HC1 machines may not be converted to MHC1 type, since the latter has a special extra winding included in the stator. PC1 machines are not available in marine versions.

4.1 ROUTINE

Routine servicing is confined to an insulation resistance check following a long period without running.

Insulation Test

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

4.2 LUBRICATION (1 or 2 Bearing machines)

The bearings are sealed for life and cannot therefore be serviced or re-greased.

Should any sign of excessive noise, heat or vibration be evident under normal running conditions, the bearing must be replaced.

Warning: No attempt should be made to dismantle or service these bearings.

4.3 FAULT FINDING

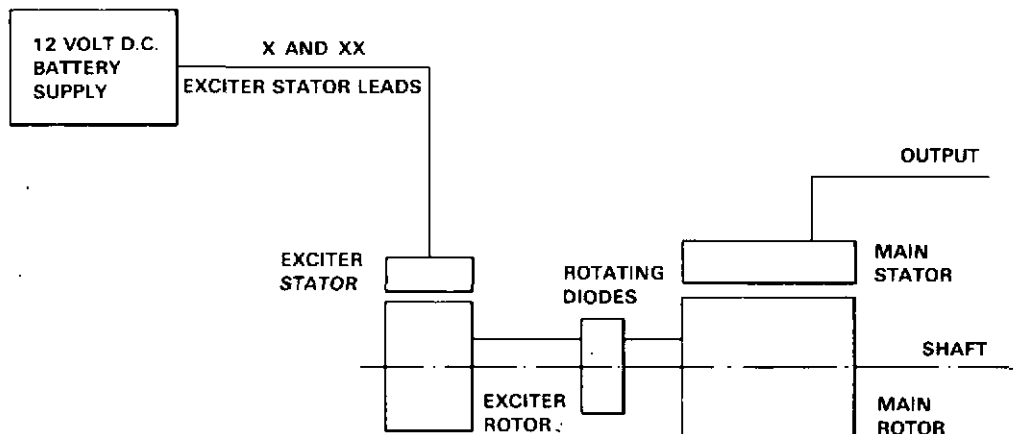
In practice fault-finding is greatly simplified by dividing the machine, for check test purposes into 2 parts, namely:

- The exciter and main machine windings plus main rectifier.
- The electronic control assembly and wiring.

4.3.1 SECTION A) WINDING AND MAIN RECTIFIER ASSEMBLY

Separately Exciting the Machine

The a.c. generator is separately excited to give an indication of the condition of the windings and main rectifier assembly. For the frame sizes covered in this manual a 12 volt d.c. battery supply is sufficient to obtain the full output voltage with $\pm 10\%$, at no load, with the speed correct at nominal.



Method of Separately Exciting the Machine (Fig. 5)

The d.c. supply is connected to the exciter stator leads marked X and XX, which should 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 lead, 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 $\pm 10\%$ of the Nominal

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 "AVR Sensing Supply from the Main Stator".

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 unbalance 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 winding.

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.

AVR Sensing Supply and Power Supply

The final test which can be made in the externally excited condition is to ensure that the sensing and power supplied 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 droop burden resistor and/or dropper transformer. These should be checked for continuity.

3 Phase Sensing

3 phase sensing is via a separate sensing unit. 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 dropper transformer, which should be checked for continuity. With the 3 phase sensing unit connected to the AVR, the voltage across lead 2-3 should be between 10 and 16v d.c.

AVR Power Supply

The generators derive their excitation power from the output windings.

SX440: With rated output voltage on the main terminals the voltage across AVR leads P2 and P3 should be between 170-250v a.c.

SX460: With rated output voltage on the main terminals the voltage across AVR leads 7 and 8 should be between 170-250v a.c.

AVR

Should the previous test 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 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.

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).

