Onan

Service Manual

Control-O-Matic

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Cummins Power Generation

CONTROL-O-MATIC

INDEX

GENERAL INFORMATION

The MCCK Control-O-Matic is an engine control, automatic-demand control, and a bilge-blower control, all combined into one top-mounted control box. The front panel, facing the generator end of the generator set, holds the charge ammeter, emergency relay and toggle switch. A unique hinge arrangement holds the front panel, cover and chassis together and opens in a very limited space to expose all the relays for servicing. See Figure 5-1.

A three-position switch on the front panel selects the "RUN," "OFF," or "AUTOMATIC" mode of operation. When the toggle switch is moved to the "RUN" position, the bilge-blower control delays cranking while it closes a 12-volt, 5-ampere circuit to operate the bilge blower (removes gases from the boat bilge). After the time delay for the bilge blower expires, the generator set cranks and starts.

When the toggle switch is moved to "AUTOMATIC," the Control-O-Matic will monitor the AC load circuit to:

1. Sense a load on the AC line.
2. Close the bilge-blower circuit.
3. Open the bilge-blower circuit.
4. Start the generator set
5. Assume the electrical load.
6. Sense when all load is removed.
7. Stop the generator set.

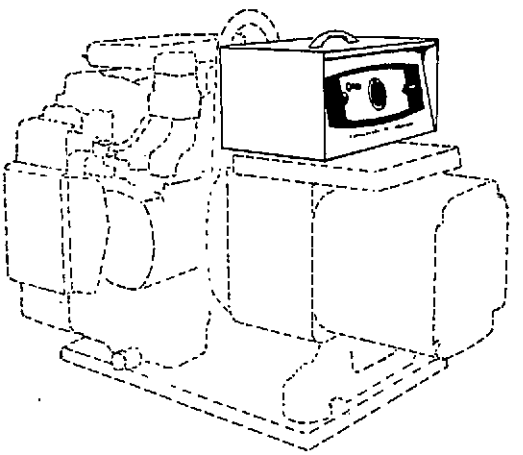

FIGURE 5-1. CONTROL-O-MATIC ON MCCK GENERATOR SET

WARNING

INCORRECT SERVICE OR REPLACEMENT OF PARTS MIGHT RESULT IN SEVERE PERSONAL INJURY AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.

OPERATION DESCRIPTION

The Control-O-Matic operation description on the following pages refers to schematic drawings with current flow shown in bold lines. Throughout the text are references to various components, terminal positions and current flow. When reading the text, follow current flow on the schematics and locate relative positions of electrical devices and terminal positions on the respective wiring diagrams (given at end of operation description). When using the wiring diagrams or schematics, remember all components are shown in their de-energized position unless otherwise noted.

The first description of Control-O-Matic operation is for Spec E and F MCCK generator sets (also follow this description for Spec D generator sets since operation is so similar). The second operation description applies only to Spec C MCCK generator sets.

CAUTION **The Control-O-Matic must operate with a negative ground only or equipment damage will result.**

SPEC D THROUGH F MODELS

Switch S1 is a three-position switch with a center "OFF" position. In the "RUN" position, the switch bypasses relay A2K1 contact (2-3) to energize the bilge blower control which goes through its time delay cycle before the generator cranks the engine. In the "AUTO" position, the Control-O-Matic starts the unit which runs as long as a load demand prevails. The load must be at least a 50-watt incandescent lamp for reliable automatic operation.

LOAD DEMAND

When the generator set is in the "AUTOMATIC" mode and a 50-watt lamp (or larger) is turned on, a load demand exists (Figure 5-2). Battery current flows through switch S1, relay A1K1 (A-B), fuse A1F1, K3 contacts, load terminal A, the load, ground, terminal M2 and back to the battery to energize relay A1K1.

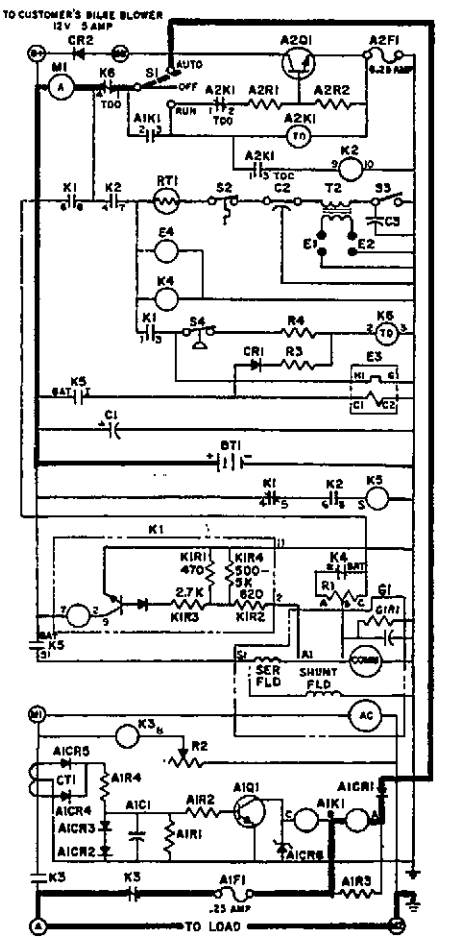

FIGURE 5-2. LOAD DEMAND

TRANSISTOR ON AND TIME DELAY

Relay A1K1 contacts (2 3) close the circuit from B+ through the heater of relay A2K1 to the 6-1/4-ampre fuse, to ground and back to the battery (Figure 5-3). The heater on the five-minute time delay begins its cycle. Simultaneously, as current flows through the heater on time delay A2K1, it also flows through the closed A2K1 contact (1-2) through resistor A2R1 to the base of the transistor, through resistor A2R2, and through the fuse to ground. This switches on transistor A2Q1.

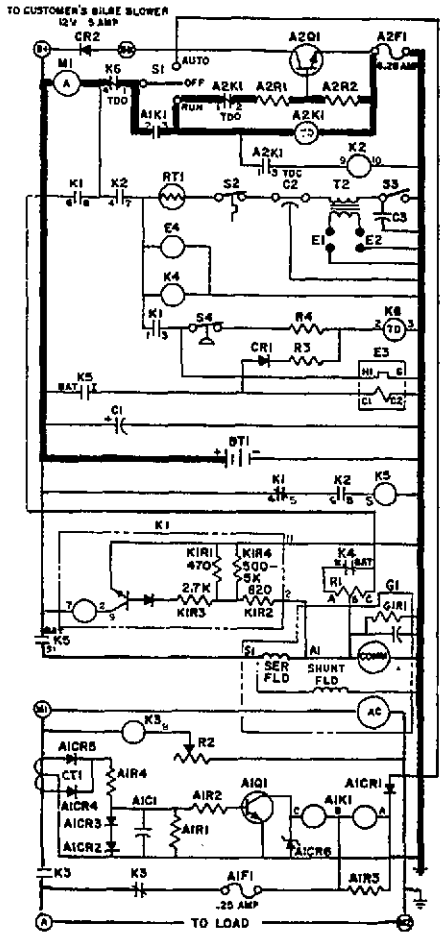

FIGURE 5-3. TRANSISTOR ON AND TIME DELAY

BILGE BLOWER ON

When transistor A2Q1 turns on (Figure 5-4), current flows from the B+ terminal through the bilge blower, to terminal BB through the transistor and fuse to ground. The bilge blower operates for five minutes to evacuate explosive vapors from the boat bilge. At the end of the five-minute period, time delay A2K1 operates to close contacts (1-3) and open contacts (1-2). Transistor A2Q1 turns off to interrupt the power to the bilge blower. Diode (CR2) between B+ and BB is a discharge diode to protect other components in the control from inductive voltage when the bilge blower is turned off.

