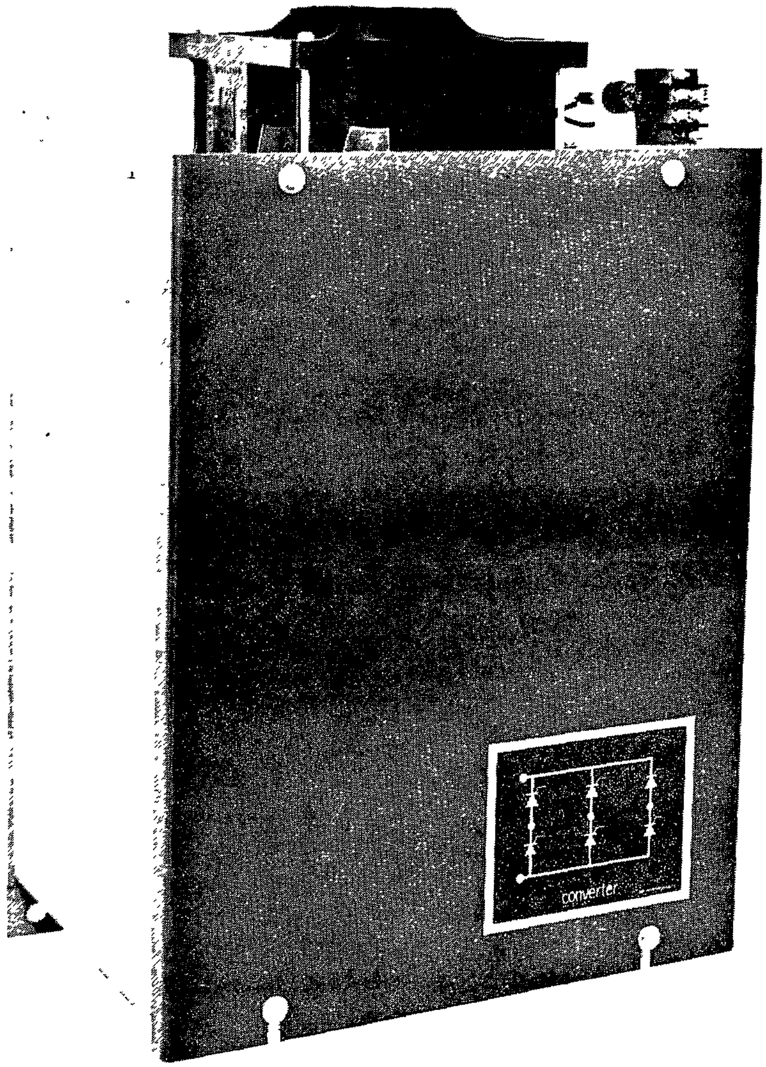
INSTRUCTIONS

GEK-22952A

POWER CONVERSION MODULE
FOR
DC-3061 SCR DRIVES

OPERATION — TROUBLE SHOOTING — REPAIR



MEDIUM MODULE

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company

GENERAL ELECTRIC

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WARNING

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OPERATORS SHOULD NOT STAND ON GROUNDED SURFACES OR BE IN CONTACT WITH GROUND WHEN APPLYING TEST INSTRUMENTS TO TEST POINTS. TEST INSTRUMENTS SHOULD NOT HAVE CHASSIS GROUNDED WHILE TESTS ARE BEING MADE. THUS THEIR CHASSIS WILL BE AT A HIGH VOLTAGE WITH RESPECT TO GROUND DURING TESTING. EXTREME CARE SHOULD BE TAKEN WHILE ATTEMPTING TO ADJUST, TROUBLESHOOT OR MAINTAIN ANY DRIVE SYSTEM DESCRIBED HEREIN.

POWER CONVERSION MODULE
FOR
DC-3061 SCR DRIVES

INTRODUCTION

The DC 3061 Power Conversion Module converts three phase A-C power into adjustable voltage D-C power. The output voltage is controlled by means of gate pulse signals fed from the driver module. The module consists of the power conversion circuit, protective components and circuitry, firing circuitry, and feedback circuitry, all mounted together in one package.

The power conversion circuit is a three phase, full wave bridge, each of its six legs containing a silicon controlled rectifier (SCR). This arrangement can furnish unidirectional current, and can control the voltage output in either polarity as long as output current is drawn; that is, it can power a D-C motor in both the first and fourth quadrants. When two of these modules are connected back-to-back, they can power a D-C motor through all four quadrants.

The SCR conversion module DC-3061 is panel mounted with three removable Heatsink Assemblies plus three pulse transformer cards, current feedback card, voltage feedback assembly and an A-C suppression panel. The power connection points are as indicated in Figure 22 while the control leads are terminated by two plug in connectors (1CA & 2CA).

RATINGS AND SPECIFICATIONS

1. A-C Power Input

(a) Voltage — three phase;
low voltage — 230 volts +10%, −5%;
high voltage — 460 volts +10%, −5%

(b) Frequency — 60 or 50 Hz

2. D-C Power Output

(a) Voltage — controllable over the following maximum ranges at −5% A-C voltage:

Conversion Type	Controllable D-C Voltage Range	
	Motoring	Regenerating
Low Voltage	0 to 285 volts	0 to 250 volts
High Voltage	0 to 570 volts	0 to 500 volts

(b) Current — depending on cooling, overload requirements and ambient temperature, the conversion module rating is matched to the D-C motor rating.

3. Control Input

(a) Gate pulses — six gate pulses spaced 60 degrees apart, each capable of being phase shifted over a range of 150 electrical degrees; each pulse to be at least 15 volts in magnitude (at 15 milliamps loading) and be at least 10 microseconds, but no more than 50 microseconds, in width.

(b) Power supply: +20 volts D-C for operation of gate pulse amplifying circuitry.

4. Control Output

(a) Voltage feedback — 0 to ±10 volts D-C for rated operating voltage range.

(b) Current feedback — 0 to +5 volts D-C for rated operating current range.

(c) Thermostat interlock — normally closed interlock which opens for excessive SCR heatsink temperature.

PRINCIPLES OF OPERATION

It will be helpful in understanding the following theory of operation to refer to the SCR conversion module elementary diagrams. A copy of the diagram, which applies to the specific drive furnished, will be found in the diagram section.

SCR POWER CONVERSION

The function of converting A-C power to adjustable voltage D-C power is performed by silicon controlled rectifiers (SCR's). The SCR is a semiconductor device which can block voltage in both directions, but is capable of conducting current in one direction when "fired" by a proper gate signal. With reverse voltage applied, the SCR behaves the same as a diode rectifier. With forward voltage applied, the SCR will block current until it is switched into the conducting state by means of a gate signal. The SCR will remain in the conducting state even after gate signal is removed, as long as forward current is maintained. Controlling the instant in time, relative to the A-C voltage wave, when the gate signal is applied to the SCR controls the amount of D-C voltage and current that is furnished to the load.

The SCR conversion module uses six SCR's connected together to form a three phase, full wave bridge. Each SCR is mounted on an aluminum heatsink. The heatsink transmits the heat produced inside the SCR to the surrounding air where the forced cooling discharges it from the case.

The operation of the three phase SCR bridge in converting A-C power to adjustable voltage D-C power is best explained by referring to Figures 1 through 6. These figures show the A-C voltage and D-C voltage wave shapes into and out of the SCR bridge, plus the voltage wave shape across each SCR. The first three figures show control of the SCR bridge in the motoring mode; that is, with positive voltage output and positive current output, or first quadrant operation. The last two figures show control of the SCR bridge in the regenerative mode; that is, with negative voltage output and positive current output, or fourth quadrant operation. The voltage wave shapes shown in these figures are all based on loaded operation. This means that for the regenerative cases, the load must be capable of delivering power (that is, both voltage and current) to the SCR conversion bridge.

Figure 1 shows the voltage wave shapes for the zero degree phase back condition, or full advance. This is not a normal operating condition since it is the absolute maximum output voltage obtainable. It is shown to provide a starting point to understanding SCR operation. To obtain this operating condition each SCR must be fired as soon as forward voltage appears across it. The operation is therefore the same as if the bridge consisted of diode rectifiers.

Figure 2 shows the effects of delaying the SCR firing 30 degrees in time with respect to the zero phase back condition. Note that the average voltage level has decreased.

Figure 3 shows the voltage wave shapes for the 60 degree phase back condition. The D-C voltage wave varies from almost the peak value to zero, six times a cycle. This would produce high peak to average D-C current in the D-C motor armature if it were not for the smoothing effect of armature inductance. (See Figure 18 in the "Trouble Shooting" section.)

Figure 4 shows the 90 degree phase back condition under sufficient load to keep current continuous. Notice that the average voltage is actually zero. This would be motor stall condition if the IR drop voltage were neglected. Since current, and therefore IR drop, can only have positive values, the motor CEMF would have to be slightly negative in practice to obtain zero terminal voltage, loaded operating condition.

Figure 5 shows the voltage wave shapes for the 120 degree phase back condition. This is a regenerative operating condition since the D-C voltage is negative and the D-C current is positive. This condition is obtained when motor rotation has been reversed by action of the motor load. The SCR drive is holding back by means of positive current, and therefore positive torque, to oppose the negative speed and voltage.

Figure 6 shows the 150 degree phase back condition, which is the maximum allowable phase retard. The current must be switched (commutated) from one A-C supply line to the next while correct polarity voltage still exists to turn off the first SCR. If the SCR firing is retarded to the 180 degree phase back condition, there is no commutating voltage available to turn off the preceding SCR, and a plugging condition will result. Therefore a 30 degree margin for SCR commutation is reserved.

PROTECTIVE COMPONENTS

The protective components described below are all included in the SCR conversion module to protect the SCR's.

The AC suppression panel has thyrectors which are connected across the A-C supply lines to suppress voltage transients. They are special selenium rectifiers which break down momentarily to limit voltage transients to a safe value. After absorbing the energy of the transient, they reform themselves. Series resistor-capacitor networks are also connected across the A-C supply lines, and across the D-C output, to suppress voltage transients.

Additional R-C networks are connected across each SCR, both to suppress voltage transients and to limit the rate of rise of voltage (DV/DT) across the SCR. If the DV/DT applied to the SCR in the forward direction exceeds a certain value, the SCR could be turned on.

Chokes are placed in the SCR bridge to limit the rate of rise of voltage (DV/DT) applied to each SCR and also the rate of rise of current (DI/DT) through the SCR when it switches on. If the (DI/DT) through the SCR at turn-on exceeds a certain value, the cell may be destroyed. The combination of chokes and R-C circuits across the SCR's limit both DV/DT and DI/DT to well within safe operating limits. The chokes (reactors) also act with the R-C circuits and thyrectors to limit A-C line voltage transients to safe limits.

A thermostat mounted on an AC bus attached to a heatsink monitors heatsink temperature. This protects against high ambient temperatures, loss of cooling air or excessive overloading of the SCR conversion module. Operation of this thermostat shuts down the drive through the monitor card in the driver.

SCR FIRING CIRCUITRY

The function of the firing circuitry in the SCR conversion module is to amplify the gate pulse signals from the driver and to electrically isolate the driver from the SCR's. This isolation function is achieved by means of pulse transformers which isolate the SCR gate leads (which are at A-C line potential) from the gate pulse circuitry. Amplification is achieved by single stage transistor amplifiers feeding the pulse transformers. This use of gate pulse signal amplification in each SCR conversion module enables a single set of gate pulse generator cards (in the driver) to control several paralleled SCR conversion modules. All of the SCR firing circuitry is contained on a printed circuit card which is mounted in the SCR conversion module.