4.4 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 (HC1)

1. Remove the 4 screws retaining AVR lid.
2. Disconnect all cables to AVR
3. Remove 4 pillars retaining AVR.

Removal of AVR (PC1)

1. Remove terminal box lid.
2. Disconnect all cables to AVR.
3. Remove 4 screws retaining AVR.

Removal of Main Rotor Assembly

1. Remove all access covers and terminal box lid.
2. Disconnect exciter leads X + & XX - at the inline spade connectors inside the terminal box.
3. **Two Bearing Machines only.** Remove screws securing the D.E. endbracket.
4. **Two Bearing Machines only.** Position rotor with a full pole face at the bottom and tap endbracket out of its spigot.
5. Lower rotor on to stator core.
6. Withdraw D.E. endbracket from bearing.
7. **Single Bearing Machines only.** Remove screws securing adaptor and tap adaptor out of its spigot.
- 8a. Internal Exciter Machines. Remove N.D.E. bearing cap securing screws and bearing cover.
- 8b. Remove N.D.E. endbracket securing screws, using 2 of these screws, push endbracket out of its spigot by using the 2 threaded holes in the endbracket flange.
- 8c. Withdraw N.D.E. endbracket complete with exciter stator.

OR

- 9a. External Exciter Machines. With external cover removed disconnect main rotor leads from rectifier.
- 9b. Remove socket head capscrew securing exciter rotor stub shaft.
- 9c. Withdraw exciter rotor/exciter/stub shaft assembly.
- 9d. Remove N.D.E. bearing cap securing screws.

9c. Remove N.D.E. endbracket securing screws, using 2 of these screws, push endbracket out on its spigot through the 2 threaded holes in the endbracket.

9f. Withdraw N.D.E. endbracket complete with exciter stator.

10. Slide rotor out of stator bore towards the D.E. and withdraw rotor.

REMOVAL OF THE BEARING(S)

The bearing(s) 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.

Reassembly

This is essentially a reverse process of the above.

FIG. 6 WINDING RESISTANCE CHART

Frame Size	Exciter		Stator Winding 211	Stator Winding 17	Stator Winding 14	Rotor
	Stator	Rotor L-L				
1A	27	0.242	1.62	2.16	1.18	0.81
1B	27	0.242	1.13	1.49	0.73	0.88
1C	27	0.242	0.79	1.06	0.583	0.96
1D	27	0.252	0.645	0.861	0.414	1.03
1E	27	0.252	0.425	0.58	0.272	1.18
1F	30	0.320	0.27	0.42	0.191	1.36
1G	30	0.320	0.214	0.31	0.139	1.53

NOTES:

1. All figures are approximate.
2. Resistance figures are at 20°C.

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:

	PC164	HC164	HC144
1. Diode set (6 diodes) with Varistor	RSK-1001	RSK-1001	RSK1001
2. Automatic Voltage Regulator	E000 24600	E000 24600	E000 24030
3. Bearing non-drive end	051-01033	051-01048	051-01048
4. Bearing drive-end (2 bearing generator only)	051-01033	051-01032	052-01032
5. 3 phase sensing unit (when applicable)	_____	_____	E000 22035

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: (0780) 62552, Telex: 32268, Fax: (0780) 66074
or any of our Subsidiary Companies listed 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.

PARTS LIST

FIG. 7a TYPICAL SINGLE BEARING MACHINE (INBOARD EXCITER)

Plate Ref	Description	Plate Ref	Description
1	N.D.E. Endbracket	24	Coupling screw
2	N.D.E. Louvred cover	25	Expansion plug
3	D.E. endbracket/adaptor	26	Upper D.E. Cover
4	Main rotor key	27	Lower D.E. Cover
5	Lifting lug	28	N.D.E. bearing cover
6	Main frame		
7	Wound main stator assembly		
8	Wound main rotor assembly		
9	Fan		
10	Shaft		
11	Wound exciter stator assembly		
12	Wound exciter rotor assembly		
13	Main rectifier assembly		
14	N.D.E. sealed bearing		
15	N.D.E. Outer bearing cap		
16	Terminal box 4 panels D.E., N.D.E., sides		
17	Terminal box lid		
18	Automatic voltage regulator		
19	Main terminal panel 4 panels D.E., N.D.E., sides		
20	Main terminal panel stud and nut		
21	Coupling hub		
22	Coupling spacer		
23	Coupling disc		