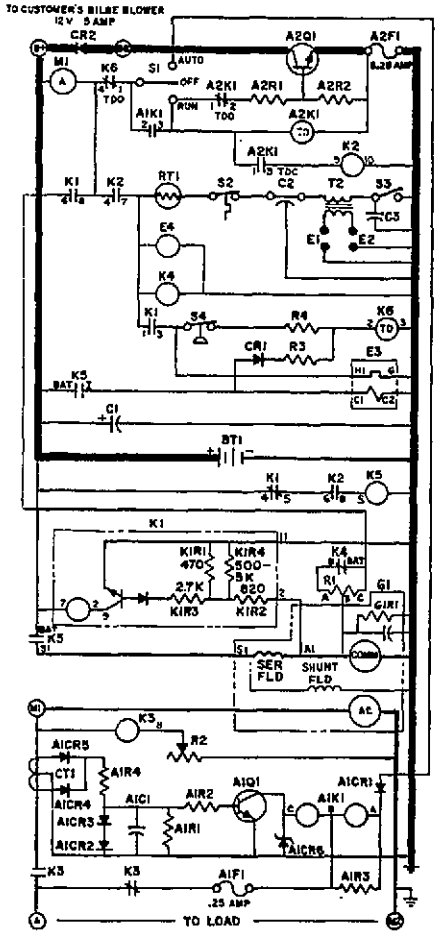

FIGURE 5-4. BILGE BLOWER ON

ENGINE CRANK

When time delay A2K1 contacts (1-3) close (Figure 5-5), current flows to energize the start-stop relay (K2). The K2 contacts close the circuit through K2 contacts (8-6) to energize start solenoid relay K5. The K5 main contact (BAT-S1) closes to supply battery power to the cranking windings on the generator.

CHOKE

The start solenoid K5 auxiliary contact (BAT-I) closes the circuit to the solenoid (C1-C2) on the thermomagnetic choke mounted on the carburetor.

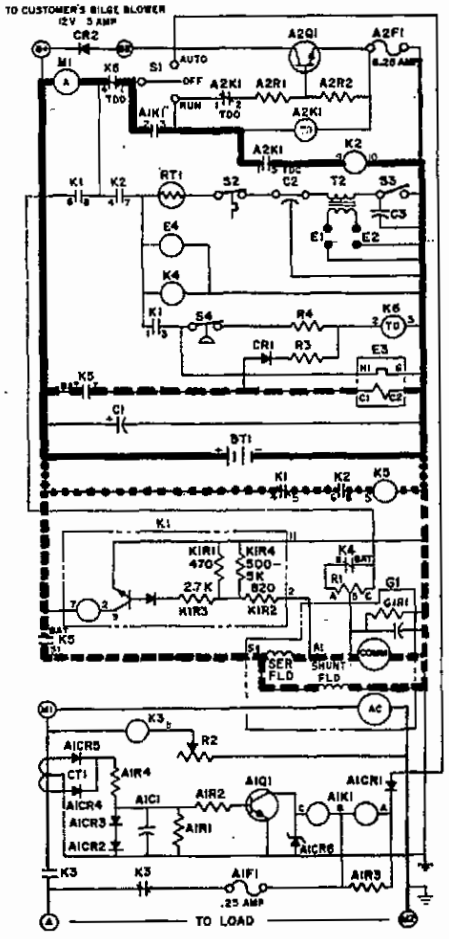

FIGURE 5-5. ENGINE CRANK CIRCUIT

CRANKING LIMITER

When start solenoid relay K5 picks up (Figure 5-6), contact I closes the circuit through diode CR1, resistor R3 to the heater on the time delay relay K6 (320-0104 emergency relay). If the generator set does not start within approximately 45 seconds, this relay opens it contacts to the time delay circuit and shuts the unit down. Diode CR1 serves as a blocking diode to prevent current flow to the choke control during a low oil-pressure condition.

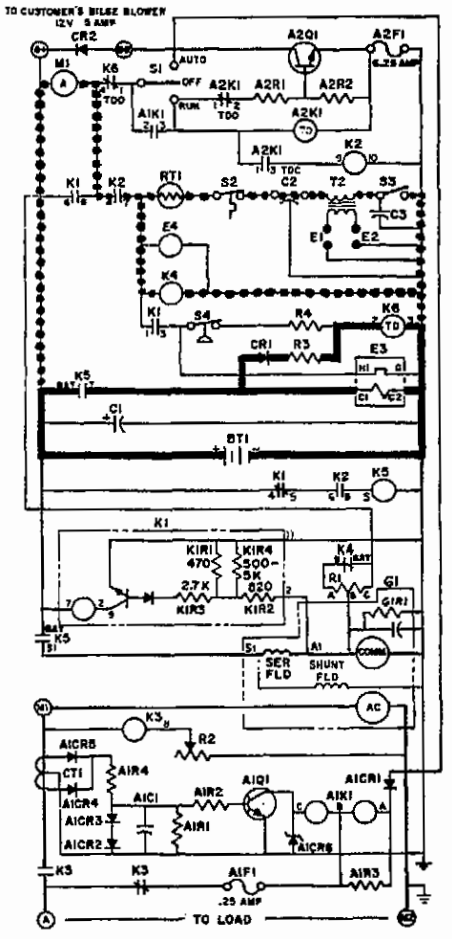

FIGURE 5-6. CRANKING LIMITER AND IGNITION

IGNITION

When relay K2 energizes, its contacts close the circuit to relay K4 and the ignition circuit. See Figure 5-6. Current flows through the ignition resistor (RT1), the high-water-temperature switch S2, the primary of the ignition coil and through the breaker points (S3) to ground. This supplies ignition power to spark plugs E1 and E2.

START DISCONNECT, CHOKE HEATER

When the generator set starts and voltage builds up, start disconnect relay K1 is energized by a transistor and Zener diode (Figure 5-7). K1 contacts (5-4) open the start relay K5 coil circuit. Relay K5 de-energizes opening its contacts to disconnect the cranking circuit and choke solenoid circuit.

Relay K1 contacts (1-3) close the circuit to the bi-metal heater (H1-G) of the thermo-magnetic choke. The bi-metal heats to open the choke for normal running as the engine warms up.

Relay K1 contacts (1-3) also close the circuit to time delay relay K6 through low oil pressure switch S4 and resistor R4. If oil pressure switch S4 does not open, time delay relay K6 operates to open the normally-closed contact K6 (1-4) to shut down the unit. Wait one minute, then push to reset.

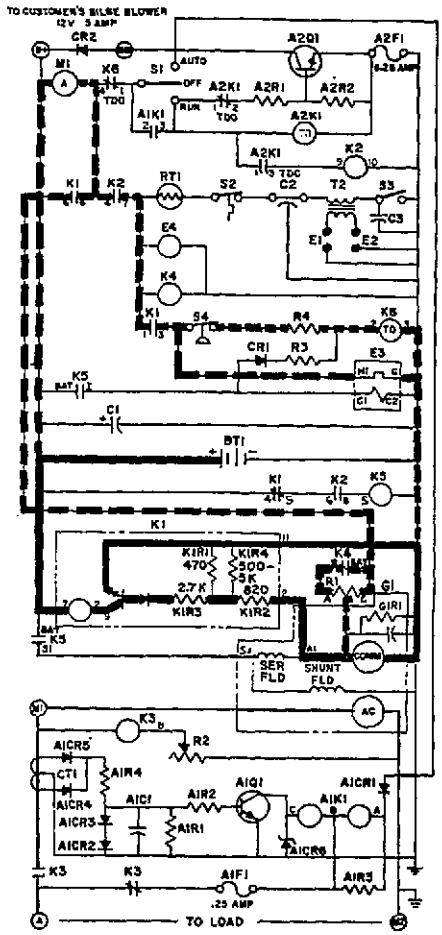

FIGURE 5-7. START DISCONNECT, CHOKE HEATER AND BATTERY CHARGE

BATTERY CHARGE

When the generator comes up to speed, it supplies battery charge current through lead S1 to start solenoid relay K5, and terminal S1 and resistor R1 (charge resistor). See Figure 5-7. The resistor is divided with the upper terminal C and the lower terminal A connected to the contact on the voltage regulator K4. The closed contact reduces the resistance to supply the high charge rate for fast battery charging.