FEEDBACK CIRCUITRY

The feedback circuitry includes both current feedback and voltage feedback elements. The voltage feedback circuit is a simple resistor bridge which reduces the rated output voltage of the SCR conversion module to a value of 10 volts for feedback to the driver. There are two resistor bridge ratios used; a 25 to 1 voltage reduction for 250 volt conversion modules and a 57 to 1 voltage reduction for 500/550 volt conversion modules. The voltage feedback is taken from terminals V1 and V2 (as shown on the SCR conversion module elementary diagram). This symmetrical circuit allows cross connection of the voltage feedbacks at the driver when using back to back SCR conversion modules.

The current feedback circuitry consists of three A-C current transformers plus rectifiers and loading circuitry. The current transformers are mounted on the incoming A-C supply lines of the SCR conversion module. The output of each current transformer is rectified and the three rectified outputs are summed together. This rectification and summation of the three A-C line currents produces a current signal of the same wave shape and having a constant ratio of magnitude to the D-C output current of the SCR conversion module. The current signal is changed into a voltage signal by means of a selected value of loading resistance. The correct loading resistor is chosen, depending on the drive rated current, by means of the XA to XD taps. The correct loading produces about a 5 volt current feedback signal at rated drive current. Diode D803 produces a .6 volt output at very low currents to operate the lockout circuits in the reversing driver. Diode D804 is used only when SCR conversion modules are paralleled, to prevent the operation of one SCR conversion module from affecting another when the current feedbacks are summed in the signal distribution assembly. With these diodes in the circuit, if any one conversion module is overloaded it will be the determining current feedback to the driver. All of the current feedback circuitry is contained on a printed circuit card mounted in the SCR conversion module.

OPERATION AND ADJUSTMENTS

The SCR conversion module is ready for operation as soon as the five power leads are connected to the connection points (see Figure 22) and the two control cables are plugged into the receptacle on the supporting rack. The A-C power leads must be connected to the correct terminals as labeled to maintain correct phase sequence. The two control cables cannot be plugged into the wrong receptacles or be plugged in upside down.

CURRENT FEEDBACK LOADING SELECTOR

The only adjustment in the SCR conversion module is the selection of the correct loading resistor on the current feedback card. The table on the SCR conversion module elementary diagram gives the correct tap (XA to XD) to use for the specific drive horsepower rating. These taps are fast-on connectors on the current feedback card, the movable jumper being plugged into one of them to select the correct loading resistance. This selection has been made at the factory and should not be changed unless a change in protective current feedback or instantaneous overcurrent trip range is desired which cannot be taken care of by adjustments in the driver.

TROUBLE SHOOTING

GENERAL APPROACH

When incorrect operation is first noticed, it is often possible to reduce the overall servicing time by studying the symptoms in order to localize the trouble. A good understanding of the functional operation, as explained in the "Principles of Operation" section, will be very helpful in isolating the problem. A systematic check of voltage wave shapes and comparison of them with the correct readings, as given later in this section, should reveal the source of many malfunctions.

The use of a good quality oscilloscope is required to properly trouble shoot this equipment.

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The use of an oscilloscope with a differential amplifier will result in much greater safety to operating personnel, since the oscilloscope chassis may then be grounded. However, much greater care in the selection of probes and leads and in the adjustment of the oscilloscope must be used to produce accurate readings. The D-C balance and the voltage gain calibration of each channel must be accurately adjusted to obtain common mode voltage rejection. When properly adjusted, good results can be obtained with the differential amplifier connected oscilloscope for most readings. However, unless the common mode voltage rejection is perfect, it may be difficult to obtain accurate readings of low voltages such as SCR gate signals.

No matter which oscilloscope connection is used, voltage attenuating probes will be required for most readings. The probes should be adjusted for correct frequency compensation using the voltage calibrator as a square wave standard. The vertical gain and the sweep speed should also be calibrated to allow interpretation of observations.

CHECKING FOR MALFUNCTIONS

NOTE

WHEN USING AN OSCILLOSCOPE WITHOUT A DIFFERENTIAL AMPLIFIER TO CHECK THE OPERATION OF THE PULSE TRANSFORMER CARD, THE COMMON (CHASSIS) LEAD OF THE OSCILLOSCOPE SHOULD BE CONNECTED ONLY TO THE F OR C TERMINALS. CONNECTING THE OSCILLOSCOPE COMMON LEAD TO ANY OTHER POINT(S) ON THIS CARD MAY CAUSE IMPROPER OPERATION OF THE DRIVE BY PERMITTING FIRING OF SCR's AT INCORRECT TIMES.

1. **Missing output voltage and current pulses causing unbalanced wave shape**

   (a) Check for firing pulses at input to pulse transformer card (terminals DA and DB to HA) and at output of card to SCR's (terminals AG and AC, BG and BC, etc.), and compare with those given in Figures 20 and 21 of the voltage wave shape check list. If no input is present, check the pulse train outputs of the driver gate pulse generators (see GEK 11016A). If input is OK but no output is present, pulse transformer card must be defective and should be replaced.

(b) Check SCR's to see if one of them is open or will not fire. Use the test circuit and follow the instructions under "Checking SCR's" in this section.

2. **Cannot obtain any output voltage or current**

(a) Check for firing pulses at input to pulse transformer card (terminals DA and DB) and at output of card to SCR's (terminals AG and AC, BG and BC, etc.). If no input is present, check the pulse train outputs of the driver gate pulse generators (see GEK 11016A) and the cable connections between the driver and SCR conversion module. If inputs are OK but no outputs are present, check 20 volt power supply to pulse transformer card terminals A and B. If no voltage is present, check power input.

(b) Check for A-C power at incoming leads T1, T2 and T3 of SCR conversion module.

3. **One large output voltage and current pulse which cannot be turned off and causes unbalanced wave shape**

(a) Check for one SCR not being able to hold off forward voltage. Disconnect the pulse train cable (1CA) from the SCR conversion module and apply A-C power. Connect oscilloscope across each SCR, one at a time (T1 - DC1, T2 - DC1, T3 - DC1, DC2 - T1, DC2 - T2 and DC2 - T3), and check voltage wave shape across SCR in the forward direction. Observe for SCR firing, or the voltage being lower across one SCR in the forward direction than the others. Also check SCR's with multimeter for excessive leakage as explained under "Checking SCR's" in this section. If a defective SCR is suspected, it should be replaced and the module rechecked.

(b) Check gate pulse generator balance (see driver trouble shooting notes in GEK 11016A).

4. **SCR conversion module trips out A-C breaker when energized**

(a) Check for shorted SCR (see instructions under "Checking SCR's" in this section).

(b) Check for loose power connections or shorted bus bar. Use multimeter selected to read ohms to check for shorts.

5. **Paralleled SCR conversion modules not sharing current**

(a) Check for firing pulses into and out of pulse transformer card, for a defective SCR, or for presence of A-C power at module terminals. See instructions under malfunctions number 1, 2 and 3 above.

6. **No current feedback signal or distorted current feedback signal**

(a) Check current feedback signal at test points A1 and A2, and compare with those given in Figures 18 and 19 of the voltage wave shape check list. If missing or distorted, check output of current transformers at terminals J1 and J2, J3 and J4, and J5 and J6 on the current feedback card, and compare wave shapes with those given in Figures 16 and 17.

If the current transformer outputs are all OK, but some of the pulses are missing at card output terminals A1 and A2, the current feedback card is defective and should be replaced. If the output of one of the current transformers is missing or distorted, the current transformer may be defective. Before removing the conversion module to replace the suspected current transformer, try to check the D-C current on the oscilloscope across a shunt to determine if a defective SCR or blown leg fuse is causing the trouble.

7. **No voltage feedback signal**

(a) Check voltage feedback signal at driver and compare with wave shapes given in Figures 8 and 9, and with wave shape measured across DC1 and DC2 power terminals. If no signal, check resistors and continuity of RES12, RES13, and RES14 circuit.

8. **Thermostat open, or trips often**

(a) If thermostat trips, shut off A-C power immediately and carefully feel SCR heatsinks. If all heatsinks are too hot to hold, check for air flow obstruction and for correct fan air flow. If only a few heatsinks are hot, check for unbalanced operation (see malfunctions number 1, 3 and 5 above). If none of the heatsinks seem excessively hot, the thermostat may be defective.

9. Erratic operation with motor load

(a) Check for correct phase sequence; should be 1-2-3 for input power terminals T1, T2, and T3.

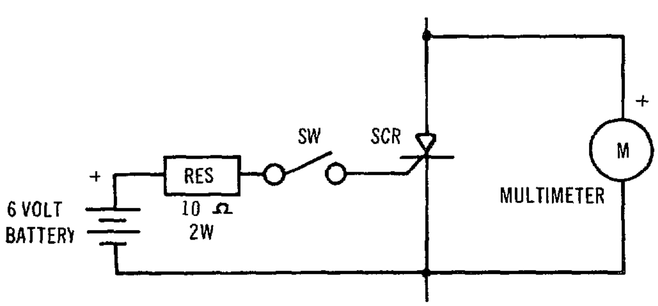
(b) Check for excessive DV/DT spikes across SCR's and wide voltage notches in A-C voltage wave. If a number of large SCR drives are operating off of the same A-C supply, line filtering may be necessary. Consult the General Electric Co.

CHECKING SCR's

Disconnect the A-C power and make sure the D-C armature loop contactor is open. Using a multimeter selected to read ohms on the times - 1K scale, check the forward and reverse resistance of each individual SCR cell. This is done by reading across power terminals T1 and DC1, T2 and DC1, T3 and DC1, DC2 and T1, DC2 and T2, and DC2 and T3. If the conversion module contains fuses for paralleling duty, test points R1, R2, R3 etc. should be used instead of terminals T1, T2 and T3. (See conversion module elementary diagram.) Good or faulty SCR's will give the following typical readings:

SCR Description	Forward Reading	Reverse Reading
Good SCR	100K to Infinity	100K to Infinity
Shorted SCR	Zero	Zero
Inoperative SCR	1 to 2K	100K to Infinity
Open SCR	100K to Infinity	100K to Infinity

Since an open SCR will give about the same resistance reading as a good SCR, another method must be used to find this type of fault. It should be pointed out however, that practically all cells fail by shorting and very few by opening. If an open SCR is suspected, or if it is desired to check the switching operation of an SCR, the following circuit should be used:



The multimeter is selected to read ohms on the 1K scale, and is connected to read the forward resistance of the SCR. When switch SW is closed, the forward resistance of a good SCR will change from a high value (100K to infinity) to a low value (1 to 10K). When the switch is opened, a good SCR will revert to its high forward resistance or blocking state if the holding current source (multimeter battery) is momentarily removed. A faulty SCR will not switch, remaining in either an open or a conducting state.

If any SCR's are suspected of being faulty from the above resistance checks, the suspected SCR heatsink assembly should be removed from the module. See instructions in the "Repair and Replacement" section of this instruction. After the SCR assembly has been disconnected, recheck the forward and reverse resistances before replacing the SCR heatsink assembly. This should be done before an SCR is definitely classified as damaged or faulty, since a fault in another SCR of another part of the circuitry can produce a faulty reading from a good SCR before it is disconnected from the circuit.

VOLTAGE WAVE SHAPE CHECK LIST

Voltage Wave Shape	Fig. No.
A-C voltage input, under load	7
D-C voltage output, motoring, under load	8
D-C voltage output, motoring, no load	9
D-C voltage output, regenerating, under load	10
D-C voltage output, regenerating, no load	11
SCR cell voltage, motoring, under load	12
SCR cell voltage, motoring, no load	13
SCR cell voltage, regenerating, under load	14
SCR cell voltage, regenerating, no load	15
A-C current, full load	16
A-C current, no load	17
D-C current, full load	18
D-C current, no load	19
Firing pulse train input (to card)	20
Firing pulse train across SCR gate	21

Also refer to the D-C and SCR voltage wave shapes given in "Principles of Operation" section as Figures 1 through 6. These diagrams do not show firing notches but are otherwise similar to actual readings.