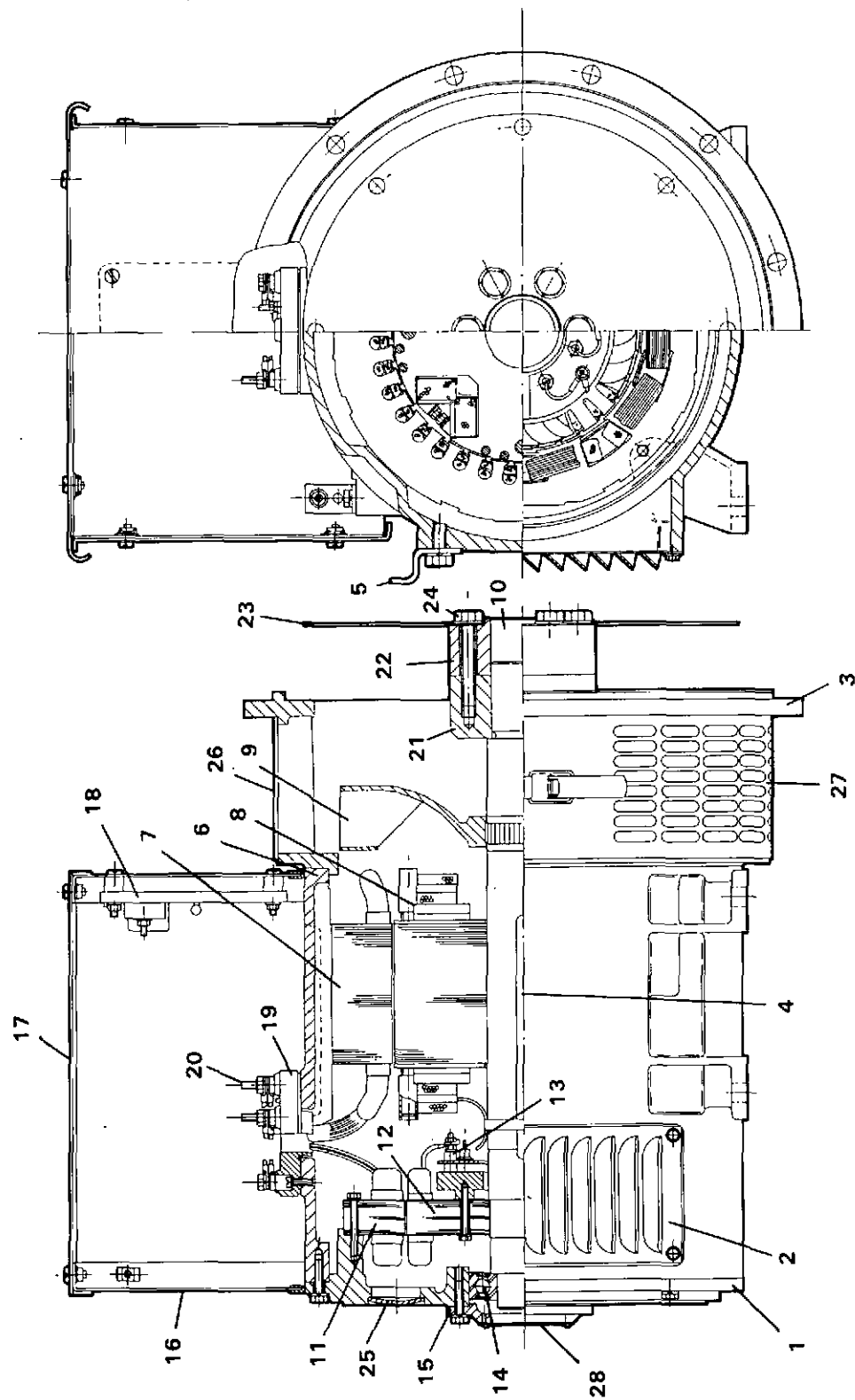


FIG. 7b TYPICAL SINGLE BEARING MACHINE (INBOARD EXCITER)

PARTS LIST

FIG. 8a TYPICAL TWO BEARING MACHINE (OUTBOARD EXCITER)