Resistor R1 is set at factory for correct two-rate charging.

Current flows from the terminal of relay K4 through closed K1 contacts (6-8), through the ammeter back to the battery for charging. When the battery reaches a preset charge level, relay K4 is energized, opening the contacts and dropping the charge to a low rate.

GENERATOR SUPPLYING POWER

When the generator AC voltage reaches approximately 105 volts on 120-volt units or 210 volts on 240-volt units, line contactor K3 energizes to open the auxiliary contacts and close the main contacts (Figure 5-8). Load current through transformer CT1 produces current to load sensor control A1. Transistor A1Q1 switches on and passes current through both coils of relay A1K1 keeping it energized. This relay remains energized as long as a minimum 40-watt incandescent light load is across the output terminals of relay K3.

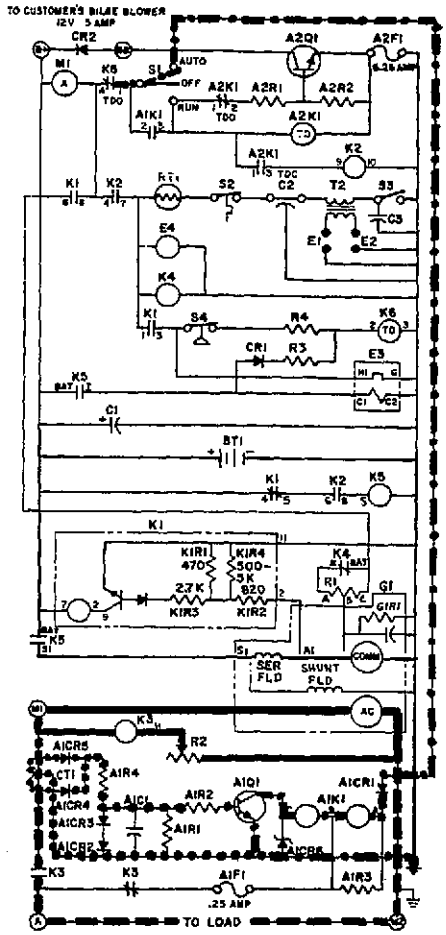

FIGURE 5-8. GENERATOR SUPPLYING POWER

STOP

When the load is removed, the flow of current through the transformer CT1 drops to zero. This switches the transistor off to de-energize relay A1K1. The contacts open to break the ignition circuit and stop the engine.

