INSTRUCTION MANUAL

FOR

H60/50

CONSTANT CURRENT/CONSTANT VOLTAGE
STABILISED POWER SUPPLY

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INTRODUCTION

The H60/50 is a regulated D.C. power supply giving either constant voltage or constant current output. Changeover from one mode of operation to the other is automatic and the point at which changeover takes place is continuously adjustable from 0 - 60 volts and 0 - 50 amps by means of the front panel controls. Indication of output is by means of two front panel meters, one measuring output voltage and the other, output current.

The supply will operate from mains inputs of 220 or 240 volts 50/60 Hz. (Units to operate from 110 volts 50/60 Hz can be supplied on request).

Since the H60/50 is a physically heavy unit and can be operated in several different modes, the following notes on installation and operation should be carefully read and understood before use.

SPECIFICATION

INPUT:

0 - 220 - 240 Volts 50/60 Hz ± 7½%
23A R.M.S. Approx. at 240 Volts input (full load).
25A R.M.S. Approx. at 220 Volts input (full load).
(On request 0 - 110 Volts 50/60 Hz ± 7½%
50A R.M.S. approx.).

OUTPUT:

Constant voltage or constant current, variable from 0 - 60 volts and 0 - 50 amps.

LOAD REGULATION:

CONSTANT VOLTAGE - Less than .01% + 200 µV for a zero to full load change.

CONSTANT CURRENT - Less than .01% + 2.4mA for a change in load resistance from zero to full load.

LINE REGULATION:

CONSTANT VOLTAGE - Less than .01% + 200 µV for a ± 7½% change in input voltage from nominal.

CONSTANT CURRENT - Less than .01% + 2.4mA for a ± 7½% change in input voltage from nominal.

RIPPLE AND NOISE (f = 10KHz).

CONSTANT VOLTAGE - Less than 1mV R.M.S.

CONSTANT CURRENT - Less than 10mA R.M.S.

MAXIMUM OPERATING AMBIENT TEMPERATURE:

50°C.

TEMPERATURE COEFFICIENT:

CONSTANT VOLTAGE.

Output voltage change per degree centigrade change in ambient temperature is typically less than .02% plus 1mV.

CONSTANT CURRENT:

Output current change per degree centigrade change in ambient temperature is typically less than .02% plus 5mA.

STABILITY.

CONSTANT VOLTAGE.

The total drift for 8 hours (after a one hour warm-up period) at a constant ambient temperature is typically less than .02% plus 2mV.

CONSTANT CURRENT.

The total drift for 8 hours (after a one hour warm-up period) at a constant ambient temperature is typically less than .02% plus 5mA.

TRANSIENT RECOVERY TIME.

Less than 50µSecs are required for the output voltage to recover to within 20mV of the nominal output voltage, following a half load change in output current.

OUTPUT IMPEDANCE (CONSTANT VOLTAGE).

Less than .001 ohms from D.C. to 100Hz.
Less than .01 ohms from 100Hz to 1KHz.
Less than .2 ohms from 1KHz to 100KHz.
Less than 2 ohms from 100KHz to 1MHz.

COOLING.

Forced air cooling is employed with overheating protection.

SIZE.

17.8 cms (7") H x 48.25 cms (19" W x 62 cms (24") D.

WEIGHT.

79 Kg (174 lbs.) Net

SPECIFICATION MEASUREMENTS.

The quoted figures apply only to units connected for normal operation i.e. not master/slave connected or externally programmed.

Output voltage regulation should be measured across terminals J and K.

Output current regulation should be measured using an external meter and shunt or by measuring the voltage across terminals A and D (1 volt approx = 50A).

Ripple and noise should be measured between terminals J and K, in constant voltage and terminals A and B in constant current, using a non-earthed measuring instrument of bandwidth 10KHz and one output terminal must be grounded to the unit case.

INSTALLATION.