Plate Ref	Description	Plate Ref	Description
1	N.D.E. Endbracket	26	N.D.E. Cover
2	N.D.E. Louvred cover	27	D.E. louveres (when fitted)
3	D.E. Endbracket	28	Socket head capscrew
4	Main rotor key	29	Selok pin
5	Lifting lug	30	Exciter stub shaft
6	Main frame	31	Exciter studs
7	Wound main stator assembly	32	Feet
8	Wound main rotor assembly	33	A.V.R. box
9	Fan	34	A.V.R. box lid
10	Shaft		
11	Wound exciter stator assembly		
12	Wound exciter rotor assembly		
13	Main rectifier assembly		
14	N.D.E. sealed bearing		
15	N.D.E. Outer bearing cap		
16	N.D.E. Inner bearing cap		
17	Terminal box 4 panels D.E., N.D.E., sides		
18	Terminal box lid		
19	Automatic voltage regulator (AVR)		
20	Main terminal panel		
21	Auxiliary terminal panel		
22	Main terminal panel stud and nut		
23	D.E. sealed bearing		
24	Waved washer D.E.		
25	Screen D.E.		

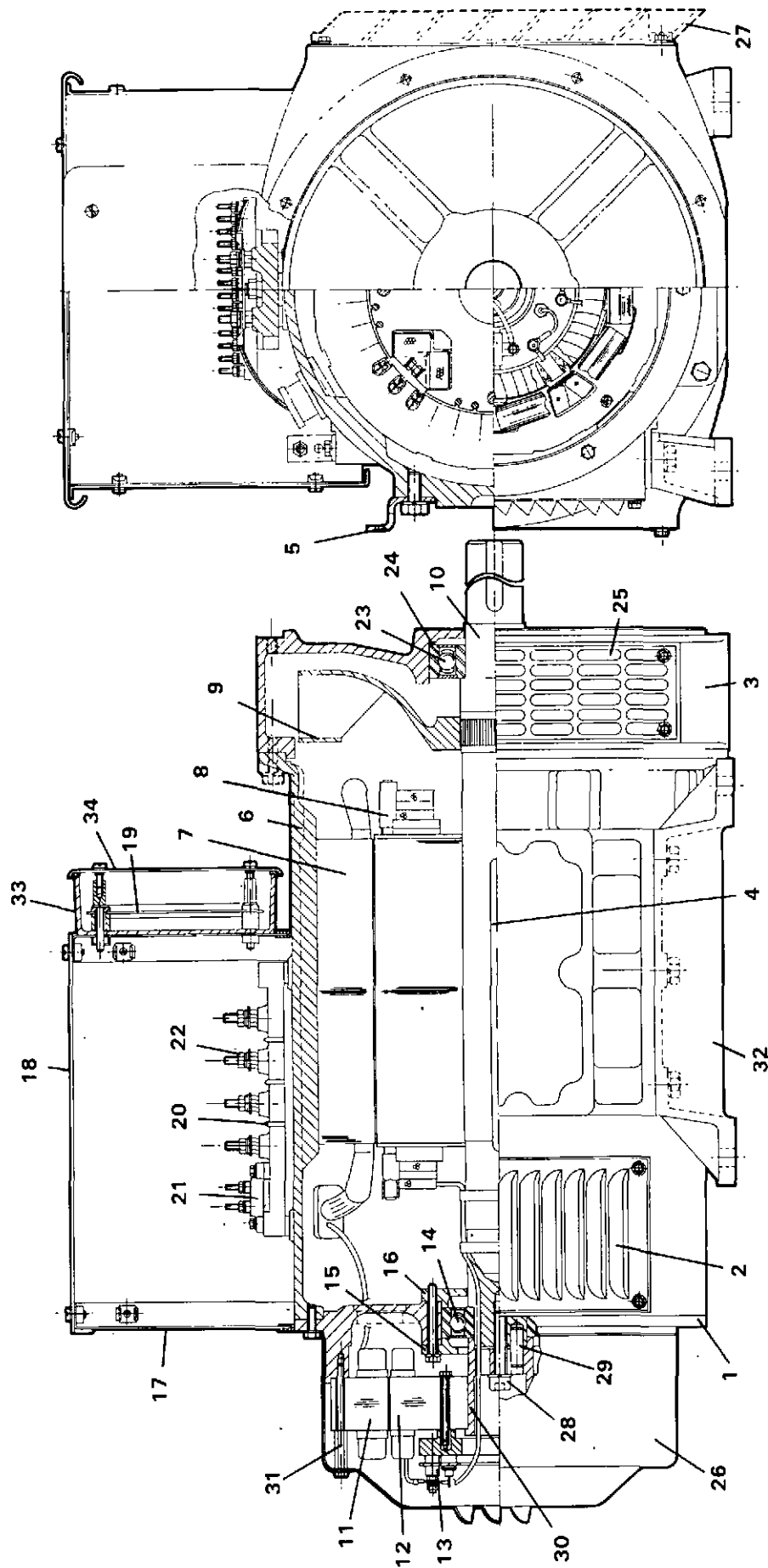


FIG. 8b TYPICAL TWO BEARING MACHINE (OUTBOARD EXCITER)