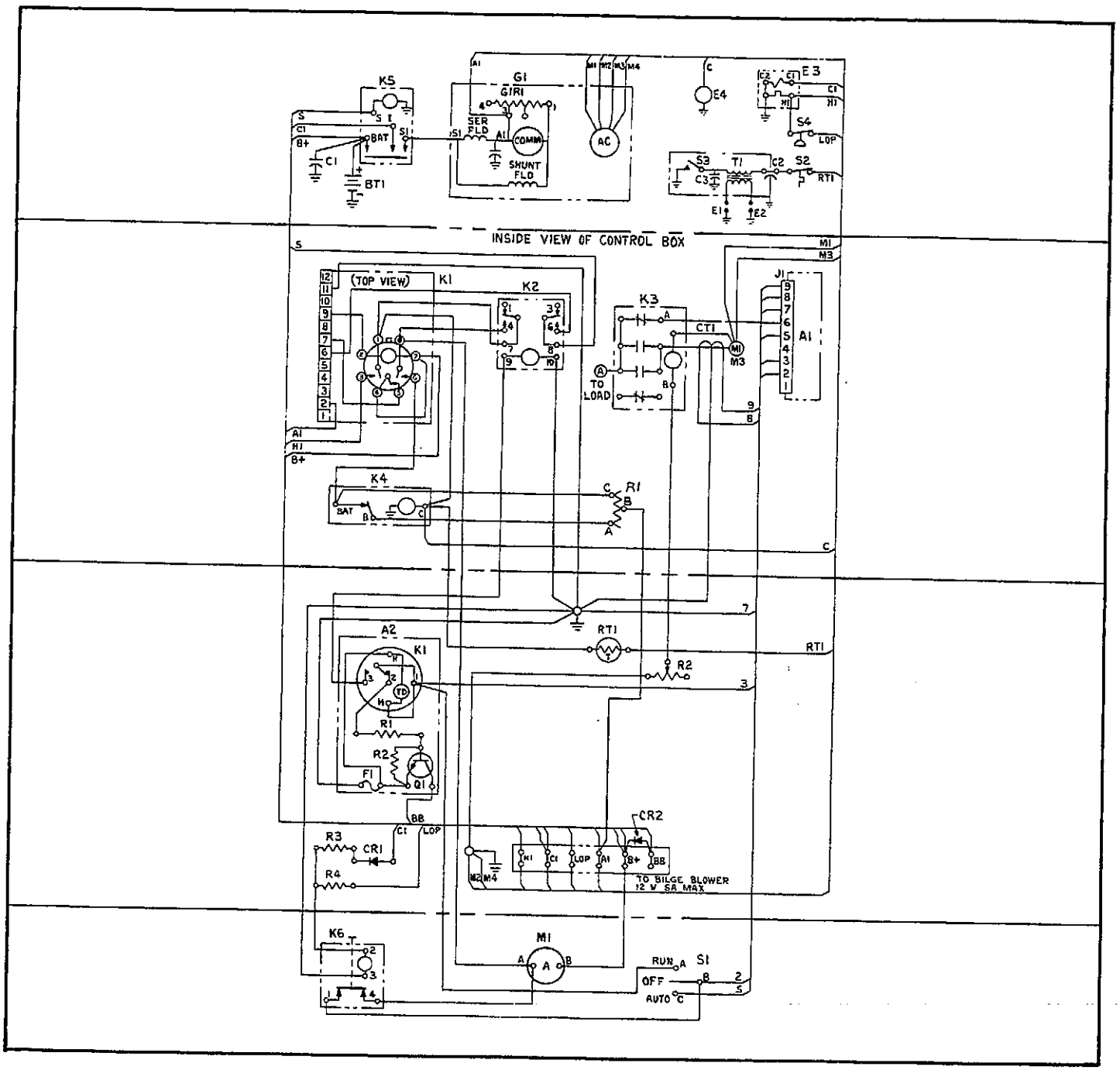

FIGURE 5-9. SPEC E AND F CONTROL-O-MATIC WIRING DIAGRAM

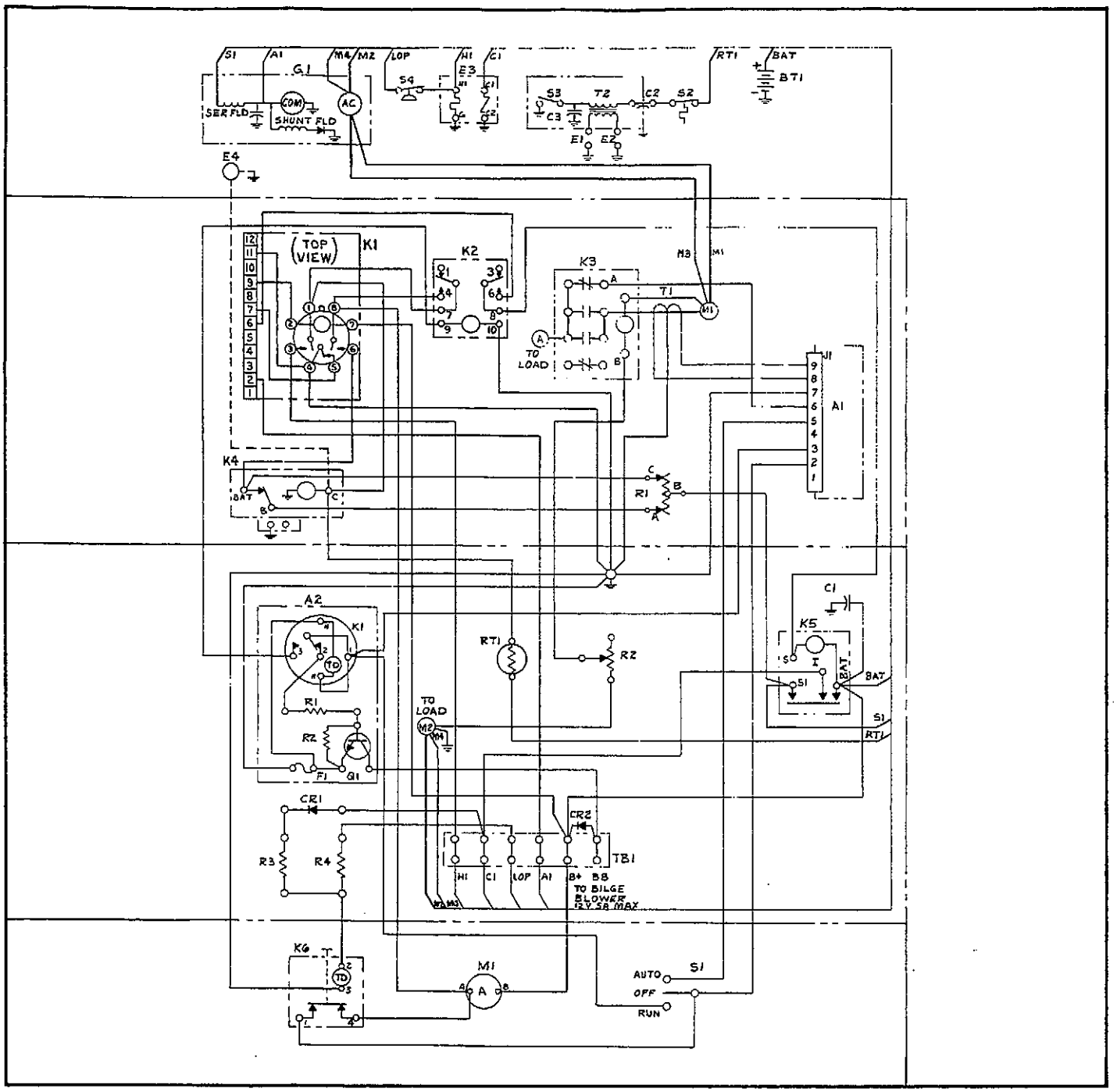

FIGURE 5-10. SPEC D CONTROL-O-MATIC WIRING DIAGRAM

SPEC C MODELS

Switch S1 is a three-position switch with a center "OFF" position. In the "RUN" position, the switch bypasses relay K4 contact (7-6) to energize the bilge blower control which goes through its time delay cycle before the generator cranks the engine. In the "AUTO" position, the Control-O-Matic starts the unit which runs as long as a load demand prevails. In this case, the load must be at least a 50-watt incandescent lamp.

LOAD DEMAND

When the generator set is in "AUTOMATIC" mode and a 40-watt lamp (or larger) is turned on, a load demand exists (Figure 5-11). Battery current flows through switch S1, relay coil K4 (2-3), K3 contacts, load terminal A, through the load to ground and back to the battery to energize relay K4.

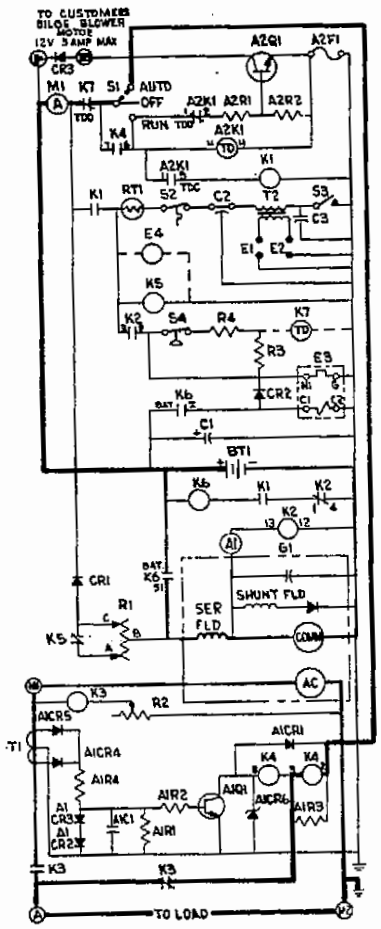

FIGURE 5-11. LOAD DEMAND

TRANSISTOR ON AND TIME DELAY

Relay K4 contacts (6-7) close the circuit from B+ through the heater of relay A2K1 to the 6-1/4-ampere fuse, to ground and back to the battery (Figure 5-12). The heater on the five-minute time delay begins its cycle. Simultaneously, as current flows through the heater on time delay A2K1, it also flows through the closed A2K1 contacts (1-2) through resistor A2R1 to the base of the transistor, through resistor A2R2, and through the fuse to ground. This switches on transistor A2Q1.

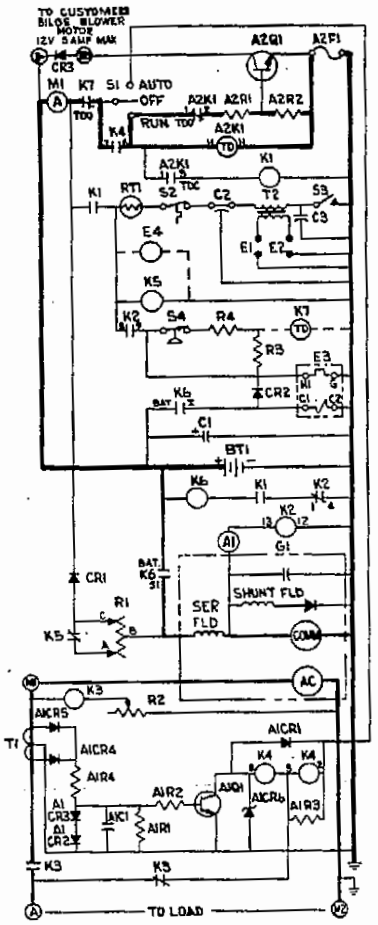

FIGURE 5-12. TRANSISTOR ON AND TIME DELAY

BILGE BLOWER ON

When transistor A2Q1 turns on, current flows from the B+ terminal through the bilge blower, to terminal BB through the transistor and fuse to ground (Figure 5-13). The bilge blower operates for five minutes to evacuate explosive vapors from the boat bilge. At the end of the five-minute period, time delay A2K1 operates to close contacts (1-3) and open contacts (1-2). Transistor A2Q1 turns off to interrupt the power to the bilge blower. Diode (CR3) between B+ and BB is a discharge diode to protect other components in the control from inductive voltage when the bilge blower is turned off.

ENGINE CRANK CIRCUIT

When time delay A2K1 contacts (1-3) close (Figure 5-14), current flows to energize the start-stop relay (K1). The K1 contacts close the circuit through K2 contacts (1-4) to energize start solenoid relay K6. The K6 main contact (BAT-S1) closes to supply battery power to the cranking windings on the generator.