REPAIR AND REPLACEMENT

DC-3061 SCR CONVERSION MODULE (Figures 22 and 23)

1. Removal of Heatsink Assembly From Conversion Module Case

(a) Remove the front cover from the module by removing the four retaining screws.

(b) Remove the PULSE TRANSFORMER CARD SCR Gate and Cathode leads from stab-on terminals and disconnect the plug for that card at the base of the module (1PG, 2PG, or 3PG). Remove the two retaining screws of the PULSE TRANSFORMER CARD ASSEMBLY (red cover) and lift out.

(c) Remove Heatsink Assembly top and bottom connection bolt and center retaining nut and slide Heatsink Assembly (including black insulation cover as indicated in Figure 24) from module.

NOTE

HEATSINK ASSEMBLY CAN ONLY BE INSTALLED IN THE PROPER ORIENTATION DUE TO THE GUIDE PIN AS INDICATED IN FIGURE 23.

2. Replacement of Heatsink Assembly

(a) Repeat the above steps in reverse by installing removed hardware and reconnecting all wires and plugs.

0° FIRING ANGLE

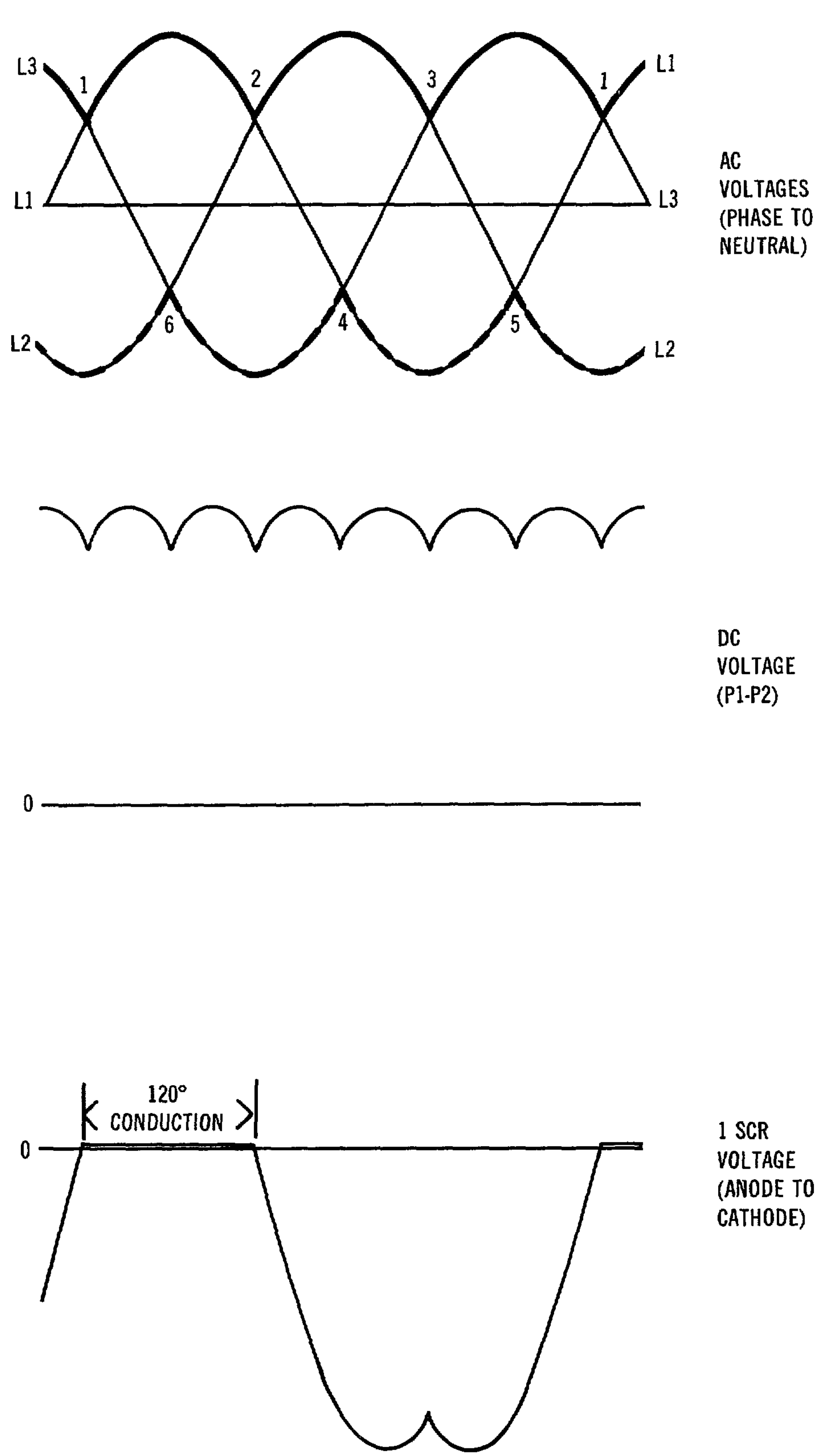


FIGURE 1

30° FIRING ANGLE

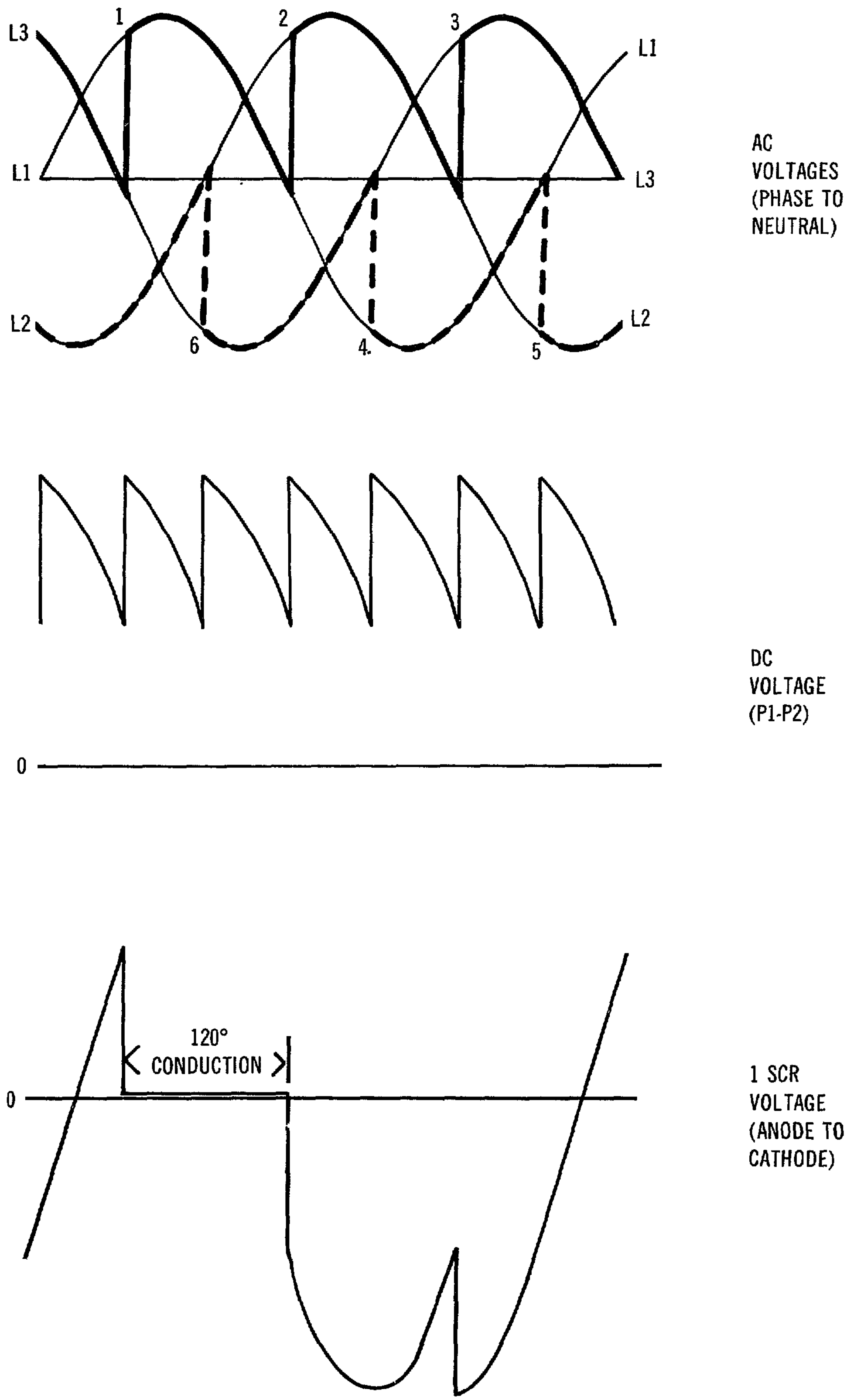


FIGURE 2

60° FIRING ANGLE

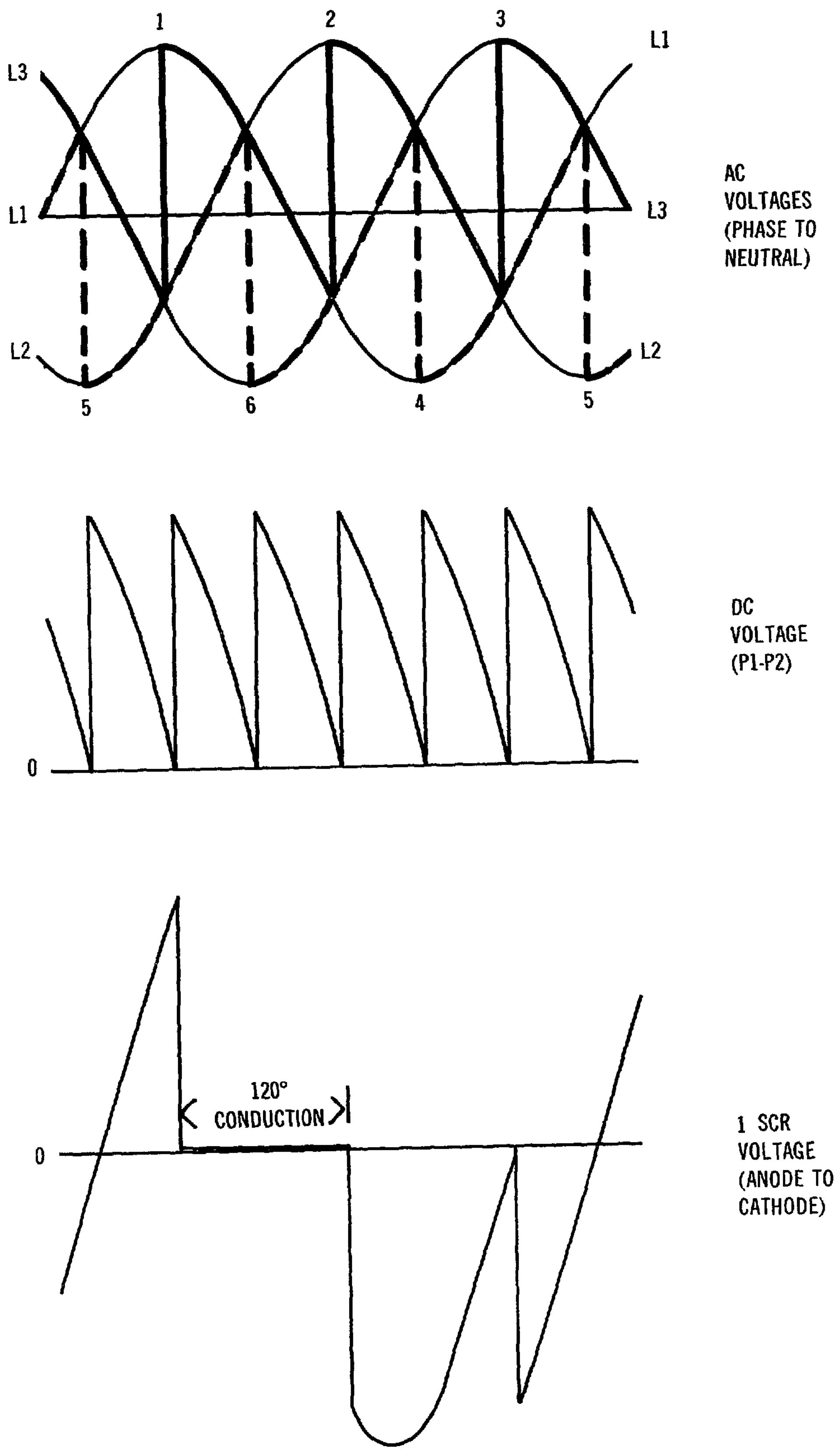


FIGURE 3

90° FIRING ANGLE

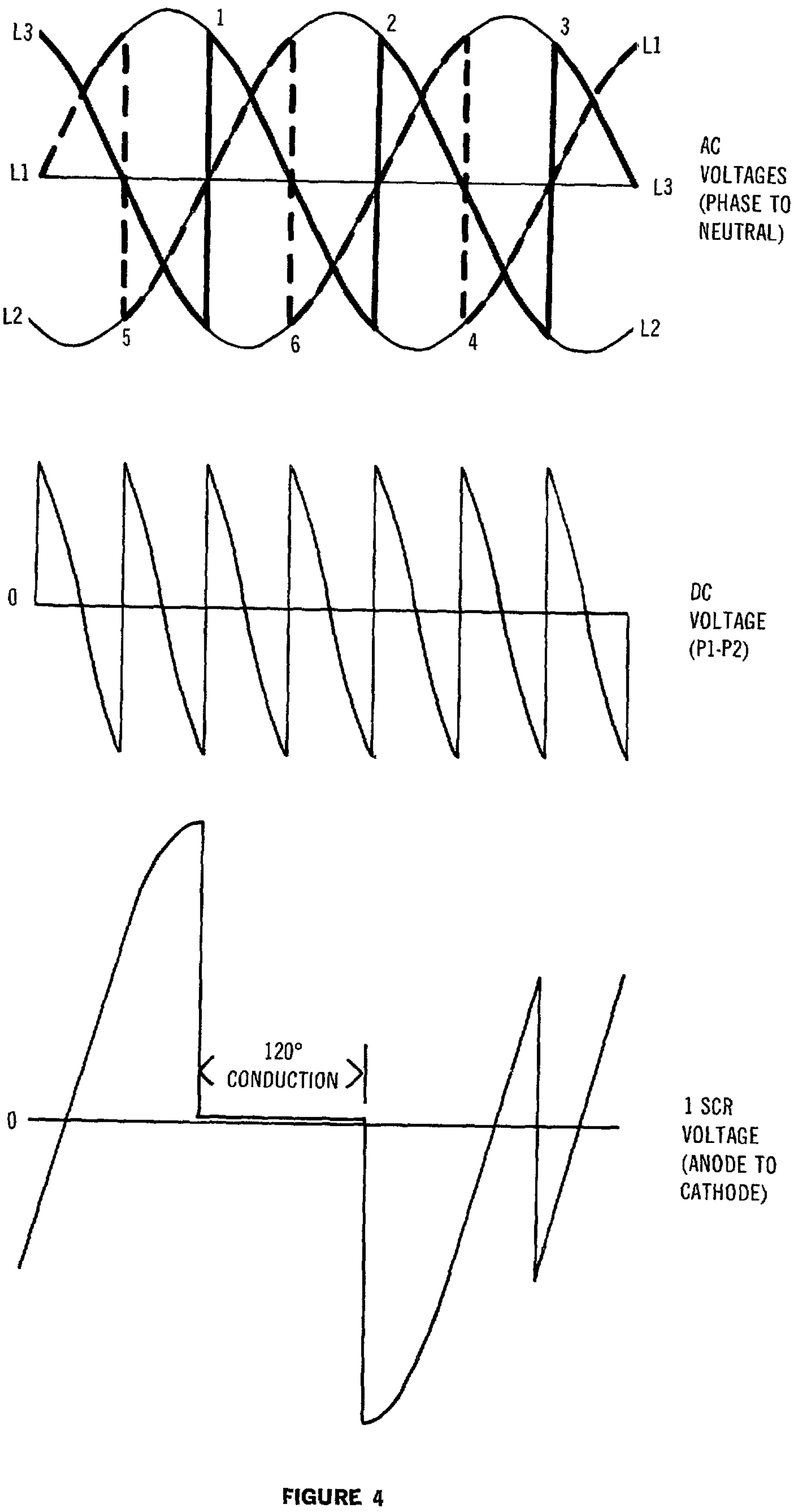


FIGURE 4

120° FIRING ANGLE

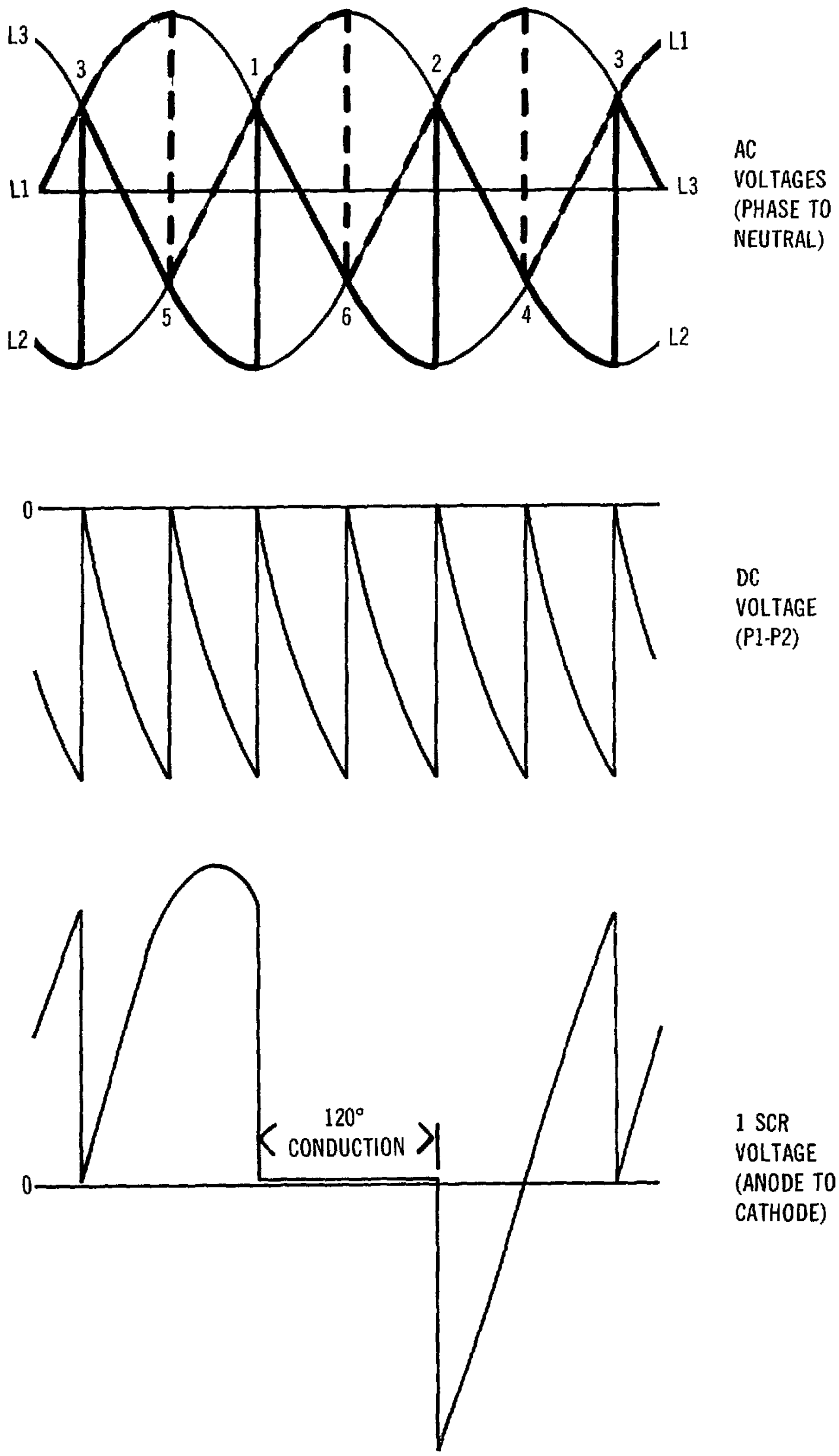


FIGURE 5

150° FIRING ANGLE

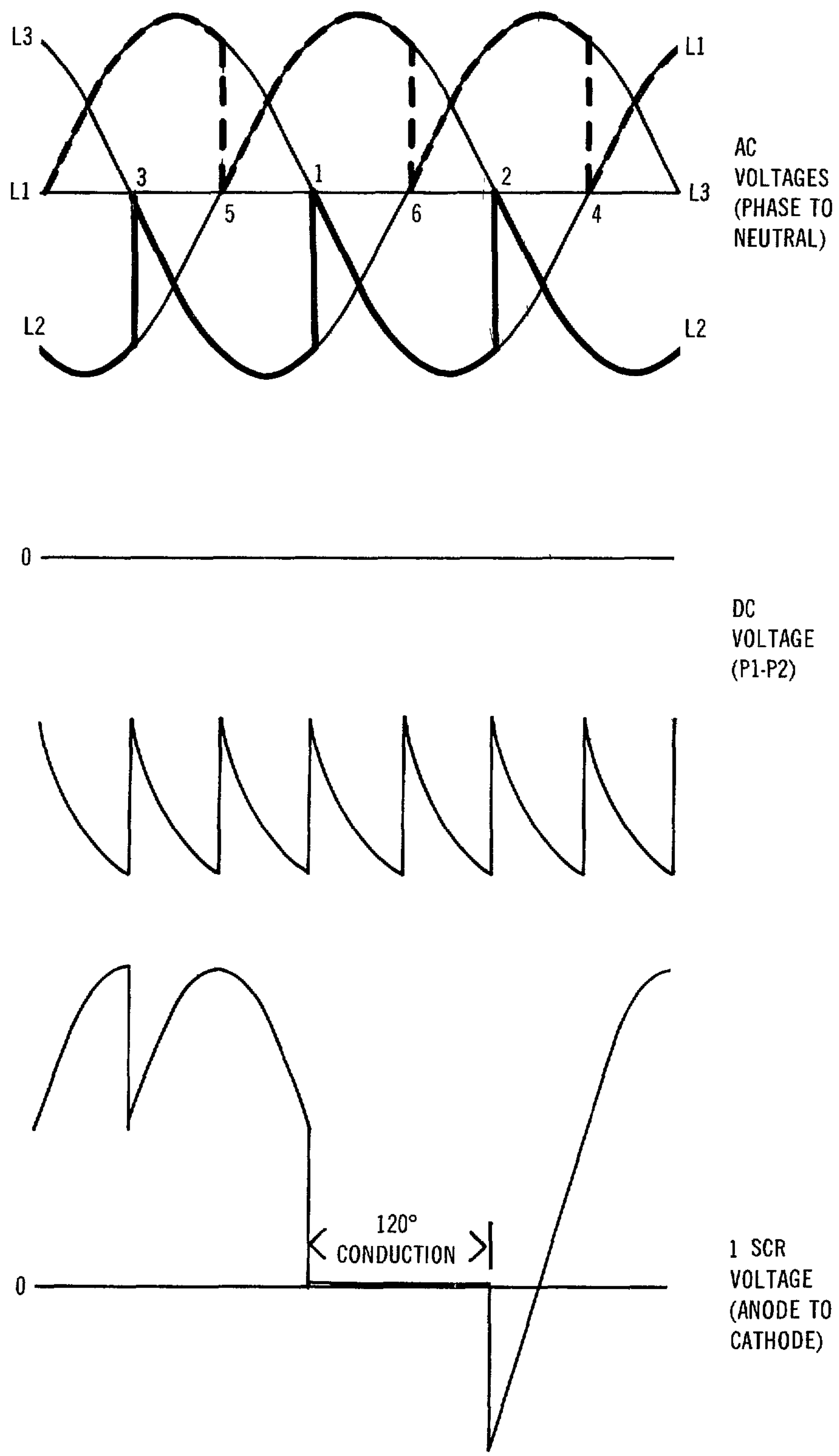
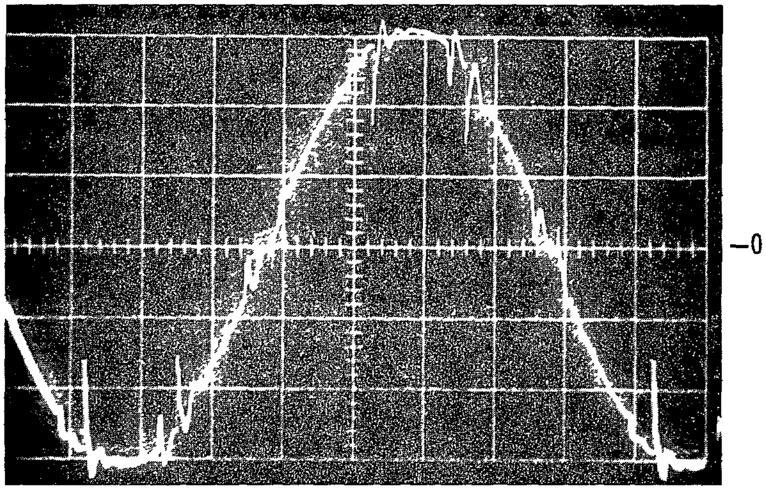