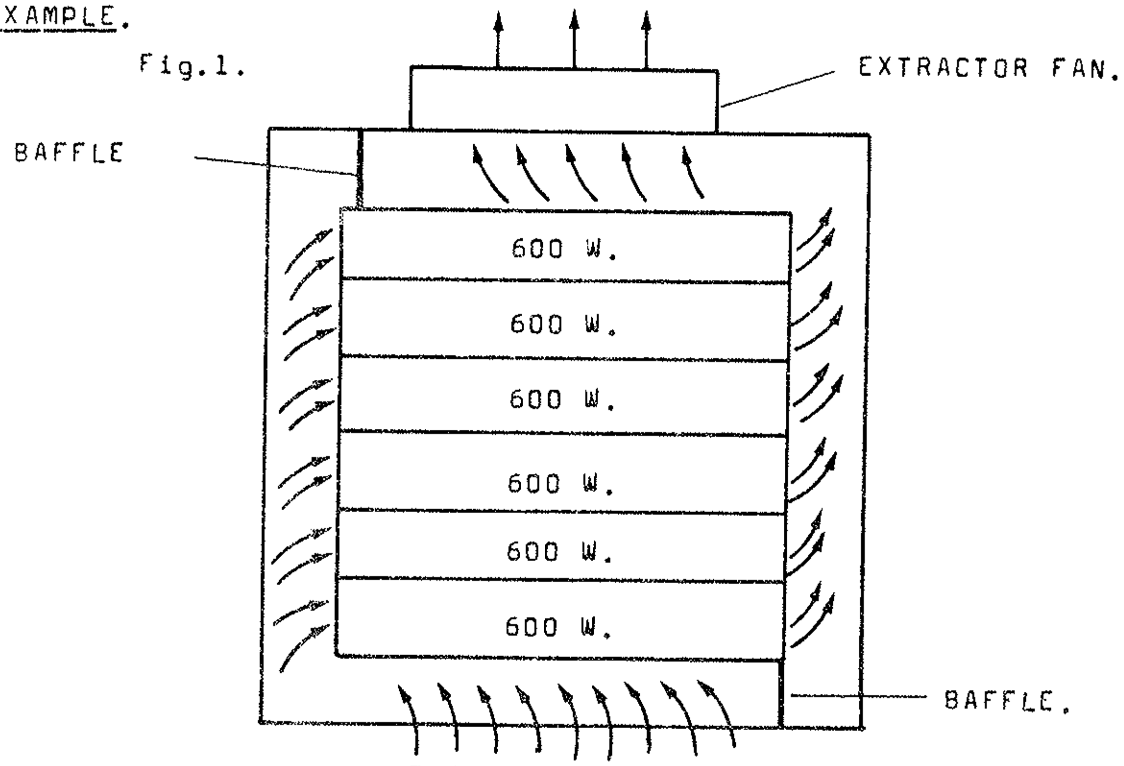
The weight of the unit is carried on its side panels and support runners should be provided directly under them, capable of supporting a weight of 79 K gms (174 lbs). The front panel must not support any appreciable weight.

Units may be operated one on top of another without removing the covers.

As the units are cooled by forced air the construction of any cabinit into which the units may be fitted must allow adequate air intake and exit. Recirculation of air must be prevented by baffles (See Fig.1). At full current output, the power dissipated within one unit is approximately 600 Watts, which raises the temperature of the air passing through it by 20-30°C. Air intake is on one side of the unit and exit on the other.

EXAMPLE.

Fig.1.



Take the case of six units operating at full load in one cabinet. Air should enter and leave the cabinet at approximately 170 m^3/hour (100 cu.ft. per minute) and to do this, an additional fan in the cabinet would be necessary.

OPERATING INSTRUCTIONS.

WARNING.

Care should be taken to ensure that the mains input setting as indicated on the label on the rear of the unit is compatible with the intended input voltage.

Connection to the mains is by the studs on the rear of the unit marked L, N, E i.e. Mains Line, Mains Neutral, Earth. Units are normally set at the factory for 240 volt operation unless otherwise requested.
As a filter is incorporated in the input circuitry, a good earth is essential.

NORMAL OPERATION.

At the rear of the unit, link terminals:-

(1) B, C and J
(2) D, E and F
(3) G, H and K

Connection to the load is via the studs on the rear of the unit marked "O/P+" and "O/P-".

Output voltage and current are adjusted by the "Course" and "Fine" controls on the front panel marked "Voltage Adjust" and "Current Adjust".

The unit will operate as a constant voltage source for load resistances greater than the resistance given by V set/I set, where V set is the setting of the unit output voltage and I set is the setting of the unit output current.

For load resistances less than Vset/I set, the unit will operate as a constant current source. The changeover from constant voltage to constant current is automatic.

THERMAL TRIP.

The unit is protected against the effects of restricted air flow or fan failure and will automatically shut down if internal overheating occurs. Indication of shutdown is provided by the illumination of the lamp in the centre of the front panel. In order to reset the unit after shutdown (provided that the cause has been rectified) sufficient time should elapse for the unit to cool (approximately 3 minutes with the fans running) and the reset button on the front panel, pressed and released. The unit will reset to correct operation.

REMOTE PROGRAMMING OPERATION.

Units may be externally programmed in either constant voltage, constant current or both, by means of external resistors.

(a) CONSTANT VOLTAGE.

Connection of the terminals at the rear of the unit is as follows:-

Link terminals (1) B, C and J
(2) D, E and F
(3) H and K

Turn the "Voltage Adjust" controls fully anticlockwise or short them out internally.
Connect the programming resistor between terminals G and K.
The programming coefficient is approximately 420Ω/volt but can be varied slightly by means of an internal adjustment of the programming current source, trimmer P7.

