DESPATCH INDUSTRIES INC

TWO LEG SCR POWER CONTROL UNIT

INDEX

Subject	Paragraph
Introduction	1.0
Applications	2.0
Specifications	3.0
Theory of Operation	4.0
Installation & Start-Up Procedure	5.0
Protective Devices	6.0
Maintenance	7.0
Corrective Maintenance (Trouble-Shooting)	8.0
Replacement Parts	9.0
Warranty	10.0
Material Returns	11.0

1.0 INTRODUCTION

Despatch Industries, Inc. SCR Power Controllers are 100% solid state, zero voltage switching units. They accept an ac input and provide an ac output which is proportionally controlled from zero to 100% of the rated output voltage. The distributed-cycle time proportioning control technique provides an output voltage that appears as a recurring burst of full sine waves to the load. This distributed cycle control is characterized by rapid on/off cycling with the on-to-on cycle time ranging typically from 16 to 48 milliseconds. The number of cycles within a burst (burst length) and the off-time between bursts is continually monitored and updated four times per second. The distributed-cycle time proportioning provides infinite resolution of the heaters to ensure that their performance meets the most stringent specifications for resistance heating applications. This also eliminates troublesome thermal shock to the resistance elements normally encountered with controllers employing fixed time base or long-period distributed-cycle control.

Standard features on all models include back-to-back SCR's to provide full-wave control, and high peak inverse voltage SCR's to provide high-voltage blocking. True zero voltage switching eliminates RFI distribuances for all practical purpose since the SCR's turn on at approximately 1/2 volt. Gain and offset potentiometers allow adjustment to most milliampere signals.

2.0 APPLICATIONS

Distributed cycle SCR power controllers are ideally suited for heater application (constant resistive loads).

3.0 SPECIFICATIONS

Inputs

0-5, 2-12 and mA Input: 4-20 mA dc, input impedance is 500 ohms maximum.

Output Current Rating

415 amps maximum.

AC Supply Voltage

208, 240, 480 or 575 Vac + 10% to -15%, 50/60 Hz.

Ambient Temperature Effect on Output

Output rating decreases by 10% for each 5°C (9°F) rise in ambient temperature over 50°C (112°F) to a maximum of 60°C (140°F).

Cooling

20 thru 220 amp models are convection cooled. 365 amp and 415 amp models are forced-air cooled.

Ambient Temperature

Operating range 0 to 50°C (32° to 122°F).

3.0 SPECIFICATIONS (CONT'D)

Type of Load

Resistive. (Constant resistive only).

Output

Distributed cycle-zero voltage switching. See Figure 3.

Output Regulation

± 2% for ± 10% line variation average ac regulation standard.

Output Linearity

± 2% input-output transfer over 10-90% of output range.

Protective Devices (See Paragraph 6.0)

Fusing: I^2t fuse protects against short-circuit overloads.

Back-Up Contactor

Contactor is to provide positive shut down of the unit.

Mounting

Units must be mounted so heat sink fins are parallel to a vertical mounting surface. Unit should have a maximum of 6" clearance on top and bottom for proper ventilation.

Dimensions

See Figures 4

4.0 THEORY OF OPERATION

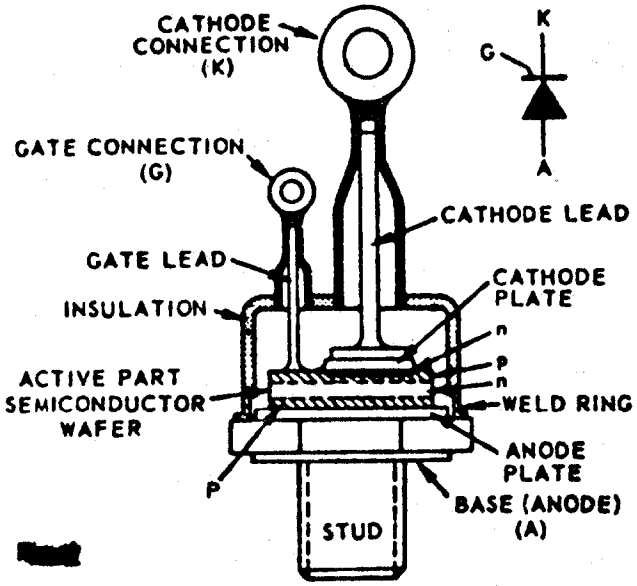
4.1 Thyristors (SCR)

The power handling elements in Power Control Units are silicon controlled rectifiers (thyristors). An SCR is a rugged solid state, semi-conductor device functionally analagous to the gas tube thyratron. The three terminals of the device are designated as anode, cathode and gate (Figure 1). The p-n junctions in the SCR are arranged such that the device will not conduct a current in either direction, when the gate to cathode signal is absent, when the cathode potential is positive with respect to the gate potential, or when the cathode is positive with respect to the anode. At any time the anode is positive with respect to cathode, a gate to cathode signal, (+) on gate (-) on cathode, may be applied and the SCR will conduct if there is an external path for at least a minimum current, called holding current, to flow.