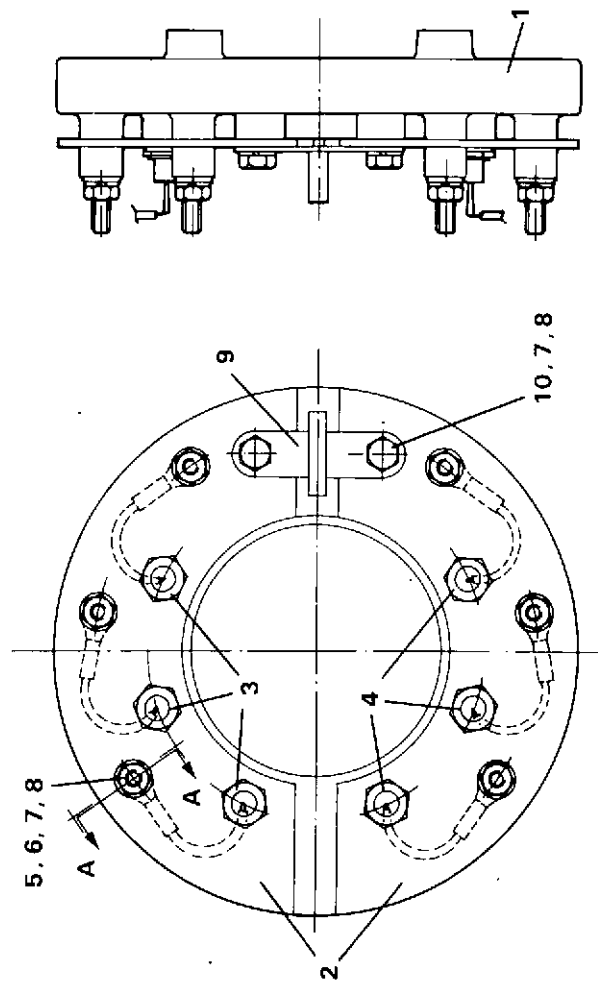
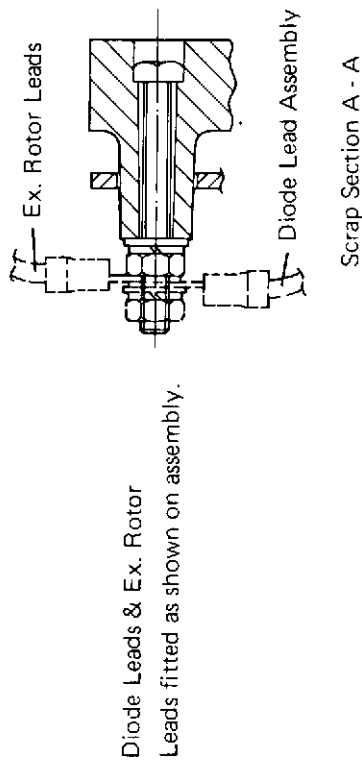


Plate Ref.	Description	Qty
1	Hub	1
2	Fin	2
3	Diode (fwd)	3
4	Diode (rev)	3
5	Hx. Screw	6
6	Hx. Nut	6
7	Pl. Washer	8
8	SC. L/Washer	8
9	Varistor	1
10	Hx. Screw	2

NOTES:

Fitting of Diodes

1. Underside of diodes to be smeared with Midland Silicone 'Heat Sink' compound type MS2623. This compound **must not** be applied to the diode threads.
2. Diodes to be tightened to a torque load of 2.03 - 2.37 N-m.
3. A rectifier assembly must comprise diodes from one manufacturer only.

Fig. 9 Rotating Rectifier Assembly

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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