CHOKE

The start solenoid K6 auxiliary contact (BAT-I) closes the circuit to the solenoid (C1-C2) on the thermomagnetic choke mounted on the carburetor (Figure 5-14).

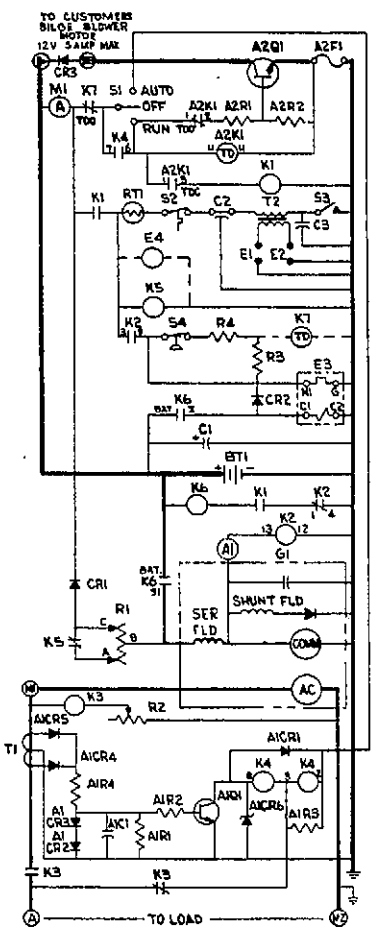

FIGURE 5-13. BILGE BLOWER ON

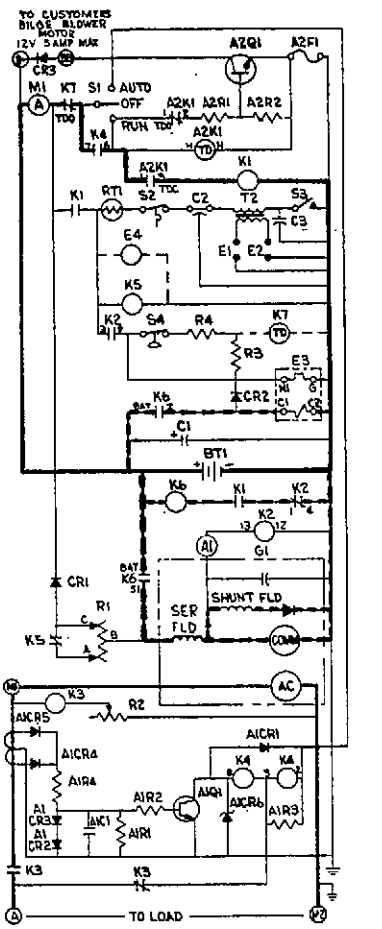

FIGURE 5-14. ENGINE CRANK CIRCUIT

CRANKING LIMITER

When start solenoid relay K6 picks up (Figure 5-15), contact I closes the circuit through diode CR2, resistor R3 to the heater on the time delay relay K7 (320-0104 emergency relay). If the generator set does not start within approximately 45 seconds, this relay opens its contacts to the control circuit and shuts the unit down. Diode CR2 serves as a blocking diode to prevent current flow to the choke control during a low oil-pressure condition.

IGNITION

When relay K1 energizes, its contacts close the circuit to relay K5 and the ignition circuit (Figure 5-15). Current flows through the ignition resistor (RT1), the high-water-temperature switch (S2), the primary of the ignition coil and through the breaker points (S3) to ground. This supplies ignition power to spark plugs E1 and E2.

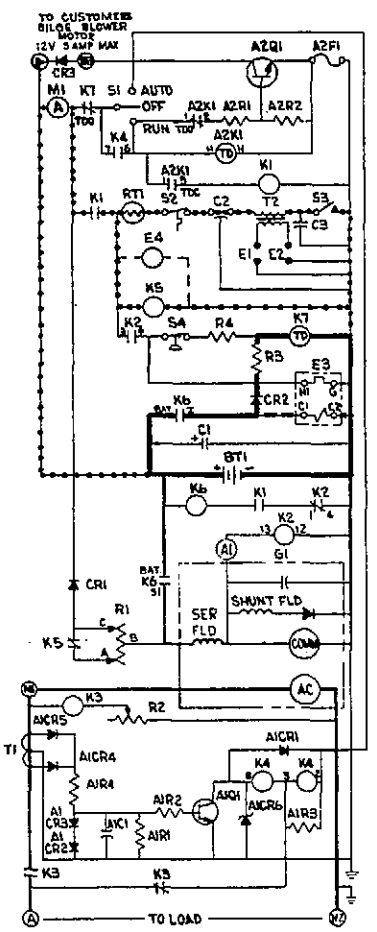

FIGURE 5-15. CRANKING LIMITER AND IGNITION

START DISCONNECT, CHOKE HEATER AND BATTERY CHARGE

When the generator set starts, start disconnect relay K2 energizes start disconnect relay (307-0642). See Figure 5-16. Relay K2 contacts (1-4) open the start relay (K6) coil circuit. Relay K6 de-energizes opening its contacts to disconnect the cranking circuit and choke solenoid circuit.

Relay K2 contacts (3-9) close the circuit to the bi-metal heater (H1-G) of the thermo-magnetic choke. The bi-metal heats to open the choke for normal running as the engine warms up.

Relay K2 contacts (3-9) also close the circuit to time delay relay K7 through low oil pressure switch S4 and resistor R4. If oil pressure switch S4 does not open, time delay relay K7 operates to open the normally-closed contact to shut down the unit. Wait one minute, then push to reset.

BATTERY CHARGE

When the generator comes up to speed, it supplies battery charge current through lead S1 to start solenoid relay K6, and terminal S1 to resistor R1 (charge resistor). See Figure 5-16. The resistor is divided with the upper terminal C and the lower terminal A connected to the contact on the voltage regulator K5. This supplies the high charge rate for fast battery charging.

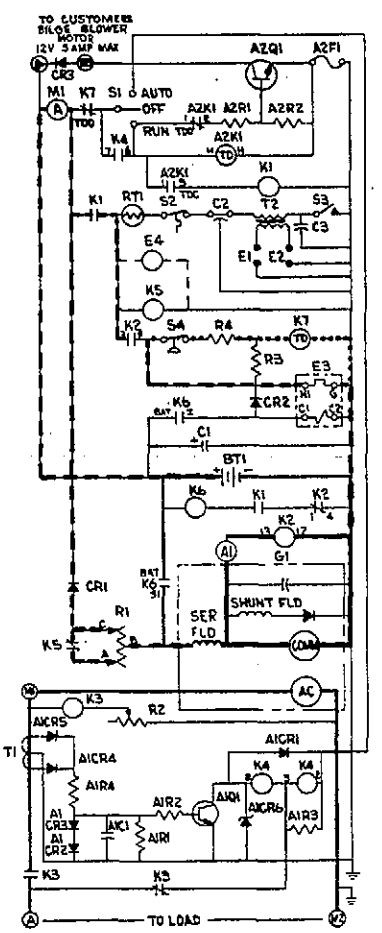

FIGURE 5-16. START DISCONNECT, CHOKE HEATER AND BATTERY CHARGE

Current flows from the terminal of relay K5 through the reverse current diode (CR1), through the ammeter back to the battery for charging. When the battery reaches a preset charge level, the coil on relay K5 is energized, opening the contacts and dropping the charge to a low rate.

Resistor R1 is set at the factory for correct two rate charging.

GENERATOR SUPPLYING POWER

When the generator AC voltage reaches approximately 105 volts on 120-volt units or 210 volts on 240-volt units, line contactor K3 energizes to open the auxiliary contacts and close the main contacts (Figure 5-17). Load current through transformer T1 produces current to load sensor control A1. Transistor A1Q1 switches on and passes current through both coils of relay K4 keeping it energized. This relay remains energized as long as a minimum 40-watt incandescent light load is across the output terminals of relay K3.