4.0 THEORY OF OPERATION (CONT'D)

4.1 Thyristors (SCR) (Cont'd)

Once conduction is initiated, the gate signal may be removed and the SCR will continue to conduct until the anode is no longer positive with respect to the cathode. In a single phase AC circuit for example, this condition will occur when line voltage goes through zero and reverses polarity. While the SCR is a rugged device, many factors such as surge currents, di/dt and dv/dt phenomen, cooling, etc. must be considered in applying them.



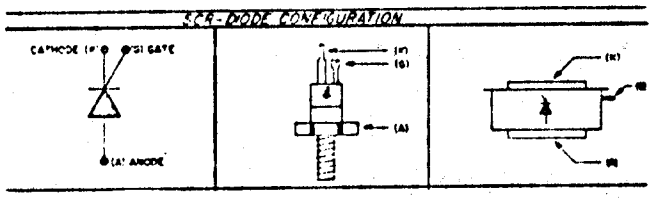


FIG. 1

4.0 THEORY OF OPERATION (CONT'D)

4.2 Two Leg Control Unit

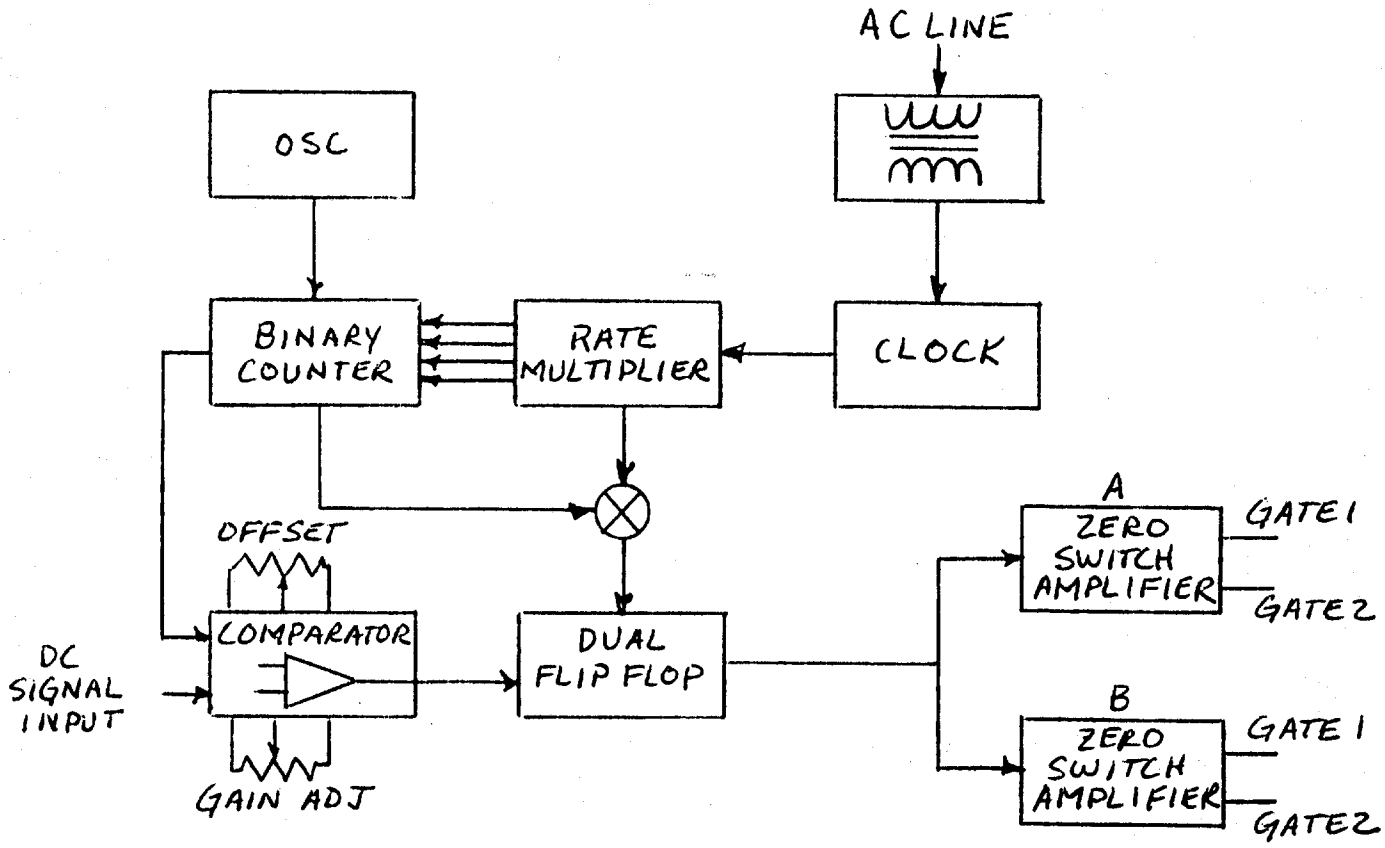


FIG-2 Block Diagram

The distributed-cycle zero switching gate driver is used to control two legs of a 3-phase line. The outputs are four isolated gate pulses which can be used to fire two pair of back-to-back SCR's. The gate pulse amplitude of 3 volts at 300 milliamps will fire most all available SCR's.