FIGURE 6

AC VOLTAGE INPUT (UNDER LOAD)



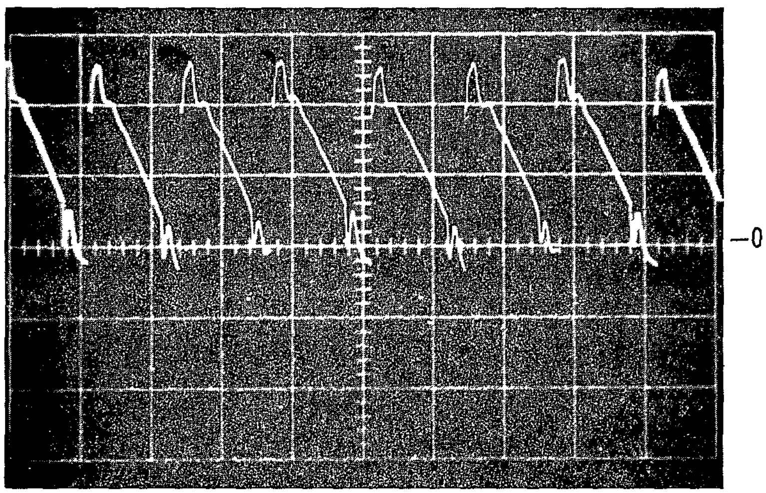
CALIB.

VERT.
100 VOLTS/CM

HORIZ.
2MS/CM

FIGURE 7

DC VOLTAGE OUTPUT (MOTORING, UNDER LOAD)



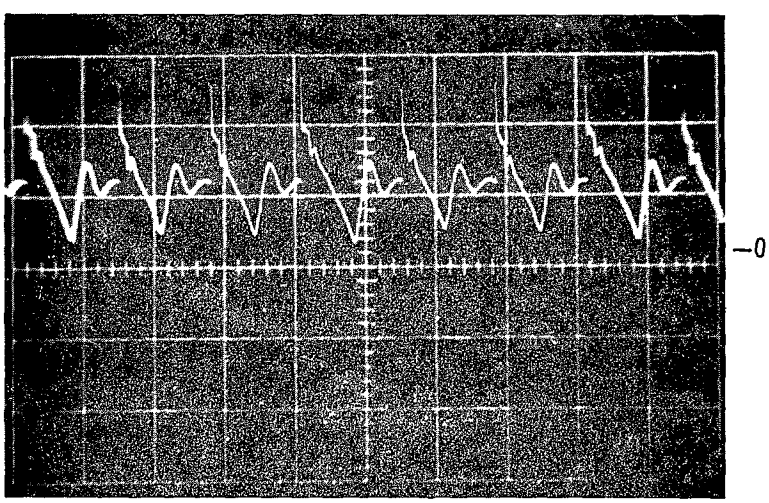
CALIB.

VERT.
100 VOLTS/CM

HORIZ.
2 MS/CM

FIGURE 8

DC VOLTAGE OUTPUT (MOTORING, NO LOAD)



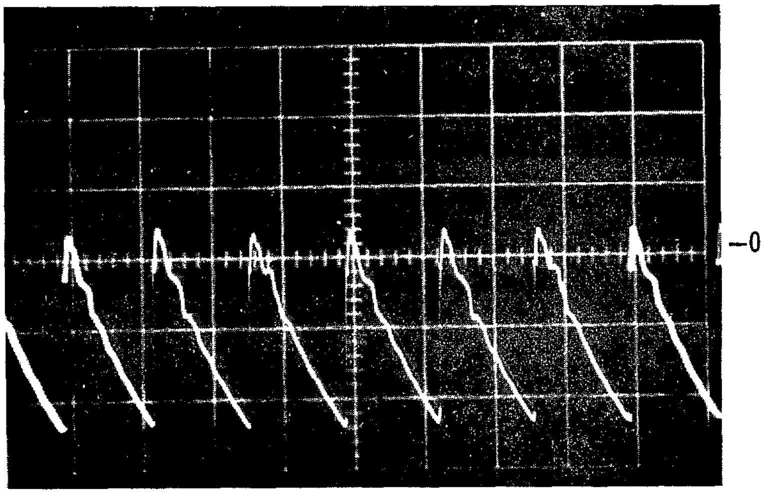
CALIB.

VERT.
100 VOLTS/CM

HORIZ.
2 MS/CM

FIGURE 9

DC VOLTAGE OUTPUT (REGENERATING, UNDER LOAD)



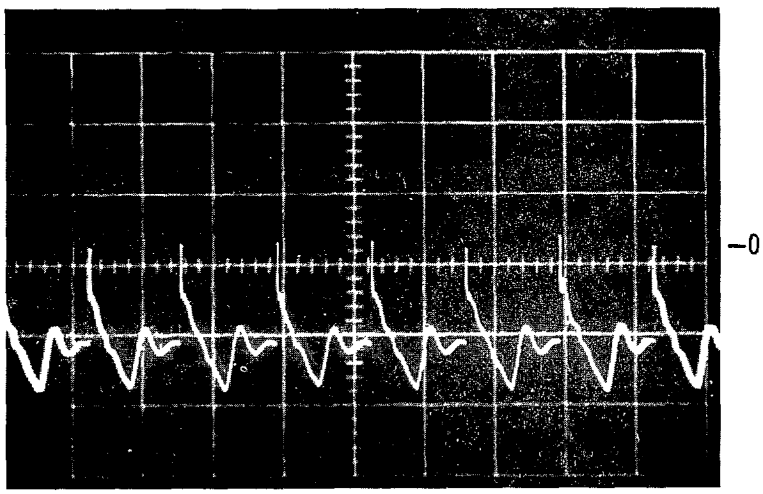
CALIB.

VERT.
100 VOLTS/CM

HORIZ.
2 MS/CM

FIGURE 10

DC VOLTAGE OUTPUT (REGENERATING, NO LOAD)



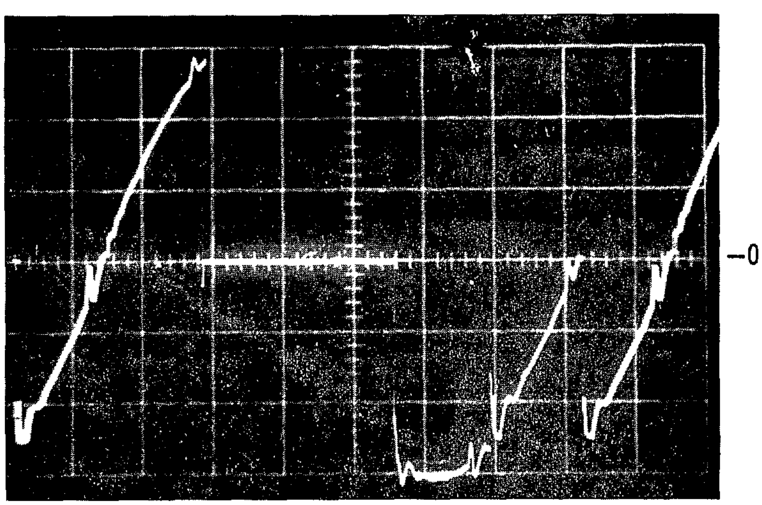
CALIB.

VERT.
100 VOLTS/CM

HORIZ.
2 MS/CM

FIGURE 11

SCR CELL VOLTAGE (MOTORING, UNDER LOAD)



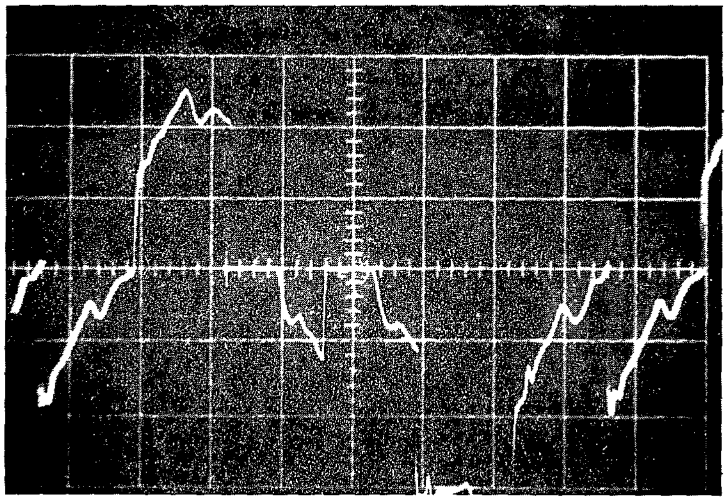
CALIB.

VERT.
100 VOLTS/CM

HORIZ.
2 MS/CM

FIGURE 12

SCR CELL VOLTAGE (MOTORING, NO LOAD)



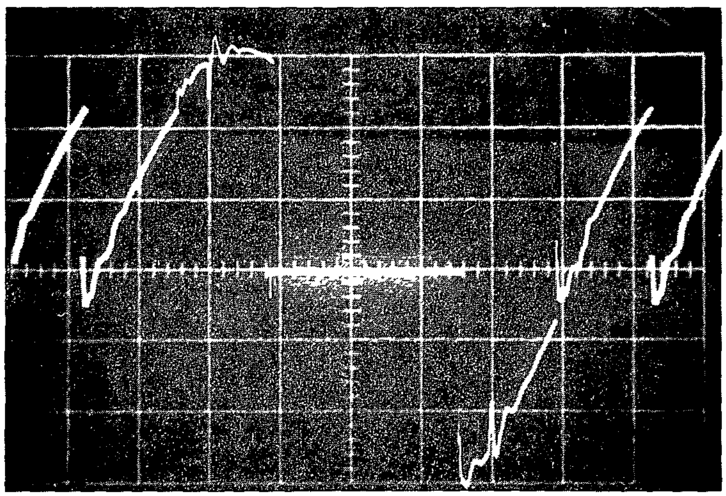
CALIB.