N.B. Stable, low noise, low temperature coefficient resistors of at least 1/4 watt rating should be used and connection from the unit to the programming resistor should be made via a twisted pair of wires.

(b) CONSTANT CURRENT.

Connection of the terminals at the rear of the unit is as follows:-

Link terminals (1) B, C and J.
(2) D and F.
(3) G, H and K.

Connect the programming resistor between terminals A and F. The programming coefficient is approximately 20Ω/amp, but can be varied slightly by means of an internal adjustment of the programming current source, trimmer P11.

N.B. Stable, low noise, low temperature coefficient resistors of at least 1/4 watt rating should be used and connection from the unit to the programming resistor should be made via a twisted pair of wires.

REMOTE SENSING (CONSTANT VOLTAGE ONLY).

Where it is required to compensate for the voltage drop across the leads connecting the load to the unit i.e. maintaining a constant voltage at the load and not at the unit output terminals, use may be made of the remote sensing facilities.

Connection of the terminals at the rear of the unit is as follows:

Link terminals (1) B and C
(2) D, E and F.
(3) G and H.

Connect terminal B to the positive output lead at the load, twisting the wire round the output lead.

Connect terminal G to the negative output lead at the load, twisting the wire round the output lead. An electrolytic capacitor of approximately 2000 μF 60V WKG should be connected directly across the load in order to reduce overshoot and undershoot following transient load changes. It may be found necessary to decouple terminal B to the positive output terminal and terminal G to the negative output terminal, (to stop instability) at the unit with an electrolytic capacitor. The value of capacity required is indeterminate as it depends upon the conditions in the particular installation.

Since the resistance of the positive output lead is now in series with the current sensing resistor (R98), it will be found necessary to adjust P11 on the control amplifier circuit board so that with the"current adjust" controls fully clockwise, an output current of 50.5 amps can be obtained with the load short circuited.

SERIES OPERATION.

Units may be connected directly in series in order to give a greater voltage range. Output current capability will

be determined by the supply set to the lowest current.
It is recommended that no more than two supplies be connected in this manner.

PARALLEL OPERATION.

A master/slave configuration is used when a current greater than that available from a single supply is required.

Connection of the terminals at the rear of the unit is as follows:-

The master supply is connected as for a single supply (normal, or remotely programmed).

On the slave supply(ies)

Link terminals (1) A and D
(2) B and J
(3) G, H and K.

Terminal C on the slave unit is connected to terminal A on the master unit.

Output voltage and current is controlled by the master supply only, provided that the "Voltage Adjust"controls on the slave units are turned fully clockwise.

N.B. Since the voltage drop of the positive output lead from each supply is added to the current sensing voltage for each supply, the following method of connection for MASTER/SLAVE systems should be used.

(1) The positive output lead from each unit should be taken to a common connection, as near to the units as possible. These leads should be of equal rating and equal length and as short as possible.

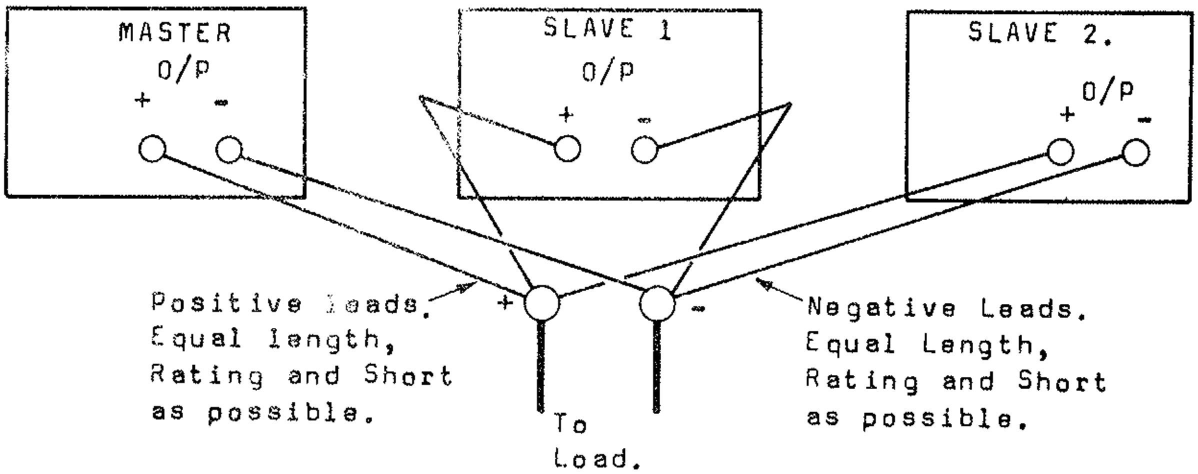
Similarly:-

(2) The negative output lead from each unit should be taken to a common connection, as near to the units as possible. These leads should be of equal rating and equal length and as short as possible.