The clock is derived and syncronized from Line-A to Line-C through an isolation transformer. The Binary Counter and rate multiplier combine to supply inputs to the comparator and flip-flop. The Binary Counter resets the flip-flop every 16 cycles of supply-line frequency. The output of the flip-flop is distributed from 1 through 16 cycles by the rate multiplier. (See Fig-3; this shows the line-to-line load voltage).

The input to the gate driver is a DC analog voltage to the comparator. A unique feature is that the output power is linear with respect to the DC signal input.

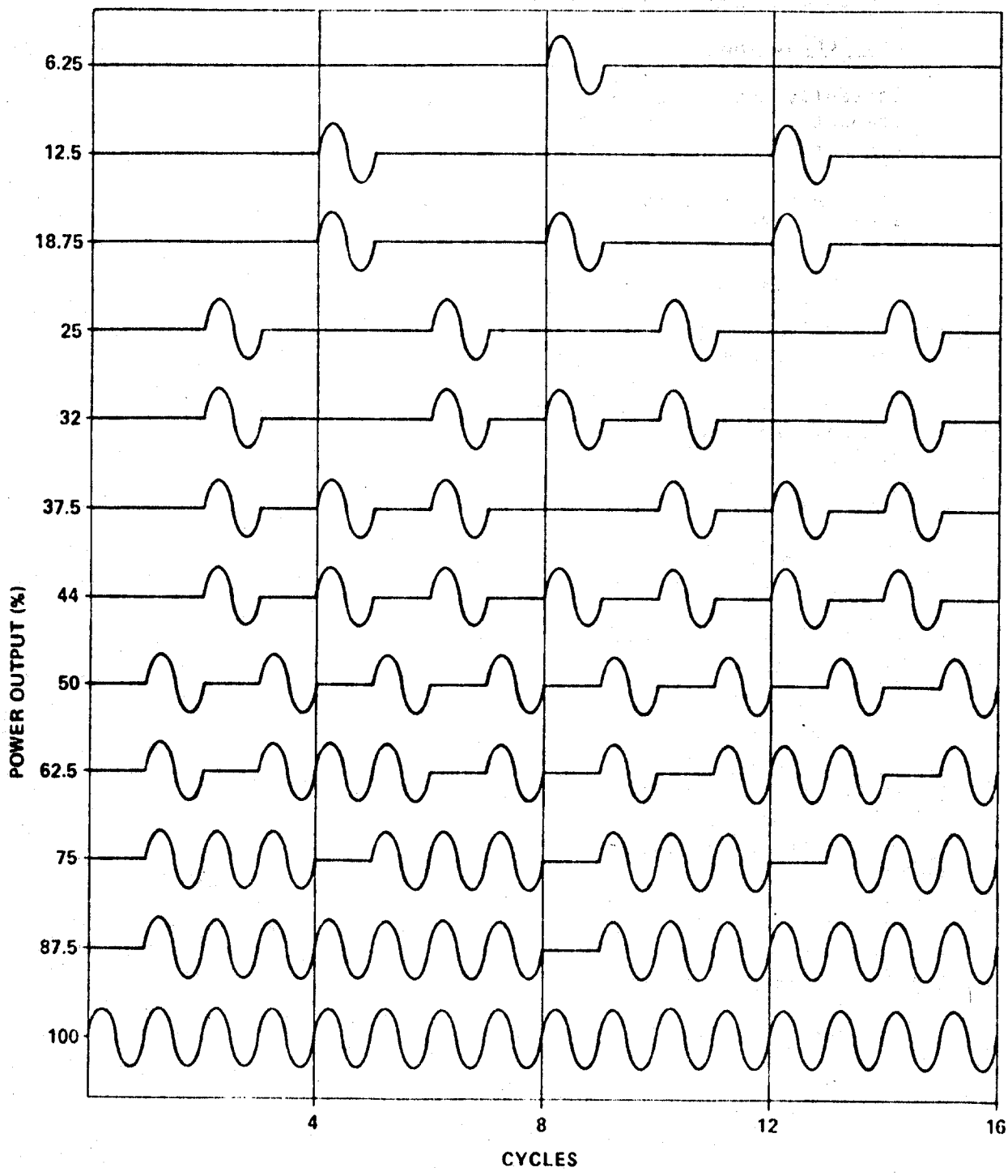


Figure 3. Distributed Cycle versus Power Output

5.0 INSTALLATION AND START-UP PROCEDURES

5.1 Unpacking

Carefully unpack the SCR Power Controller from the shipping carton, and inspect it for shipping damages. Immediately report any damages to the carrier.