VERT.
100 VOLTS/CM

HORIZ.
2 MS/CM

FIGURE 13

SCR CELL VOLTAGE (REGENERATING, UNDER LOAD)



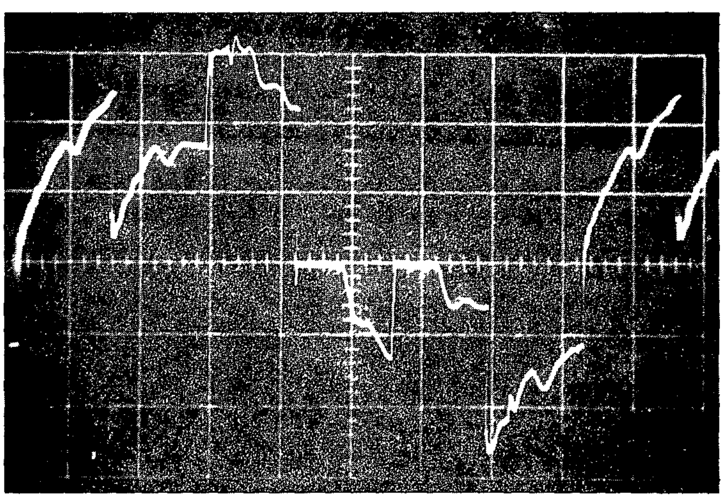
CALIB.

VERT.
100 VOLTS/CM

HORIZ.
2 MS/CM

FIGURE 14

SCR CELL VOLTAGE (REGENERATING, NO LOAD)



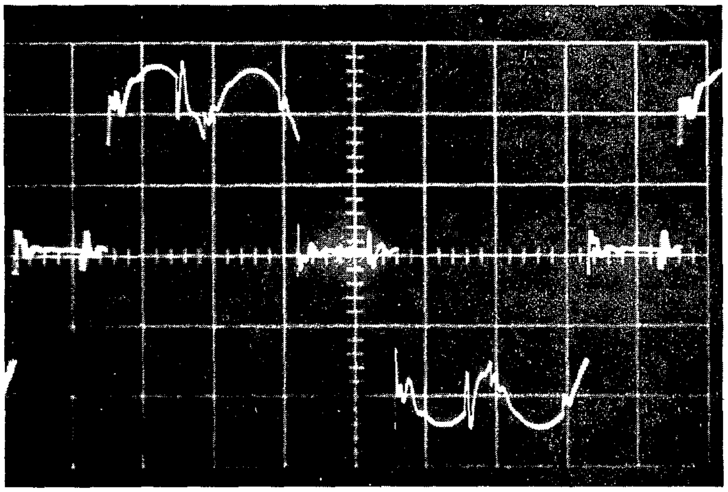
CALIB.

VERT.
100 VOLTS/CM

HORIZ.
2 MS/CM

FIGURE 15

AC CURRENT (FULL LOAD)



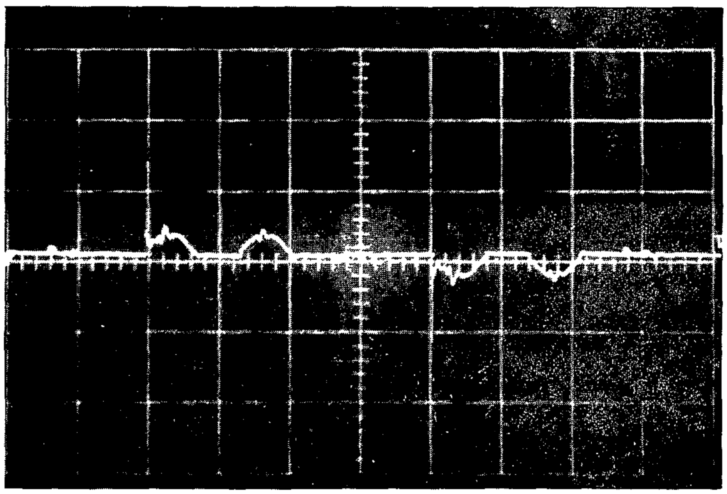
—0

CALIB.

HORIZ.
2 MS/CM

FIGURE 16

AC CURRENT (NO LOAD)



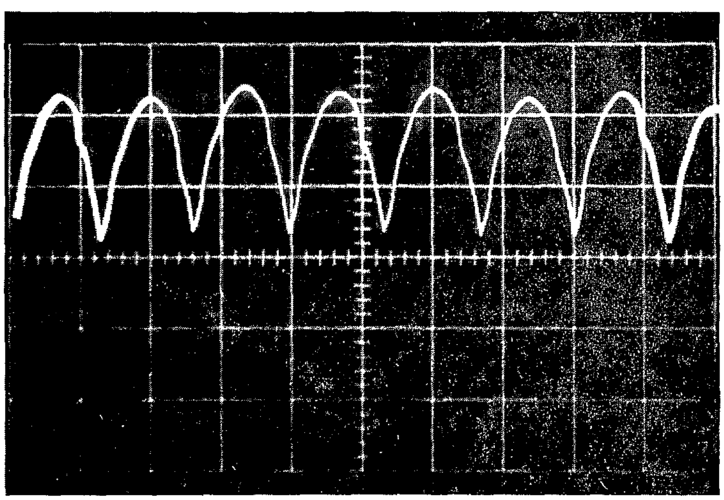
—0

CALIB.

HORIZ.
2 MS/CM

FIGURE 17

DC CURRENT (FULL LOAD)



—0

CALIB.

HORIZ.
2 MS/CM

FIGURE 18

DC CURRENT (NO LOAD)

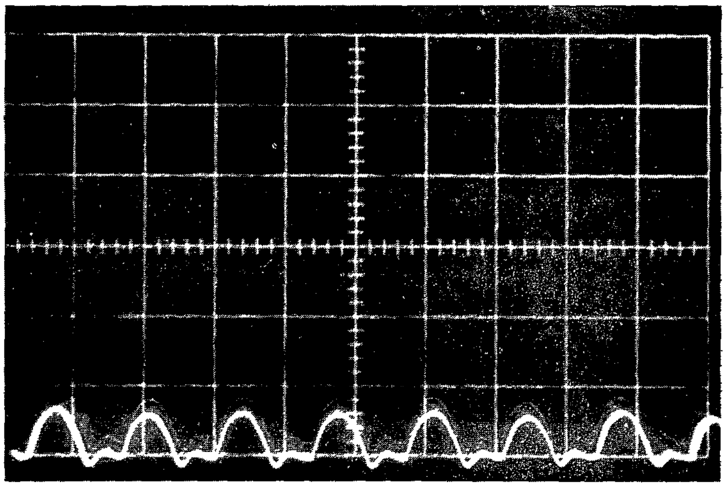


FIGURE 19

FIRING PULSE TRAIN INPUT

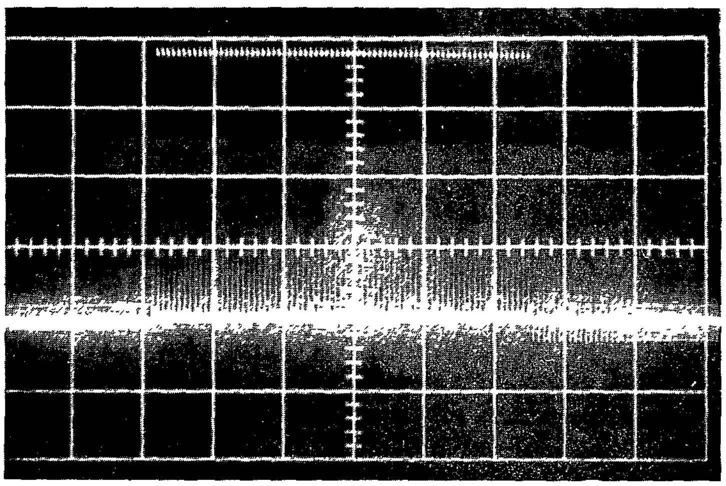


FIGURE 20

FIRING PULSE TRAIN ACROSS SCR GATE

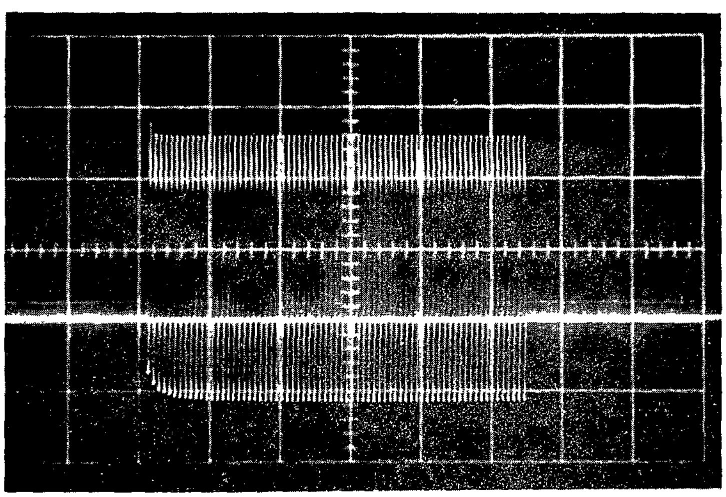
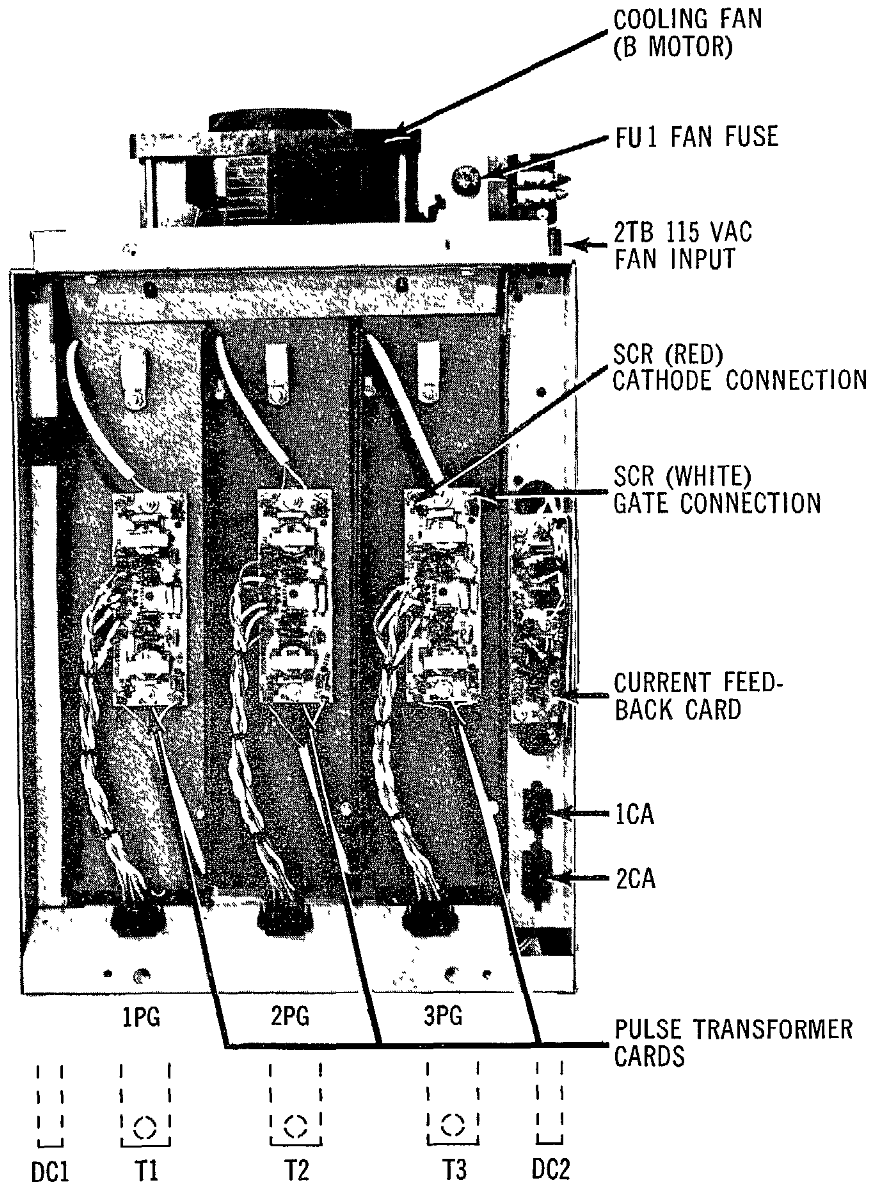


FIGURE 21



Dashed lines indicate input/output connection points in underside of module bottom.