(3) The load connection leads should be taken to the

common positive and negative connections.

e.g.



Current sharing should be checked by measuring the voltage across terminals A and B on each unit. The voltages should be equal to within 1%. Any slight differences may be balanced out by adjustment of P8 on the control amplifier board ON THE SLAVE UNITS ONLY.

EXTERNAL METERS.

Connection to an external voltmeter should be made to terminals J and K when normal operation is used or across the load when remote sensing is used. (Terminal J is positive with respect to terminal K).

A signal of 0 to approximately 1 volt corresponding to a 0-50A is available at terminals A and B (terminal A being positive with respect to B). Connection may be made from these terminals to a meter of 1mA full scale deflection, with suitable series resistance to provide a remote load current indication.

CIRCUIT DESCRIPTION.

BLOCK DIAGRAM.

The function of the pre-regulator is to minimise the power dissipation in the series regulator by keeping the voltage across it constant under all output and input conditions.

Output current is monitored by the voltage across the current sensing resistor, and this signal is fed to the constant current amplifier. Any change in output current is detected, amplified and fed to the series regulator in such a sense as to oppose the change.

Similarly, output voltage is sensed by the constant voltage amplifier and any change is amplified and fed to the series regulator in such a sense as to oppose the change.

The Schematic Diagram shows the interconnection of the various circuits.

S.C.R. CONTROL.

The firing circuit consists of a variable ramp generator, which is synchronised to twice the supply frequency, driving a Schmitt Trigger circuit, the output of which is applied to a pulse output stage feeding the S.C.R.'s.

The ramp generator, VT4, C3 is controlled by the potential divider R7, P1, R8, R9 which senses the voltage across the series regulator stage. VT3 is a constant current source which limits the maximum current at which VT4 can charge C3. VT5 emitter is connected to VT4 emitter and its base is A.C. coupled via a potential divider to the sensing point. The effect of this is to cancel variations in charging current caused by ripple at the sensing point. D4, D4A, D5, D5A, R3, R11 and C4 feed a full wave rectified sine wave in series with the ramp waveform, which is directly proportional to mains supply amplitude. R4, R5, R6, VT1, VT2 and D6 form a zero threshold switch which discharges the ramp capacitor C3 every half cycle, thus synchronising the ramp to twice the mains supply frequency.

VT.40 and VT41 form an overvoltage control which limits the unregulated line voltage to approximately 73 volts.

AUXILIARY SUPPLY.

Supplies for the control amplifier circuit board are derived from a 36 - 0 - 36 volt winding on MT.2. This is rectified by diodes D11 and D12 and smoothed by capacitors C7 and C8. VT9, VT10, VT11, Z4 and associated resistors form a compound current source feeding zener diodes Z5 and Z6 giving a +15 - 0 - -15 volt supply for the control amplifiers.

Also on this circuit board is the thermal overload circuitry. This senses the regulator heatsink temperature via the thermistor mounted on the heatsink assembly and shuts down the supply if a dangerous temperature is reached. A warning lamp and reset button are provided and are situated in the centre of the front panel.

VT.28 and VT.29 form a Schmitt Trigger which senses between the zero line and potential divider P6, R37, TH1 and R36 (TH1 being connected between pins 1 and 6). Normally VT28 is non-conducting, but if a dangerous temperature is sensed then the Schmitt trigger changes state and VT28 conducts. This causes SCR1 to conduct lighting the warning lamp and feeding a shutdown signal via pin 12 to the control amplifier. After the heatsink has cooled sufficiently to allow the Schmitt Trigger to reset, the unit can be reset by pressing and releasing the reset button connected between pins 11 and 14.

P5, R80 and P12, R79 are meter calibration resistors.

CONTROL AMPLIFIERS.

These consist of the following:- (a) Voltage reference and constant voltage amplifier (b) Current reference and constant current amplifier (c) Shutdown and short circuit protection amplifier (d) drive amplifier.

(a) Voltage Reference and C.V. Amplifier.

VT.13, Z7, R39 and R40 comprise a current source feeding reference zener Z8 and potential divider R41, P7, P12 and P13. VT14 and VT15 form a differential amplifier which compares the voltage at the junction of P7 and R42 position, with the zero line. Since P7 is connected to the negative output terminal, any change in output voltage produces a proportional change in voltage at the junction of R41 and R43. This is amplified at VT14 collector, and fed via D15 to the drive amplifier in such a sense as to oppose the original change.