The controller is shipped as a complete unit and only needs to be mounted and wired for operation.

5.2 Mounting

Select mounting location and make sure ambient temperature does not exceed operating range limits given in specifications.

Mount units vertically so that heat sink fins are parallel to vertical mounting surface. Make sure that clearance on top and bottom of unit is at least 6". Refer to Figure 4 for mounting dimensions.

5.3 Wiring

Figure 5 illustrates typical wiring connections for given controller models.

NOTE: All wiring must comply with applicable locals codes, regulations and ordinances.

WARNING

DO NOT SERVICE EQUIPMENT WITH VOLTAGE APPLIED. HEAT SINKS ARE ELECTRICALLY HOT AND CAN BE THE SOURCE OF FATAL ELECTRICAL SHOCKS.

5.4 Percent Output Meter (Optional)

The meter is a 0-1 MA meter with 0-100% scale. See Figure 5 for connection.

5.5 Start-Up With Temperature Controller

5.5.1 - Start-up the system or oven.

5.5.2 - Procedure for adjusting Gain-Offset: Example: 4-20 mA

1. Start with gain pot full C.C.W., offset full C.W.
2. Apply 20 mA DC signal. (Turn control instrument upscale from setpoint).
3. Turn gain pot C.W. slowly until full output is reached.
4. Apply 4 mA DC signal. (Turn control instrument downscale from setpoint).

5.0 INSTALLATION AND START-UP PROCEDURES (CONT'D)

5.5 Start-Up With Temperature Controller (Cont'd)

5. Turn offset pot C.C.W. until power just goes off.

6. Apply 20 mA DC signal.

7. Turn gain pot until power is full on.

8. Repeat steps 4-7 and check so that 4-20 mA gives 0-100% power output.

5.5.3 Power Output

1. Measure and record the input line voltage across each of the three legs (L1, and L2, L2 and L3, L1 and L3).

2. Set the temperature control instrument upscale from setpoint to give 100% output to the SCR unit.

3. Measure and recorder the voltage across each of the output terminal legs (H1 and H2, H2 and H3, H1 and H3).

   If the voltage at the output is not the same as the input, see Paragraph 8.0 on corrective maintenace.

6.0 PROTECTIVE DEVICES (NOT PROVIDED ON BASIC UNIT)

WARNING

FAILURE TO USE THESE DEVICES CAN RESULT IN SERIOUS BODILY INJURY, PROPERTY DAMAGE OR DEATH.

6.1 Fuses

The power control unit must be protected by special I^2t fuses.

The fuses are selected to match the I^2T characteristics of the SCR's.

In the event of fuse failure, replace the fuse with recommended type only. See Paragraph 9.1 for correct sizing.

6.2 Back-Up Contactors

The power control unit does not provide complete isolation of the incoming line and heater when the controller is off. A high voltage potential will be present at the heater, irregardless of current flow, due to leakage through the SCR's and the direct connection of the one incoming line leg to the heater.

The electromechanical back-up contactor is necessary to provide a complete power disconnection and also a means of interlocking monitoring devices, such as fan motor starters, airflow switches, and hi-limit temperature controllers. See Figure 5 for proper wiring connections.