FIGURE 22—DC-3061 SCR Conversion Module (With Front Cover Removed)

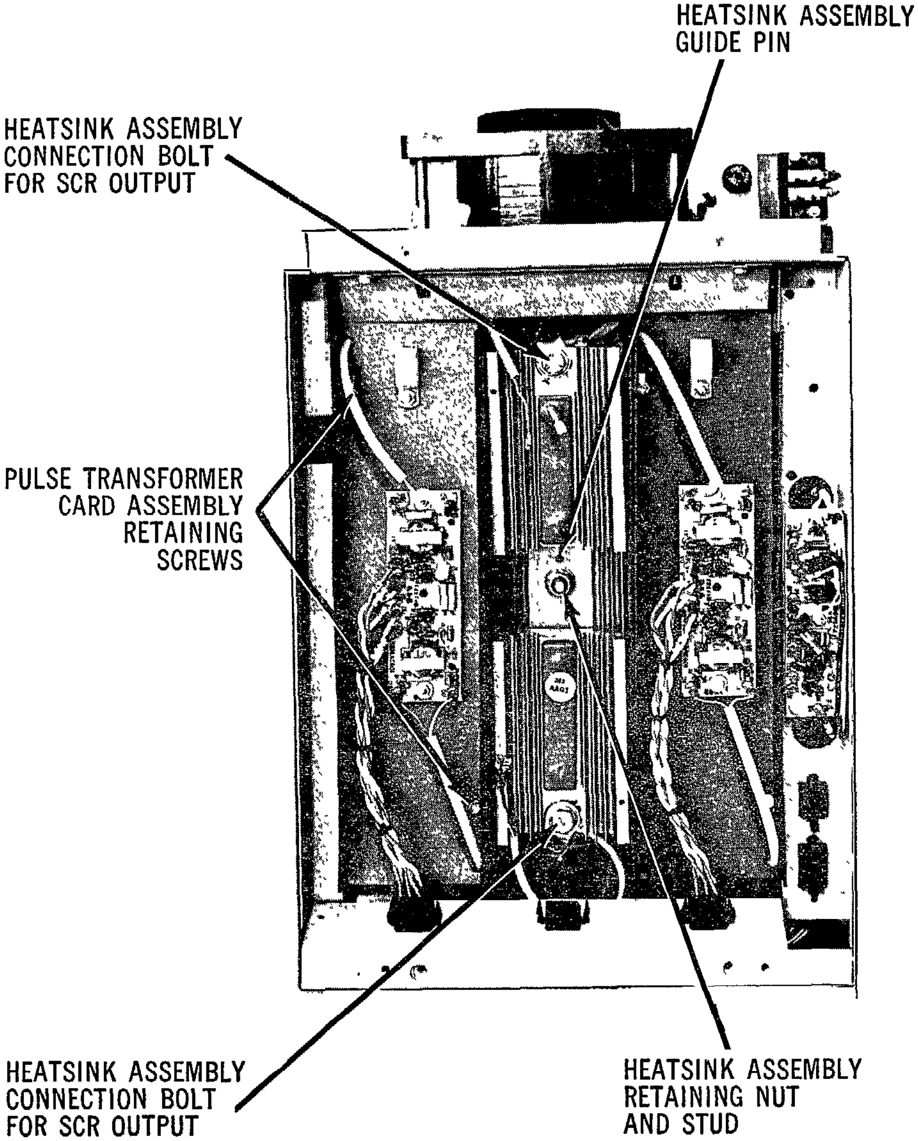


FIGURE 23—DC-3061 SCR Conversion Module (With Center Pulse Transformer Card Assembly Removed Showing Heatsink Assembly)

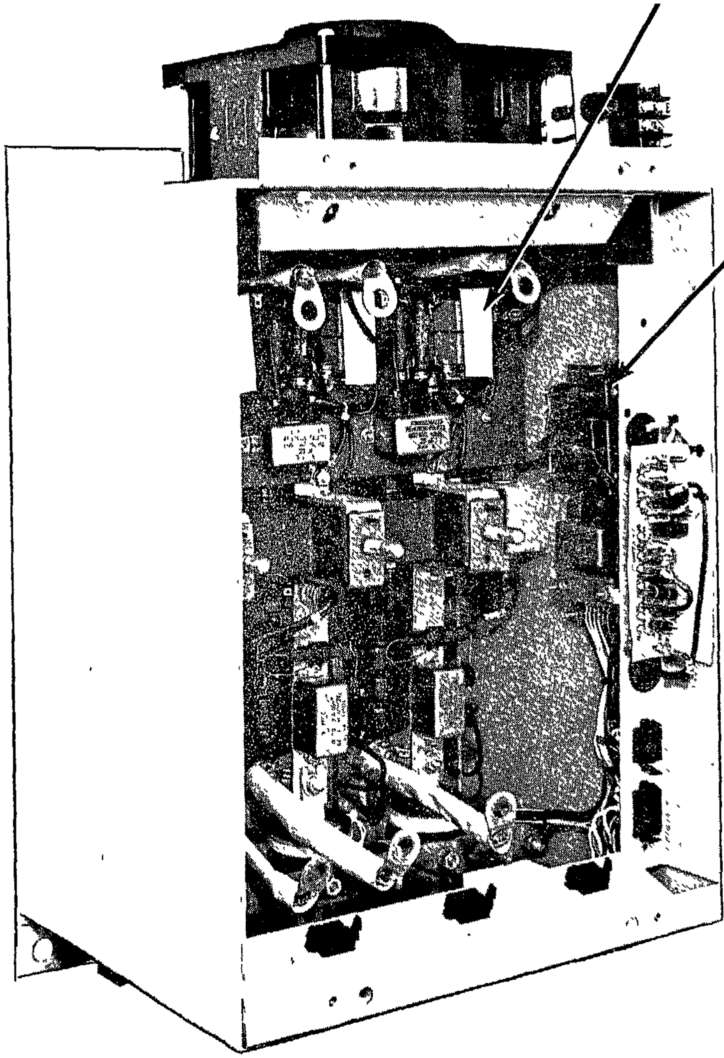
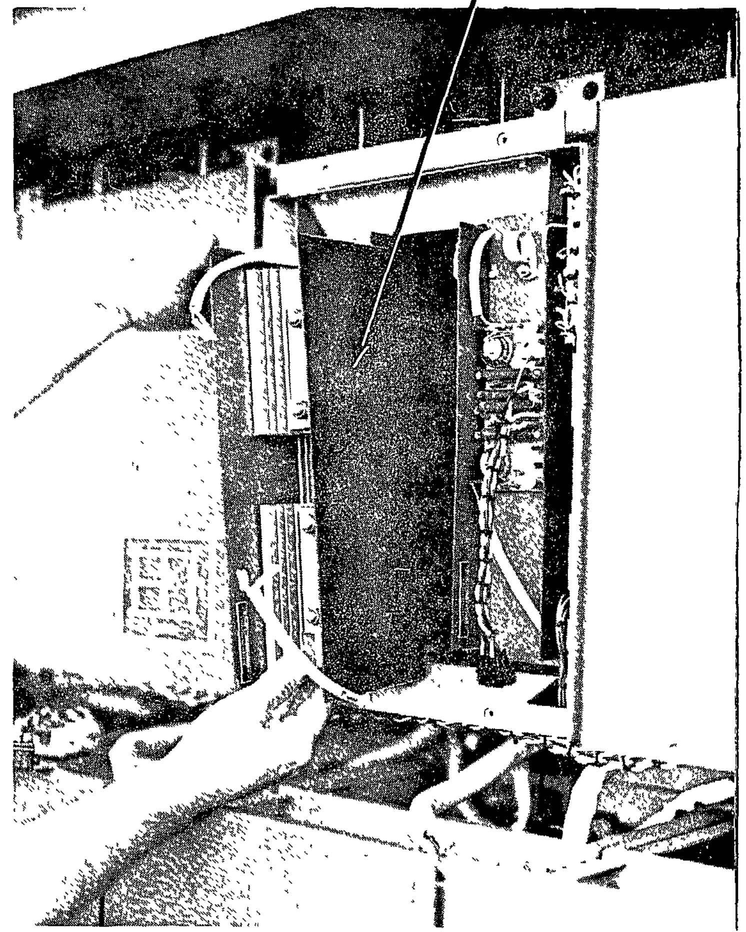


FIGURE 25—SCR Conversion Module With Heatsinks Removed



NOTE

TYPICAL PRESS PACK HEATSINK ASSEMBLY (WITH 2 SCR's). WHEN EXCHANGING HEATSINK ASSEMBLY RETAIN BLACK INSULATION COVER (BOX) AND NYLON SCREWS.

(FOR SCR REPLACEMENT PROCEDURES—SEE FIG. 27)

FIGURE 24—Removal of SCR Heatsink Assembly

PARALLEL SCR POWER CONVERSION MODULES

With SCR Power Conversion Modules connected in parallel to provide higher power output capability, additional assemblies and components are required for two and four quadrant operation. As a typical example, an equipment configuration of two forward direction SCR Power Conversion Modules and one reverse direction SCR Power Conversion Module will be used. (See Figure 26, page 22). The additional hardware required for the paralleling is as follows:

1. Master Signal Distribution Assembly (MSDA)
2. Paralleling Panels (PP#1 & PP#2)
3. DC Output Decoupling Fuses (DFU1; DFU2; DFU3) II & IV Quadrant Drives only
4. Current Transformers (CT) for Fuse Failure Detection (if supplied)
5. AC Input Line Fuses and Bus Work (FU)

Each of the above will be briefly described.

MASTER SIGNAL DISTRIBUTION ASSEMBLY (MSDA)

This assembly is used to distribute the Gate Pulse Generator firing signals to the parallel (1 direction) Power Conversion Modules and supply the +20vdc operating voltage for the pulse transformer cards. Only one set of Gate Pulse Generators is used to fire the SCR's in the parallel modules to insure firing coordination. Also, the Voltage and Current Feedback Signals from the parallel modules are each connected together and returned separately to the driver.

PARALLELING PANEL

In the above equipment configuration, two Parallel Panel Assemblies are required. Each panel contains three line chokes, three AC fuse failure indicating lights (normally "on") and the AC input fuses, DC decoupling fuses and associated bus work with cover. Also, current transformers may be supplied as an option to provide signals for such purposes as drive shutdown command or alarm upon a loss of any of the fuses, +20vdc supply or severe phase inbalance between parallel modules. When the current transformer option is provided, an additional terminal board (2TB) is furnished for signal distribution.