STOP

When the load is removed, the flow of current through the transformer T1 drops to zero. This switches the transistor off to de-energize relay K4. The contacts open to break the ignition circuit and stop the engine.

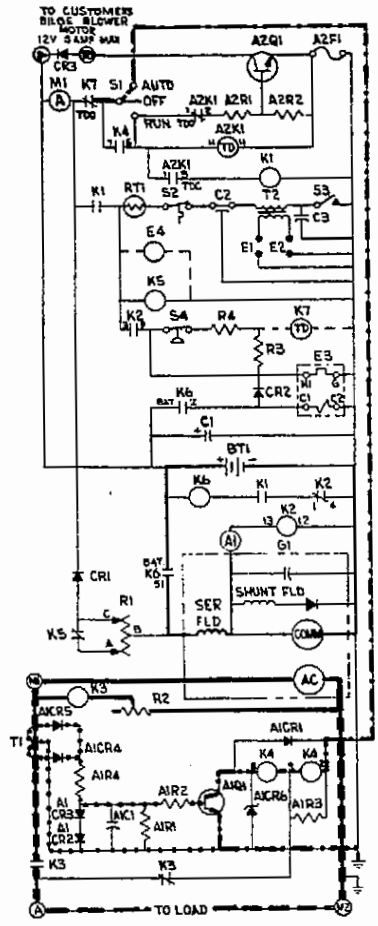

FIGURE 5-17. GENERATOR SUPPLYING POWER

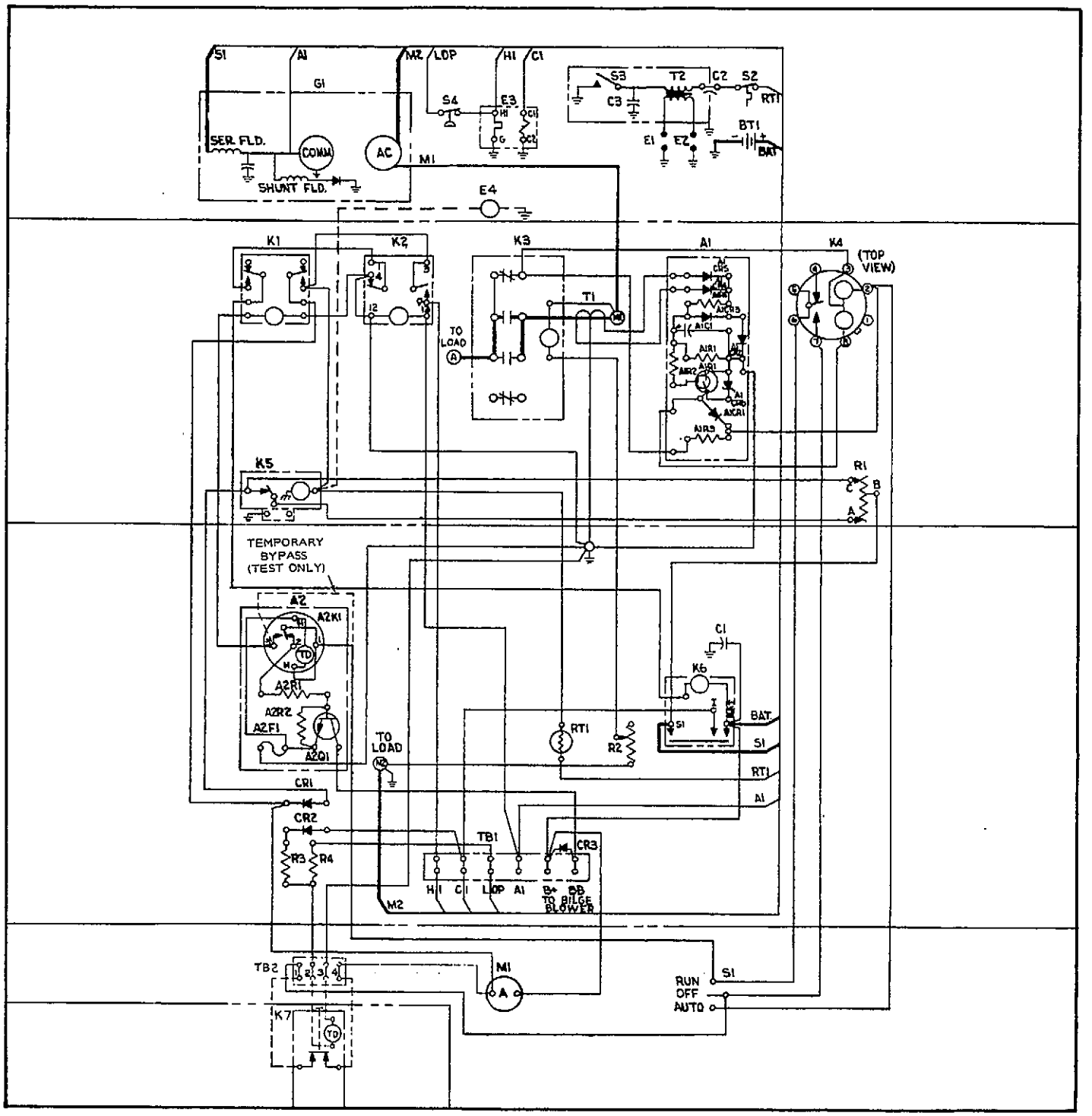

FIGURE 5-18. SPEC C CONTROL-O-MATIC WIRING DIAGRAM

TROUBLESHOOTING

Find the trouble listed, then perform the checks in order given. Tests for the printed circuit board or load sensor board are given after the troubleshooting procedures. A 20,000 ohm/volt VOM is needed for some of the following tests.

SPEC D THROUGH F (120-VOLT)

Generator set won't crank after bilge blower delay with Control-O-Matic switch in "RUN" position.

1. Check battery connections and battery voltage.
2. Check to see if start solenoid K5 picks up. If not:

   Spec E and F: Check for a faulty solenoid by connecting a jumper from the S terminal to battery positive (B+). This bypasses contacts K1 and K2. If it picks up, check for proper operation of relays K1 and K2.

   Spec D only: Check for a faulty solenoid by connecting a jumper from the S terminal to ground. This bypasses contacts K1 and K2. If it picks up, check for proper operation of relays K1 and K2.

Generator set does not crank on load demand.

1. Move the toggle switch to "RUN" position. Unit should crank after approximately a five-minute delay.
2. Apply some load (at least 100 watts) to load the circuit. Move toggle switch to "AUTO" position. Unit should continue running.
3. If unit stops with 100-watt load, move toggle switch to "OFF" position. Remove cover from A1K1 printed circuit board. Connect a jumper wire from terminal C of relay A1K1 to the ground terminal in the Control-O-Matic. Move toggle switch to "AUTO". Unit should start and run. If it does not, remove relay to check continuity of relay coil terminals A, B and C of 307-1087. Resistance A-C equals approximately 34 ohms. See Figure 5-19.

   Apply 6 to 12 volts to terminals A-C to see if relay operates. When relay operates, contacts should close.
4. If relay is okay, check voltages as follows. The voltage measured from the chassis-ground terminal to:
   a. the B+ terminal on the start solenoid should equal battery voltage.
   b. terminal A of relay socket should equal battery voltage less 0.5 to 0.7 volts.
   c. terminal B of start-run relay should be near zero if K3 contact is closed properly and sufficient load is connected to the load circuit.
5. Check voltages of load sensor amplifier with unit running under a minimum load of 100 watts. Start generator set in "AUTO" position for this test by jumpering the outside terminals of switch S1.
   a. Measure AC output voltage of transformer T1 at terminals on load sensor amplifier. The voltage should read 2 to 3 VAC.