(b) CURRENT REFERENCE AND C.I. AMPLIFIER.

VT27, Z11, R76 and R75 comprise a current source feeding reference zener Z10 and potential divider R78, P11, P14 and P15. VT20, VT21 and VT22 form a differential amplifier feeding the drive amplifier via D16. Pin 15 is connected to the +ve output terminal and pin 18 is connected to the junction of P12 and P11. Any change in output current causes the voltage across R98 (the current sensing resistor) to change. This produces a proportional change between the bases of VT20 and VT22 which is amplified at VT20 collector and applied via D16 to the drive amplifier in such a sense as to oppose the original change.

(c) SHUTDOWN AND SHORT CIRCUIT PROTECTION AMPLIFIER.

This circuit consists of VT.23, VT24, VT,25, VT.26 and associated resistors. Pin 16 is connected to the unregulated D.C. line, pin 17 is connected to the anode of S.C.R.1 on the thermal overload circuit board, and pin 9 is connected to the positive end of R98, the current sensing resistor.

Normally, VT.23, is held non-conducting since VT.24 VT.25 and VT.26 are conducting. If the voltage across the series regulator (i.e. across pins 14 and 16), exceeds approximately 20 volts, VT.26 and VT.25 cease to conduct and the heavy bias on VT.24 is removed. As the voltage across pins 14 and 16 increases, VT.23 starts to conduct, feeding a signal, via D17, to the drive amplifier in such a sense as to reduce output current. Output current is reduced linearly to approximately (1A) when the voltage across pins 14 and 16 reaches approximately 60 volts. This prevents "second breakdown" failure of the series regulator transistors on applying a sudden short circuit to the output terminals of the unit.

If a thermal overload is detected, S.C.R.1 (on the auxiliary supply circuit board) conducts and connects pin 17 to the -15 volt auxiliary line. This forward biases D18 and VT23 conducts. This feeds a "shutdown" signal, via D17, to the drive amplifier, and no output current can flow until the unit is reset.

(d) DRIVE AMPLIFIER.

This consists of VT.16, VT.17, VT.18 and VT.19. VT.18 is a dynamic load for VT.17 in the differential amplifier. The output from VT.17 collector is fed to the base of emitter follower VT.16 and the signal from its emitter is fed via pin 6 to the series regulator.

SERIES REGULATOR.

This consists of transistors VT.30 - 39, VT.30 and VT.31 being cascaded emitter followers driving the parallel connected emitter followers VT.32 - 39.

INTERNAL ADJUSTMENTS.

MAINS INPUT.

Units are set at the factory for operation at 240 volts input unless otherwise requested. For 220 volts operation see fig. 2. Unless 110 volt operation has been specifically requested, no attempt should be made to operate a standard unit with 110 volts input, as internal changes of wire gauge etc. are incorporated in units intended for 110 volt operation. For connections see fig.2.

WARNING.

No attempt should be made to make any adjustments without strict reference to the following instructions, otherwise damage may result.

METER CALIBRATION.(P12 and P5)

(1) VOLTMETER With the unit giving 60 volts output (measured using an accurate external meter) adjust P12 (on the auxiliary supplies circuit board) until the front panel meter reads 60 volts.

(2) AMMETER With the unit giving 50 amps output (measured using an accurate external meter) adjust P5 (on the auxiliary supplies circuit board) until the front panel meter reads 50 amps.

MAXIMUM OUTPUT VOLTAGE (P7).

With both "Voltage Adjust" controls turned fully clockwise adjust P7 (on the control amplifiers circuit board) until an output of 60.5 volts is measured using an external meter.

MAXIMUM OUTPUT CURRENT (P8).

(1) With both "Current Adjust" controls turned fully anticlockwise, adjust P8 until a positive output current of less than 50mA is measured on an external meter.

(2) With both "Current Adjust" controls turned fully clockwise, adjust P11 until a current of 50.25 amps is measured on an external meter.

THERMAL OVERLOAD (P6).

With the unit running at 50 amps output and a thermocouple type thermometer probe attached to the top regulator heatsink near the inlet fan (with top and bottom covers in place) block the air inlet and outlet vents. The warning lamp should light and the unit shutdown when a temperature of approximately 100°C is measured. If this is not so, adjust P6 and repeat the operation after allowing 3-4 minutes off load running for cooling.

N.B. Should any further adjustments appear to be necessary all the following instructions should be carried out in the set sequence.

SEPARATION VOLTAGE (P1, P3 and P4).