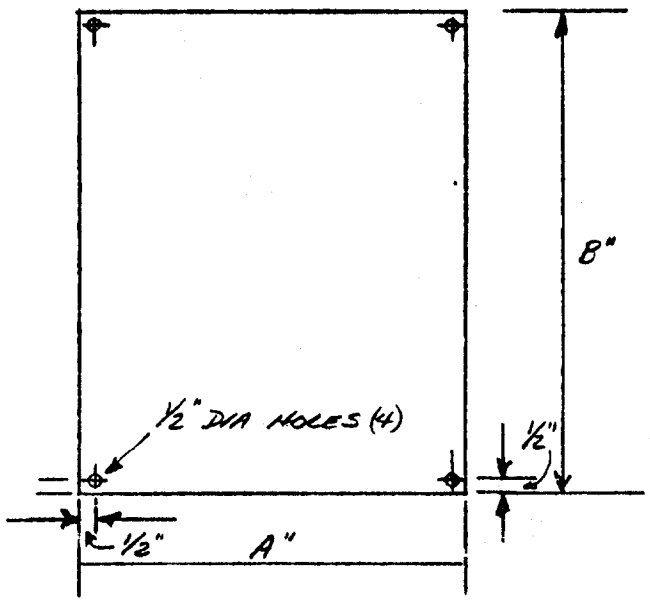
No. E-7583-A

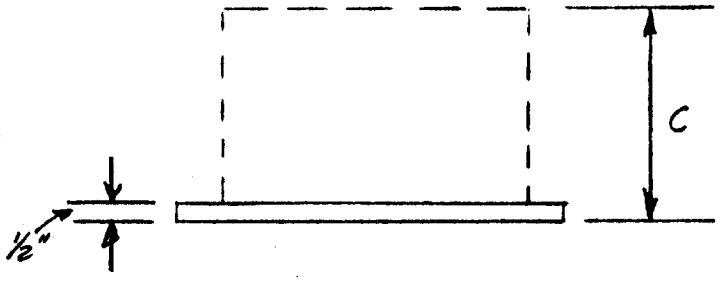
SER. | DATE 4/5/79

DRAWN BY PLH | CHECKED

DESPATCH OVEN COMPANY
MINNEAPOLIS, MINNESOTA

CHASSIS DIMENSIONS
FIGURE #4





MODEL NUMBER *	WIDTH "A"	HEIGHT "B"	DEPTH "C"
20X-2-SG	14"	15"	7¼"
50X-2-SG	14"	15"	7¼"
110X-2-SG	16"	26"	9"
145X-2-SG	20"	26"	10¾"
220X-2-SG	20"	26"	11⅛"
365X-2-SF	20"	30"	9⅜"
415X-2-SF	20"	30"	11⅛"

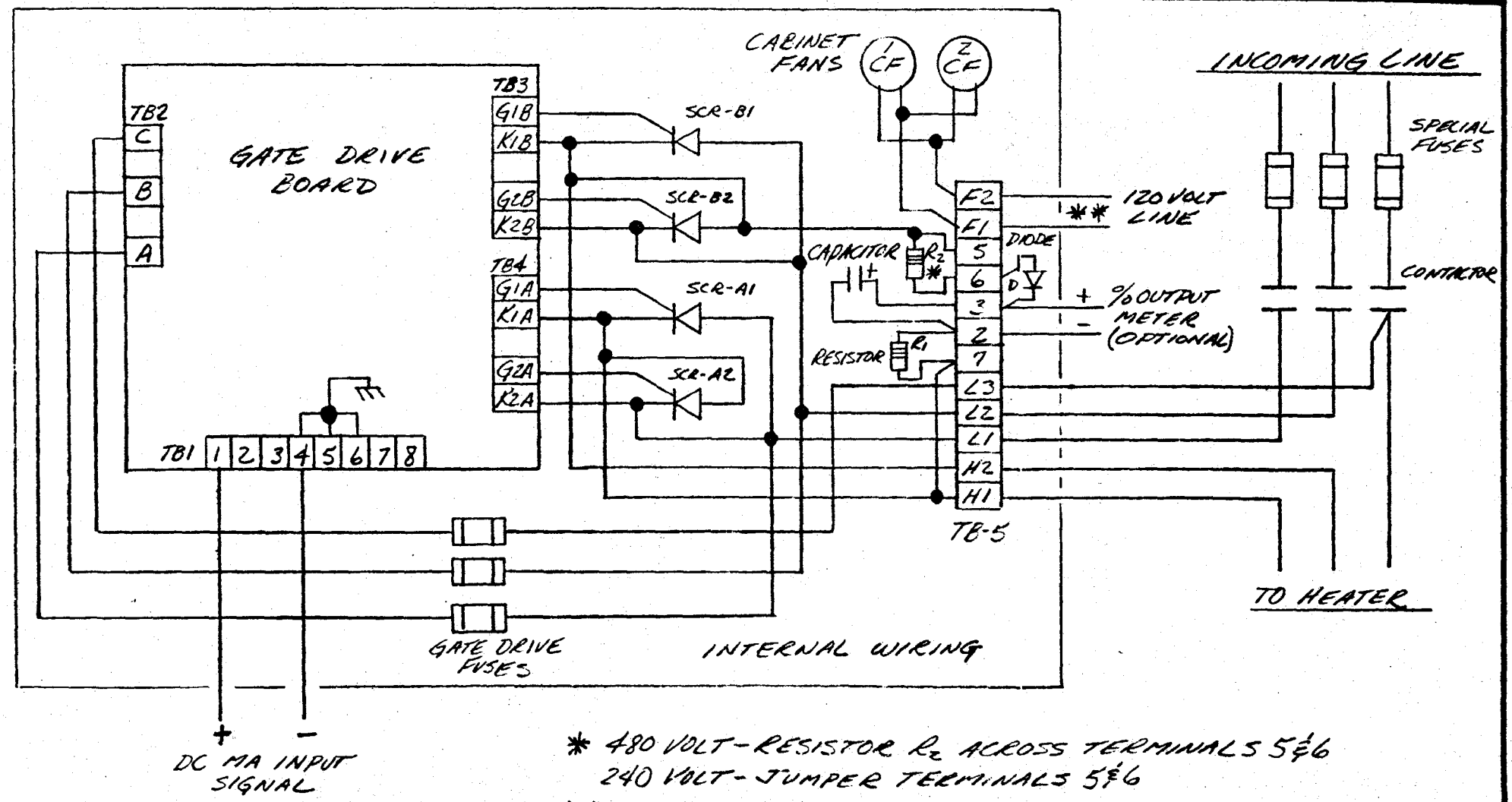
* REPLACE "X" WITH "B" FOR 240 VOLT UNIT

TYPICAL WIRING CONNECTIONS

No. E-7583

SER.	DATE 3/29/79
DRAWN BY DLH	CHECKED

DESPATCH OVEN COMPANY
MINNEAPOLIS, MINNESOTA



* 480 VOLT - RESISTOR R_2 ACROSS TERMINALS 5 & 6
240 VOLT - JUMPER TERMINALS 5 & 6

** 365 AND 415 AMP UNITS ONLY

REV-1 DLH 8/13/79

7.0 MAINTENANCE

The power control unit is virtually maintenance free. However, good ventilation is important and care should be taken to keep ventilation openings in enclosures clean and unobstructed.