      Use a 20,000 ohm voltmeter to minimize error.
   b. Voltage from ground to the transistor side of resistor A1R2 should measure 0.6 to 0.7 VDC.
   c. Voltage across A1K1 coil A-C should read 5 to 14 VDC.
   d. Remove jumper from switch S1.

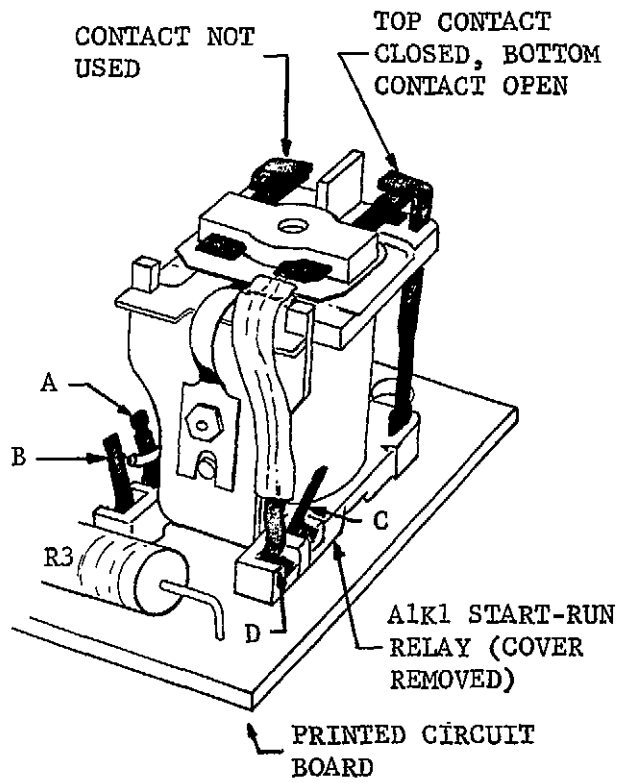

FIGURE 5-19. START-RUN RELAY A1K1

Generator set starts automatically under load, but stops when contactor pulls in.

1. Recheck size and type of load. Minimum requirements are a 50-watt incandescent lamp load or a 425-watt heater load.
2. Recheck adjustment of contactor pick-up resistor R2.
   a. Apply a load and help contactor pick up and hold in as the generator set starts. If this corrects the problem, reduce the resistance of R2.
   b. Apply a load and hold the contactor to delay pick-up. If this helps, increase the resistance setting of resistor R2.
3. Move toggle switch to the "OFF" position. Connect a jumper from terminal C of relay A1K1 to ground terminal. Move toggle switch to the "AUTO" position. The unit should start and run.
4. Apply a load such as a 100-watt lamp; then remove the jumper while the unit is running with the switch in the "AUTO" position. If it stops, place the toggle switch to "OFF," jumper the two outside terminals of the toggle switch, and place switch in "AUTO" position to restart. While the unit is running with a 100 watt minimum load, measure the voltage on the load sensor amplifier as follows:
   a. AC output voltage of transformer CT1 (Spec E and F) or T1 measured at terminals on load sensor amplifier should be 2 to 3 VAC.
   b. Voltage from ground to the transistor side of resistor A1R2 should measure 0.6 to 0.7 VDC.
   c. Voltage across A1CR6 should read less than 5 VDC.
   d. Voltage across relay A1K1 coil A-C should read 5 to 14 VDC.

Generator set will not stop when load is removed.

1. Move the toggle switch to the "OFF" position to stop the generator set. If the engine does not stop, remove the battery lead and check for a faulty start solenoid. The contacts may have stuck closed.

2. Remove the load from the load side of the contactor in the Control-O-Matic and reconnect battery.
3. Move toggle switch to "AUTO" position.
   a. If the unit does not crank, place the toggle switch in the "RUN" position to start the unit. Move the switch to "AUTO" position; the generator set should stop. If the unit stops with the load lead removed from the load side of the contactor, it indicates that there was sufficient load on the AC line to keep the Control-O-Matic energized. Recheck the load circuit.
   b. If the generator set cranks with the toggle switch in the "AUTO" position and the load lead disconnected, the start-run relay or load amplifier are malfunctioning. Remove the ground lead from battery.
4. Take out the printed circuit board and remove the cover from the start-run relay A1K1 (marked "K1" on board). See Figure 5-19 for references during tests.
   a. With the VOM set at x10, measure resistance between A and B — should be approximately 34 ohms. Resistance between A and C or B and C should be approximately 650 ohms (x100 scale). As shown in Figure 5-19, the top K1 contact should be closed, the bottom contact open. There should be continuity between the top contact and point D.
   b. Check Zener diode A1CR6 ("CR6" on printed circuit board). Resistance should be 600 ohms in one direction, infinity in the other direction. Check resistance of transistor A1Q1 (marked "Q1" on p.c. board) leads in one direction, then reversing leads and checking resistance in that direction. B to C — 750 ohms, infinity; B to E — 750 ohms, 11,000 ohms; C to E — 700 ohms, infinity.

Bilge blower control circuit does not function.

Check the 6-1/4-ampere fuse A2F1.

Blower circuit is continuously energized and generator set won't crank.

Check heater element of thermal relay for an open circuit or a poor connection which may prevent relay from heating up enough to switch.

Blower circuit is not energized, but unit starts after a 2- to 6-minute period.

1. Check blower operation by placing a jumper from terminal BB to ground. Switch S1 must be in "RUN" position for these checks. Measure voltage from BB to ground — should be 2 volts or less.
2. Measure voltage from terminal 2 of A2K1 to ground. Voltage should equal battery voltage. Check voltage across resistor A2R2. Voltage should be 0.7 to 1.5 volts. If these tests are satisfactory, the transistor is defective. Replace it.

SPEC C ONLY (120-VOLT)

Generator set won't crank after bilge blower delay with Control-O-Matic switch in "RUN" position.

1. Check battery connections and battery voltage.
2. Check to see if the start solenoid K6 picks up. If it doesn't, check for a faulty solenoid by connecting a jumper from the S terminal to ground. This bypasses contact K1 and K2. The start solenoid should pick up. If it picks up, check for proper operation of relay K1 and K2.

Generator set does not start on load demand.

1. Move the toggle switch to "RUN" position. Unit should crank after approximately a five-minute delay.
2. Apply some load (at least 100 watts) to load the circuit. Move toggle switch to "AUTO" position. Unit should continue running.
3. If unit stops with 100-watt load, move toggle switch to "OFF" position. Connect a jumper wire from terminal 8 of relay K4 to the ground terminal in the Control-O-Matic. Move toggle switch to "AUTO." Generator set should start and run. If it does not, remove relay to check continuity of relay coil terminals 2-3 and 8 of 307-0062. Resistance 2-3 equals approximately 100 ohms; 2-8 equals approximately 1000 ohms. Apply 6 to 12 volts to terminals 2-8 to see if relay operates. When relay operates, contacts 4-6 open and contacts 6-7 close.
4. If relay is good, check voltages as follows. The voltage measured from the chassis-ground terminal to:
   a. the B+ terminal on the start solenoid should equal battery voltage.
   b. terminal 2 of relay socket should equal battery voltage.
   c. terminal 3 of start-run relay should be near zero if K3 contact is closed properly and sufficient load is connected to the load circuit.
5. Check voltages of load sensor amplifier with unit running under a minimum load of 100 watts. Start generator set in "AUTO" position for this test by jumpering the outside terminals of switch S1.
   a. Measure AC output voltage of transformer T1 at terminals on load sensor amplifier. The voltage should read 2 to 3 VAC. Use a 20,000-ohm voltmeter to minimize error.
   b. Voltage from ground to the transistor side of resistor A1R2 should measure 0.6 to 0.7 VDC.
   c. Voltage across A1CR1 should read 5 to 14 VDC.
   d. Remove jumper from switch S1.