With the unit output terminals short circuited, turn the output current up from zero to 50 amps. Connect a voltmeter across the reservoir capacitors (C30-33) and adjust P1 to give 8.5 volts whilst adjusting P3 to maintain stability. Optimum stability occurs when the ripple voltage measured with an oscilloscope across C30-33, is uniform from cycle to cycle. Adjust P4 until the voltage just starts to rise.

SHORT CIRCUIT PROTECTION P9 and P10).

Disconnect the lead from pin 16 on the control amplifiers circuit board at it's connection to the reservoir capacitors (C30-C33) near the front of the unit. With the output terminals short circuited adjust the output current from zero to 50 amps. Connect a 0-60 volt variable D.C. power supply (current is less than 5mA) between the positive output terminal and the disconnected wire. Slowly increase the voltage from the variable supply. At approximately 20 volts, output current should start to fall. Adjust P10 so that the change in current is smooth and not a sudden step when varying the voltage about this point. Increase the voltage to 60 volts, and adjust P9 to give an output current of less than 1 amp. Repeat the operation until no further improvement can be made. Remove the variable supply and reconnect the lead from pin 16.

MAXIMUM LINE VOLTAGE (P2).

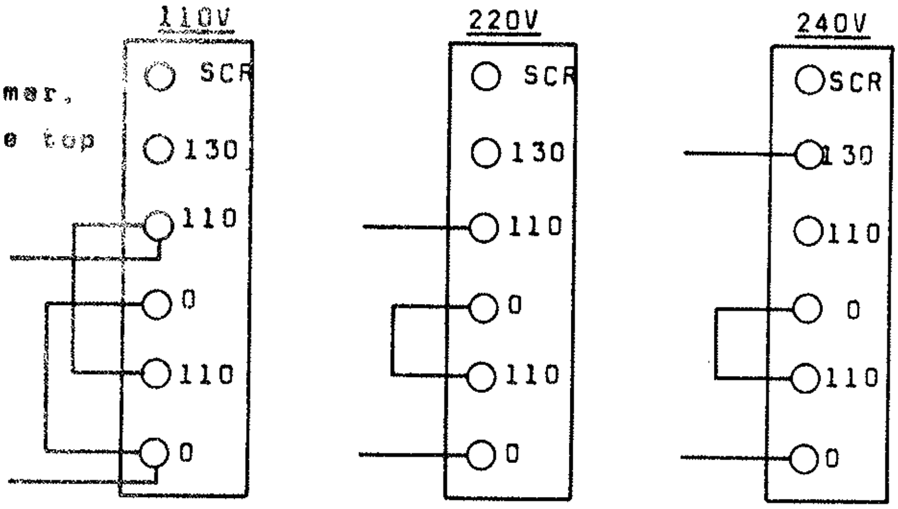
With the unit connected to the mains supply by a "Variac", adjust the input voltage to -8% from nominal with the unit at 60 volts 50 amps output. Adjust P2 until the ripple voltage (measured by an oscilloscope connected across terminals J and K in CV or terminals A and B in CI.) just starts to increase rapidly.

N.B. All trimmers should be locked with a suitable compound after adjustment.

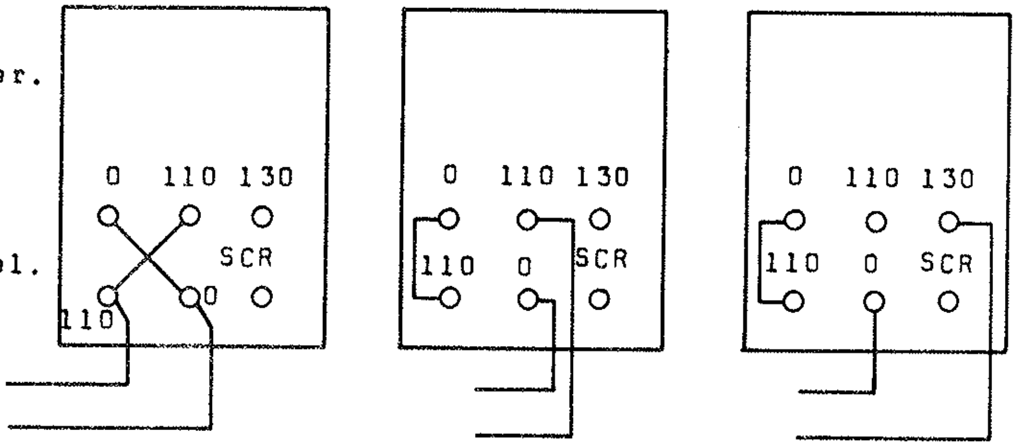
FIGURE 2.

CONNECTIONS FOR OPERATION FROM 110, 220 and 240V MAINS SUPPLY.