On fan cooled units, check operating of fans and clean as required. Fans supplied are permanently lubricated and hence do not require oiling. If fans become excessively dirty, light weight filters should be employed at the air intake of the equipment cabinet.

Dust or other foreign matter that may accumulate on the heat sinks should be carefully removed in order to insure efficient cooling.

It is also good practice to periodically check the electrical connections for tightness.

8.0 CORRECTIVE MAINTENANCE (TROUBLE-SHOOTING)

WARNING

HIGH VOLTAGE IS PRESENT ON TERMINALS, FUSES, AND THE HEAT SINKS. VOLTAGE CHECKS TO BE MADE ONLY BY QUALIFIED ELECTRICAL MAINTENANCE PERSONNEL: E.G. ELECTRICIAN OR TECHNICIAN.

8.1 Trouble-Shooting Table

Symptom	Possible Cause	Suggested Remedy
No Output (all three phases)	Blown incoming fuses	See test #4
	Blown gate drive fuses	
	Back-up contactor not operated	Check voltage at output of contactor
	No control signal	See Test #1
	Gate drive board malfunction	
	Gate drive board gain adjustment	See Paragraph 5.5.2
Full output all three phases with no control input	Gate drive board mal-function	See Test #1
	Gate drive board gain adjustment	See Paragraph 5.5.2
Unbalanced output with no input	Shorted SCR's	See Test #2
	Gate drive board mal-malfunction	See Test #3
Unbalanced onput with maximum input	Blown incoming fuse	
	Blown gate board fuse	See Test #4
	Gate drive board	See Test #3
	SCR gate to cathode open	See Test #2
Unit does not completely shut off or turn 100% on	Gate drive board zero ang gain adjustment	See Paragraph 5.5.2
Output pulsing at 85-90% with no control	Control signal polarity wrong	Check input signal and reverse if necessary

8.0 CORRECTIVE MAINTENANCE (TROUBLE-SHOOTING) (CONT'D)

8.2 Tests

It is advisable to test the SCR's in their respective heat sinks. To test press pak types, the SCR "MUST" be mounted on its heat sink and have the proper mounting force applied between its main terminals (cathode and anode). Erroneous readings will be obtained if the press pak type device is not mounted to its heat sinks. Tests for both type units (stud type and press pak type) are the same.

Using a Simpson Model #260 (or other suitable VOM), the tests are performed as follows:

8.2.1 Test #1 (Gate Drive Board Turning On)

1. Set VOM to 10 volt DC scale.

2. Measure between test point #9 and common. (These are turrets mounted on the gate drive board).

3. Voltage should be 8.VDC at full on condition and 0.VDC at full off condition. The board is not 100% on if the voltage is pulsing or not stable.

4. Connect the minus lead to terminal #4 and the plus lead to terminal #1 on the gate drive board. The voltages should be approximately .8VDC at off position to 6.8VDC at the full on position with a 4-20 mA input signal.

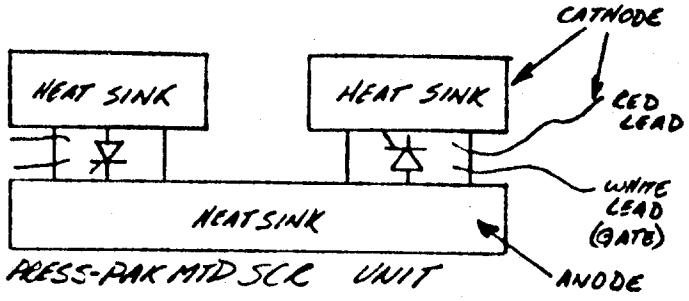
5. See Paragraph 5.5.2 for zero and gain adjustment if the unit does not turn off and on at the correct voltage.

8.2.2 Test #2 (SCR Quality)

A. SCR Failure To Turn On

1. Set the temperature control set point upscale to give 100% output to the SCR unit.

2. Measure the voltage between the anodes and cathodes of the SCR's (see below).



3. If there is a voltage present on one of the phases when the unit is 100% on, the SCR's of that phase are not working properly.

4. Set VOM to 500 VDC scale.

5. Connect the minus lead to the top sink and the plus lead to the bottom (large) sink. The meter should read approximately 0 VDC. If the meter reads approximately half of the incoming line voltage, the SCR with the anode face up is suspect.