DC OUTPUT DECOUPLING FUSES II & IV QUADRANT

DC Output Decoupling Fuses in the DC output of each power conversion module are supplied to provide isolation protection between trays in the case of a malfunction in one of the trays or motor overload.

AC INPUT LINE FUSES AND BUS WORK

AC Line Fuses are provided to protect the equipment against line surges or module misfiring (shoot through) and regenerative faults. The fuses and chokes are an integral part of the bus work. The AC Line Chokes are provided to further insure proper SCR firing coordination.

TYPICAL FUSE FAILURE DETECTION CIRCUIT (WITH CT'S)

If any of the three AC fuses which protect the first forward conversion module (1FSCM) should fail, the "loss of phase" light on the monitor card will illuminate and the driver fault relay (RX855) will trip and shut off (OR signal alarm) the drive. If any of the three AC fuses which protect the second forward conversion module (2FSCM) or if any of the three DC decoupling fuses DFU) should fail, the "blown fuse" light on the monitor card will illuminate and the driver fault relay (RX855) will trip and shut off the drive (OR signal alarm).

The 230 or 460VAC to the synchronizing transformers on the STA is wired from 2TB points T11A, T12A, and T13A on the first panel (PP#1). If one of the three AC line fuses on the first panel fail, the voltage to one of the synchronizing transformers is lost and this occurrence will trigger the "loss of phase" circuit on the monitor card.

When operating in quadrants I and IV, three current transformers (CT), within each panel (PP), detect the flow of current through each phase. The CT's which are in the same phase in each panel (PP) are wired together in the opposing direction. As long as AC current of equal magnitude flows the signals from the two CT's cancel each other. If an AC or decoupling fuse fails, the signal from one of the CT's is lost and the signal from the other CT will operate the relay on the signal level detector (SLD) card which is located in the voltage regulator. The relay closure will connect a positive voltage to the STA which will operate the "blown fuse" circuit on the monitor card. The circuit sensitivity is set to allow a normal unbalance of 15% by the SLD "Gain" potentiometer.

When the reverse tray is utilized in quadrants II and III, the three CT's in panel (PP#1) will have an output because AC current is flowing through these CT's and not through the CT's in panel (PP#2). A reverse current feedback signal is used at the summing junction at the SLD card to prevent relay operation by cancelling the CT output. The failure of DFU3 is sensed by the normal fuse failure circuit which is located on the STA. The voltage from across the blown fuse is connected to TB31 and 32 or 30 on the STA. This signal will operate the "blown fuse" circuit on the monitor card.

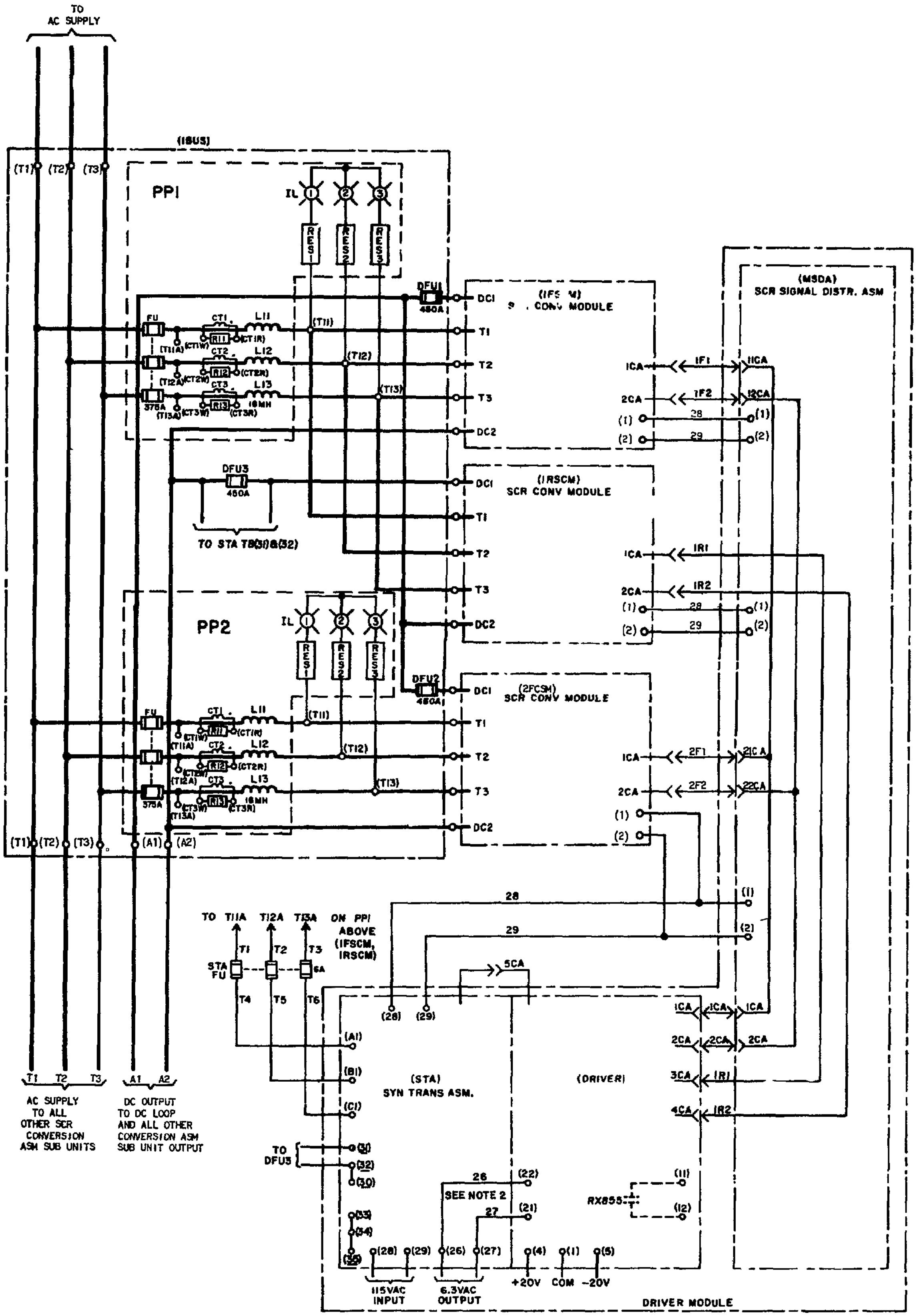


FIGURE 26—Typical Paralleling Configuration

SCR REPLACEMENT PROCEDURE

In the event of an SCR cell failure the following steps are required for replacement of the press pak cell on the heatsink assembly.

If minimized down time is a critical factor, it is recommended that one of each type (SCR and Rectifier) heatsink assembly (one assembly consisting of two cells mounted on heatsinks with insulation cover) be an "on the shelf" spare.

Heatsink Assembly

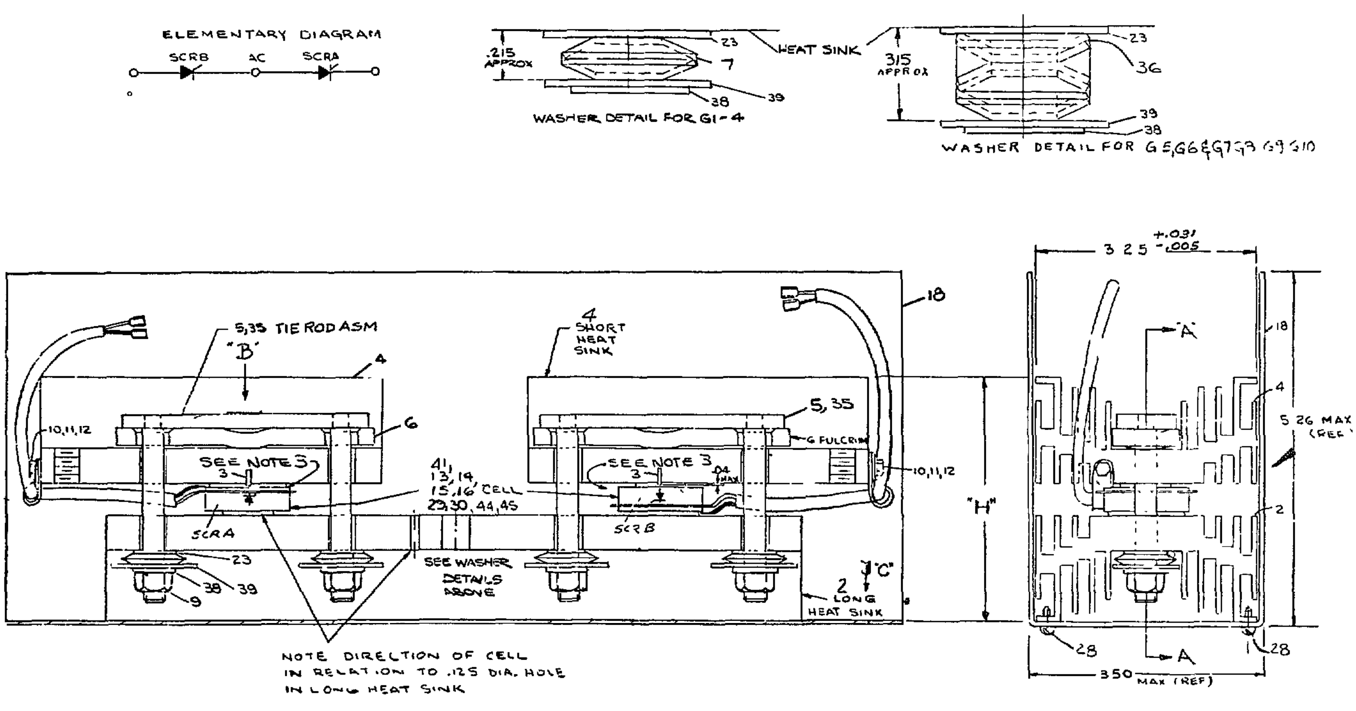
a. Remove the two nylon screws (part 28) from the back of the black insulating cover (part 18) and remove the cover. Reference heatsink pictorial for parts location and identification.

Part	Name	Part	Name
1	ASM Diag.	11	Screws
2	Heatsink	12	Washer
3	Roll Pin	13	SCR
4	Heatsink	17	ASM Washer
5	Tie Rod	18	Insul. Cover
6	Fulcrum	22	Washer
7	ASM Washer	27	Screw
9	Nut	28	Nylon Screws
10	Clamps	29	Plate

b. Remove the associated SCR leads cable from the cable clamp for the failed cell (parts 10, 11 and 12).

c. SCR Cell Replacement

1. Place heatsink assembly with green tie rods (part 5) facing down and remove the nuts (two only) of the failed cell subassembly (part 9). This allows the tie rod to slip down to rest on the working surface.
2. Remove the failed cell and clean the heatsink surface with a soft cloth and inspect the surface to make sure it is smooth.
3. Take the new replacement cell, twist the cell leads together, place white tubing over twisted cell leads and crimp on the female spade terminals and apply a *small* amount of "Burndy Penetrox A"® (or equivalent joint compound) to the small hole on each side of the cell (with a dab on top) so that under pressure the compound will cover only the raised center circular surface on each side.
4. Place new cell in the same orientation as the failed cell and place on the roll pin (part 3) of the heatsink so the roll pin is in the center hole of the cell.
5. Place the two nuts (part 9) back on the tie rod (with parts 23, 7, 39 and 38 on the tie rod as indicated) and tighten each nut *finger* tight so the threads showing are approximately the same on both sides.
6. Check that both cell holes are still over the roll pins.
7. With the nuts finger tight, use a wrench and tighten each nut 1/6th of a turn (alternate between nuts) until the nuts have completed 1-5/6th turns each for the ½" thick cell or 2-3/6th turns for the 1" thick cell. Inspect the assembly to make sure that the heatsinks are aligned equally and parallel with each other and the long heatsink.



FIGURE—27

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