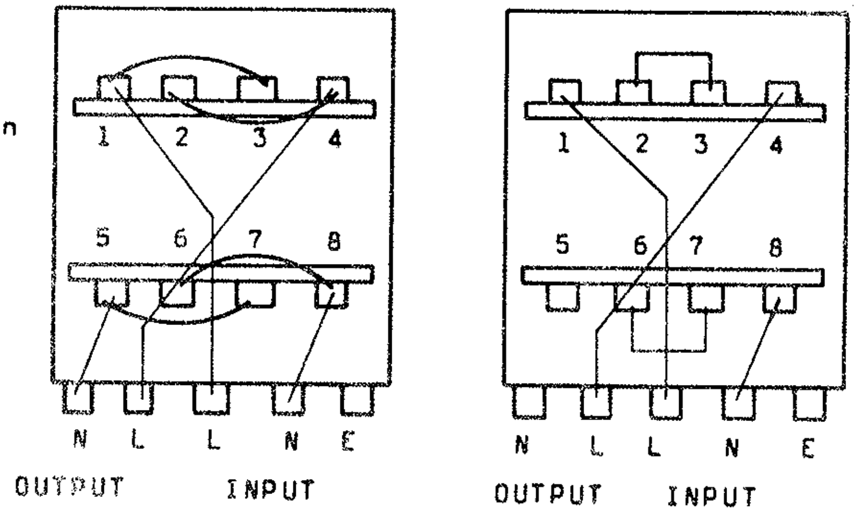
1). Main Transformer. Access: Remove top cover located centrally in unit.



2). Auxillary Transformer. Access: Located behind front panel.



3). Choke. For access and location see Fig.3.

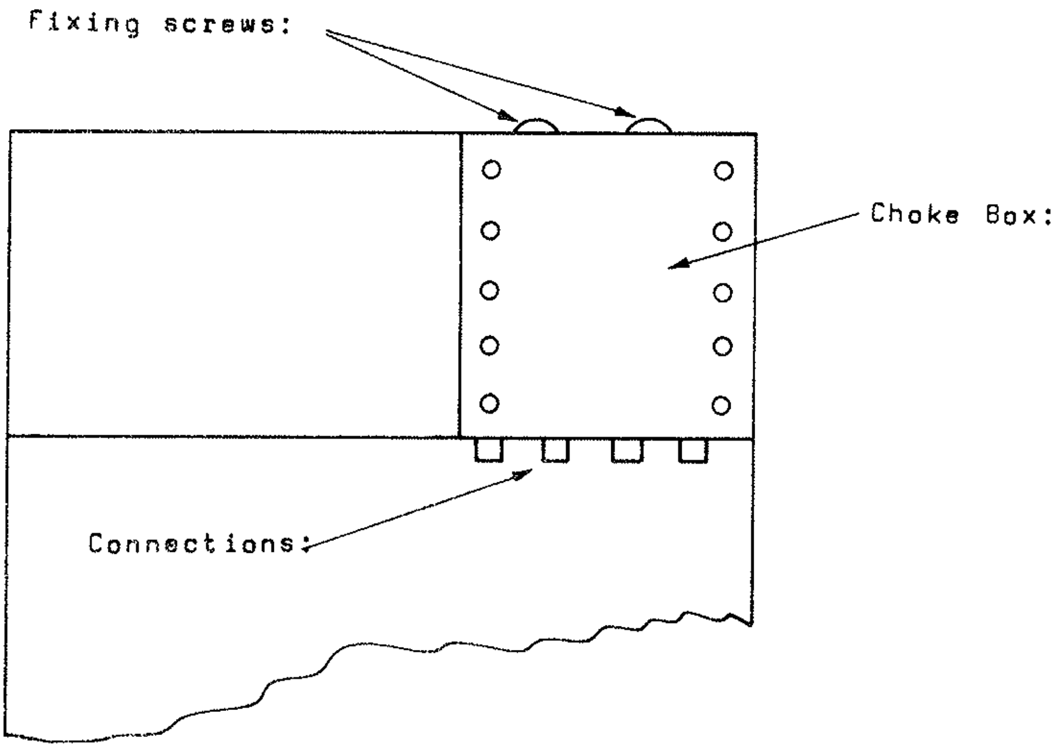


As for 220V

FIGURE 3.