6. If the meter reading is negative, reverse the meter lead and remeasure. If the meter reads approximately half the incoming line voltage, the SCR with the anode facing down is suspect.

7. Open the main line disconnect switch. Remove the leads from the SCR's so they are isolated from each other.

8. Set VOM to approximately R x 10,000 range.

9. Connect the minus lead to the SCR cathode and the plus lead to the SCR anode. A good SCR will exhibit a high resistance from anode to cathode. In general, this resistance value should be on the order of 500 Kohms or greater.

10. Reverse the ohm meter polarity across the device under test to measure its reverse resistance. A good SCR will again exhibit a high value of resistance (500 K or greater).

11. Set the ohm meter to the R x 1 position.

8.0 CORRECTIVE MAINTENANCE (TROUBLE-SHOOTING) (CONT'D)

8.2.2 Test #2 (SCR Quality) (Cont'd)

A. SCR Failure To Turn On (Cont'd)

12. Connect the minus lead of the ohm meter to the SCR cathode and the plus lead to the SCR gate. A good SCR will exhibit a gate-cathode resistance of 20-200 ohms. Generally, the larger the SCR, the smaller the gate/cathode impedance will be. Reject any SCR's with shorted or open gate/cathode junctions.

13. The true measure of the quality of an SCR, however, involves a considerable amount of test equipment; e.g., high voltage power supplies and gate triggering amplifiers, etc. In most instances, however, the defective cell can be isolated by using the VOM method described above.

B. SCR Shorted

1. Turn the temperature control set point down scale to give 0% control output signal to the SCR unit.

2. Measure the voltage between the anode and cathode of the SCR. If there is no voltage present in one of the legs, then the SCR may be shorted.

3. Open the main line disconnect switch. Disconnect the gate lead from the SCR. Repeat step 2. If there is voltage present, the gate drive board is defective. If no voltage is present, proceed to step 7.

8.2.3. Test #3 (Gate Drive Board Output)

1. Set VOM to 10 VDC scale.

2. Measure across the gate to cathode (G1A-K1A, G2A-K2A, etc.) with the minus lead on the K1A and the plus lead on G1A.

3. The reading should be approximately .5 to .9 VDC for full on to 0.VDC for full off condition.

4. If the board is on when it should be off, or off when it should be on, proceed to Test #1.

5. If the board has erratic voltage readings, there may be a blown fuse. Proceed to Test #4.

8.0 CORRECTIVE MAINTENANCE (TROUBLE-SHOOTING) (CONT'D)

8.2.4. Test #4 (Output Voltage)

1. Measure and record the voltage across each of the output terminal legs (H1 and H2, H2 and H3, H1 and H3).

2. The output voltage should be the same as the input voltage. The following table will help determine if the unbalance output is due to a blown fuse in the incoming line or on the unit.

Legs	Fuse Blown In Line		
	Line 1	Line 2	Line 3
H1 and H2	240V	240V	480V
H2 and H3	480V	240V	240V
H1 and H3	240V	480V	240V

NOTE: The chart is for 480 volt units. The valves for 240 volt units are half as much.

3. Erratic operation may result from gate drive board fuse L3 being blown, although the unit has full output.

4. Make a continuity check on fuses that are suspected blown.

8.3 Replacement of SCR's

A. Stud Type

1. After removing the defective device from the heat sink, clean the heat sink mounting surface thoroughly.

2. Coat the SCR or diode mounting surface with a light film of thermal joint compound (Wakefield #120 or equivalent). Do not coat SCR or diodes stud threads with the compound.

3. Install the SCR or diode on the heat sink finger tight. Torque the SCR or diode (if heat sink is threaded) mounting nut to value shown in the following table.

TORQUE TABLE

Stud Size	Toque to* (lb.-in.)	or (Kg-cm)
¼ - 28	30	35
½ - 20	150	175

*All values are maximum. Values - 10% minimum.

WARNING

EXCESSIVE TORQUE CAN DAMAGE THE NEW DEVICE. INSUFFICIENT TORQUE MAY NOT PROVIDE THE CORRECT THERMAL BOND BETWEEN THE DEVICE AND THE HEAT SINK AND HENCE SCR'S OR DIODES MAY BE SUBJECT TO THERMAL RUNAWAY AND FAILURE.

8.0 CORRECTIVE MAINTENANCE (TROUBLE-SHOOTING) (CONT'D)

8.3 Replacement of SCR's (Cont'd)

B. Press Pak Type SCR

1. After removing the defective device from the heat sinks, thoroughly clean the device mounting surfaces.

2. Coat the new devices anode/cathode mounting surfaces with a thin film of thermal joint compound (Wakefield #120 or equivalent).

3. Inspect the clamp assembly "stud bar" insulated coating for cracks or other damage.

4. Install the new device between the two heat sinks. Insure that the device is centered on the groove pins embedded in the heat sinks.

   NOTE: Insure that the SCR anode/cathode orientation is correct. See Figure #5 for correct position.

5. Install stud bar through both heat sinks and the mounting force spring and evenly tighten both nuts finger tight.

6. Recheck alignment of the SCR between the heat sinks. SCR must be centered on the alignment pins (groove pins).

7. Alternately tighten each nut one half turn until the force indicator reads 400 pounds per leaf. In the case of one half inch thick SCR pellets, the loading on the device will be 800 pounds. (Two leaf springs x 400 pounds per leaf = 800 pounds). For one inch thick pallets loading on the SCR will be 2,000 pounds. (Five leaf springs x 400 pounds per leaf = 2,000 pounds).

   NOTE: Springs supplied are equipped with swivel assemblies that will apply the force to the center of the SCR pellet. Do not use other types of spring assemblies. Contact the factory for acceptable alternates if the existing spring assembly is damaged.

9.0 REPLACEMENT PARTS

9.1 Fuses & SCR's

Rated Amps	Power Unit Model No.	Voltage	Fuses*		SCR
			Despatch	Chase-Shawmutt	Despatch
20	20B-2-SG	240	013217	A25X25	017861
	20C-2-SG	480	013213	A60X25	017862
50	50B-2-SG	240	007549	A25X60	010388
	50C-2-SG	480	013225	A60X60	010389
110	110B-2-SG	240	007460	A25X150	010392
	110C-2-SG	480	007466	A60X150	010393
145	145B-2-SG	240	013361	A25X200	010392
	145C-2-SG	480	013205	A60X200	010393
220	220B-2-SG	240	019230	A25X300	017863
	220C-2-SG	480	013207	A60X300	010394
365	365B-2-SF	240	019231	A25X500	017863
	365C-2-SF	480	019232	A60X500	010394
415	415B-2-SF	240	019231	A25X500	017863
	415C-2-SF	480	019232	A60X500	010394

*Fuses shown are for the maximum current of the power control. To size fuse according to actual heater current, multiply the current times 1.2 and use the next highest size.

9.2 Gate Drive Board

Voltage	Despatch
200/400	019228
230/460	015146
575	019229

9.3 Gate Drive Board Fuses

Despatch
007467

4.4 Fans (365 and 415 Power Units Only)

Model	Despatch
365 Amp	006049
415 Amp	017973

9.0 REPLACEMENT PARTS (CONT'D)

9.5 Output Meter Circuit

Part		Despatch
Meter		019181
Capacitor		004907
Resistors		010532
Rectifier	240V	030398
	480V	010396

10.0 WARRANTY

Despatch Industries, Inc. warrants equipment manufactured by Despatch Industries, Inc. to be free from defects in workmanship and materials under normal use and service for a period of one (1) year from the date of delivery or the period of twenty-one hundred (2100) accumulated hours of use, whichever period is shorter.

Components manufactured by others, including but not limited to expendable items, are excluded from this warranty and are warranted (if at all) only in accordance with the warranty, if any, issued by such other manufacturer.

Use or service with corrosive or abrasive chemicals or materials is not deemed normal.

If Purchaser gives written notice specifying the particular defect or defects within 14 days after discovery thereof, Despatch Industries, Inc. will correct without charge any workmanship that is demonstrated to Despatch Industries, Inc. satisfaction to have been defective at time of installation or erection and will repair or replace at the warrantor's option, without charge, f.o.b. Despatch Industries, Inc. factory, parts covered by this warranty that upon inspection are found defective under normal use within the warranty period above stated.

All work of removal and reinstallation or installation of parts, whether or not found defective, and shipping charges for defective or replacement parts shall be at the sole expense of Purchaser.

The foregoing warranty shall not apply to equipment repaired or altered by others, unless such repairs or alterations were specifically agreed to in writing by an officer of Despatch Industries, Inc.

Despatch Industries, Inc. shall not be liable for incidental or consequential damages of any kind (whether for personal injury, lost profits or otherwise), whether arising from breach of this warranty, negligence or other tort or otherwise, which occur during the course of installation of equipment, or which result from the use or misuse by user, its employees or others of the equipment supplied hereunder, or from any malfunction or nonfunction of such equipment, and Purchaser's sole and exlusive remedy against Despatch Industries, Inc. for any breach of the foregoing warranty or otherwise shall be for the repair or replacement of the equipment or parts thereof affected.

10.0 WARRANTY (CONT'D)

The foregoing warranty shall be valid and binding upon Despatch Industries, Inc. if and only if user loads, operates and maintains the equipment supplied hereunder in accordance with the instruction manual to be provided upon delivery of the equipment.

Despatch Industries, Inc. does not guarantee the process of manufacture by user or the quality of product to be produced by the equipment supplied hereunder and Despatch Industries, Inc. shall not be liable for lost profits.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES AND REPRESENTATIONS WHATSOEVER, INCLUDING BUT NOT LIMITED TO THOSE OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.

11.0 RETURNS

Written authorization must be obtained before any material is returned to the factory for repair, replacement or other reasons. Contact the Customer Service Department of Despatch Industries, Inc. for the required information (612/331-1873).