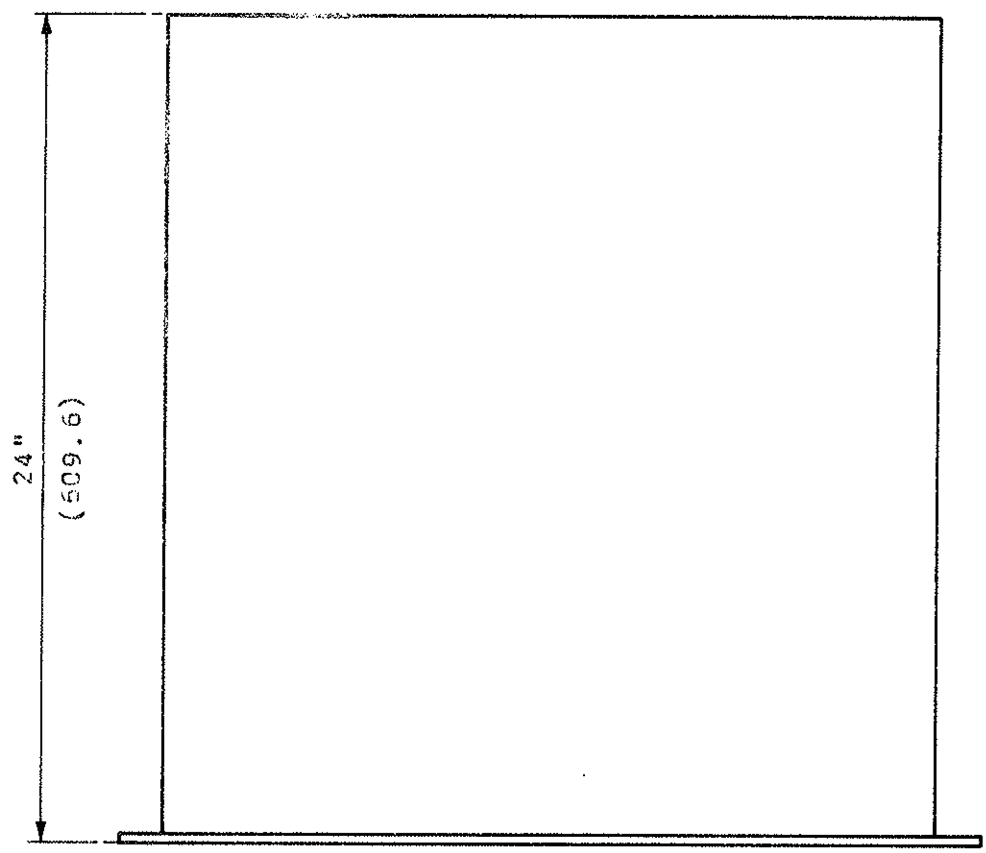
1) Choke: Access and location:

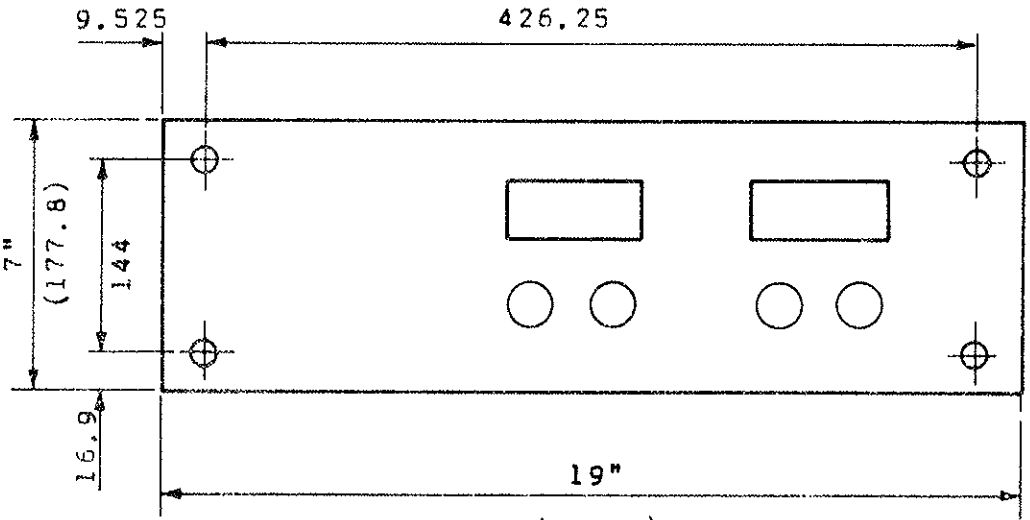
Located on left of rear panel viewed from front of unit.
Remove the lid of the choke box. This then gives access to the choke connections which should be connected as shown in the choke diagram; Fig. 2.



REAR OF UNIT VIEWED FROM BOTTOM:

MECHANICAL SPECIFICATION.





WEIGHT: 79kg (174 lbs).

ERRATA AND ADDENDA

ALTERNATIVE COMPONENTS TO THOSE LISTED ON CIRCUIT DIAGRAM MAY BE USED IN THE EVENT OF SUPPLY DIFFICULTIES. MAJOR CHANGES TO THE DESIGN OR MANUAL ARE LISTED BELOW:-