Generator set starts automatically under load, but stops when contactor pulls in.

1. Recheck size and type of load. Minimum requirements are a 50-watt incandescent lamp load or a 425-watt heater load.
2. Recheck adjustment of contactor pick-up resistor R2.
   a. Apply a load and help contactor pick up and hold in as the generator set starts. If this corrects the problem, reduce the resistance of R2.
   b. Apply a load and hold the contactor to delay pickup. If this helps, increase the resistance setting of resistor R2.
3. Move toggle switch to the "OFF" position. Connect a jumper from terminal 8 of relay K4 to ground terminal. Move toggle switch to the "AUTO" position. The generator set should start and run.
4. Apply a load, such as a 100-watt lamp; then remove the jumper while the unit is running with the switch in the "AUTO" position. If the unit stops, place the toggle switch to "OFF," jumper the two outside terminals of the toggle switch, and place in "AUTO" position to

restart. While the unit is running with a 100-watt minimum load, measure the voltage on the load sensor amplifier as follows:

a. AC output voltage of transformer T1, measured at terminals on load sensor amplifier should be 2 to 3 VAC.

b. Voltage from ground to the transistor side of resistor A1R2 should measure 0.6 to 0.7 VDC.

c. Voltage across A1CR6 should read less than 5 VDC.

d. Voltage across diode A1CR1 should read 5 to 14 VDC.

Generator set won't stop when load is removed.

1. Move the toggle switch to the "OFF" position to stop the unit. If the generator set does not stop, remove the battery lead and check for a faulty start solenoid. The contacts may have stuck closed.
2. Remove the load from the load side of the contactor in the Control-O-Matic and reconnect battery.
3. Put toggle switch in "AUTO" position.
   a. If the generator set does not crank, place the toggle switch in the "RUN" position to start the unit. Put the switch in "AUTO" position: it should stop. If it stops with the load lead removed from the load side of the contactor, it indicates that there was sufficient load on the AC line to keep the Control-O-Matic energized. Recheck the load-circuit.
   b. If the generator set cranks with the toggle switch in the "AUTO" position and the load lead disconnected, the start-run relay or load amplifier are malfunctioning. Remove the ground lead from battery. Remove the start-run relay. Check continuity from terminal 6 to 7 of relay 307-0062. This circuit should be open. Check continuity with 1-1/2 volts or less from tube socket pin 8 to ground. The circuit should show a high resistance (approximately 20,000 ohms), with positive on pin 8 and will show a low resistance (approximately 20 ohms) with negative to pin 8.
   c. If this check indicates continuity in both directions, unsolder one end of Zener diode A1CR6 and repeat same test. If resistance increases to the expected values, the Zener diode has shorted. To verify this, check continuity in both directions on the Zener diode itself. If resistance does not increase with the diode disconnected, check the transistor for a short from the collector to the emitter.

Bilge blower control circuit does not function.

Check the 6-1/4-ampere fuse A2F1.

Blower circuit is continuously energized and generator set won't crank.

Check heater element of thermal relay for an open circuit or a poor connection which may prevent relay from heating up enough to switch.

Blower circuit is not energized, but unit starts after 2- to 6-minute period.

1. Check blower operation by placing a jumper from terminal BB to ground. Switch S1 must be in "RUN" position for these checks. Measure voltage from BB to ground — should be 2 volts or less.
2. Measure voltage from terminal 2 of A2K1 to ground. This voltage should equal battery voltage. Check voltage across resistor A2R2. Voltage should be 0.7 to 1.5 volts. If these tests are satisfactory, the transistor A2Q1 is defective. Replace it.

PRINTED CIRCUIT BOARD AND LOAD SENSOR BOARD TESTS

300-0740 PRINTED CIRCUIT BOARD

Remove the printed circuit board from the control. Check components with an ohmmeter set at R X 100 scale except where noted. Always recheck zero setting when changing scale settings.

CAUTION **The volt-ohm-milliameter used must have batteries of 3 volts or less or diodes on the printed circuit board can be damaged during the tests.**

With the printed circuit board positioned as shown in Figure 5-20, start the tests on the left. All readings given are approximate.

1. Condenser C1 and resistor R1 have a resistance of approximately 10,000 ohms in one direction and 1100 ohms in the other direction.
2. Rectifiers CR2 and CR3 normally have resistance of 15,000 ohms in one direction and 750 ohms in the other direction.
3. Check transistor Q1 (three-lead component) like a rectifier. Check resistance in one direction, reverse leads and check resistance in that direction. B to C - 750 ohms, infinity; B to E - 750 ohms, 11,000 ohms; C to E - 700 ohms, infinity.
4. Resistors R2 and R4 should have resistances of 200 ohms and 47 ohms respectively. Use R X 1 scale for R4.
5. Rectifiers CR4 and CR5 should have a resistance of 600 ohms in one direction, infinity in the other direction.
6. Resistance of Zener diode CR6 should be 700 ohms in one direction, infinity in the other direction.
7. Rectifier CR1 normally has 600 ohms in one direction, infinity in the other direction.
8. Using the R X 1 scale, check resistor R3. Resistance should be 33 ohms.

300-0573 LOAD SENSOR BOARD

Check the load sensor board components using the wiring diagrams and Figure 5-21 as references.

1. Place the control in the "OFF" position and disconnect the battery if the sensor board is mounted in the control. Check components starting at the left side of the board with an ohmmeter set at R X 100 scale.
2. The first resistor should be 25 ohms, ±10%.
3. Check the rectifier by placing the ohmmeter leads on the terminals. The resistance should be higher in one direction than in the other (when leads are reversed). If zero or the same in both directions, replace.
4. The Zener diode should have high resistance in one direction and fairly high in the other when leads are reversed. If meter has high-voltage batteries and the scale selection applies over 20 volts, the diode will conduct in one direction and indicate a low ohm value or zero in the other direction. If resistance is low both directions, replace.
5. Check transistor (3-lead component) like a rectifier. Check resistance in one direction, reverse leads and check in the other direction. Repeat check in both directions for all three leads. Should have high resistance in one direction and low in the other. Replace if low or high resistance in both directions.
6. The vertical resistor to the right of the transistor should be 2,200 ohms ±10%. The horizontal resistor should be 220 ohms ±10%.
7. The condenser (+ mark up) should indicate resistance of approximately 750 ohms in one direction and approximately 340 ohms in the other.

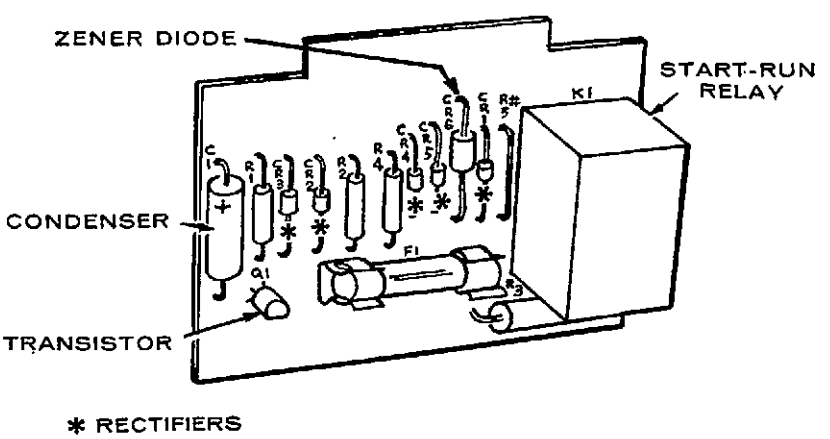

FIGURE 5-20. 300-0740 PRINTED CIRCUIT BOARD

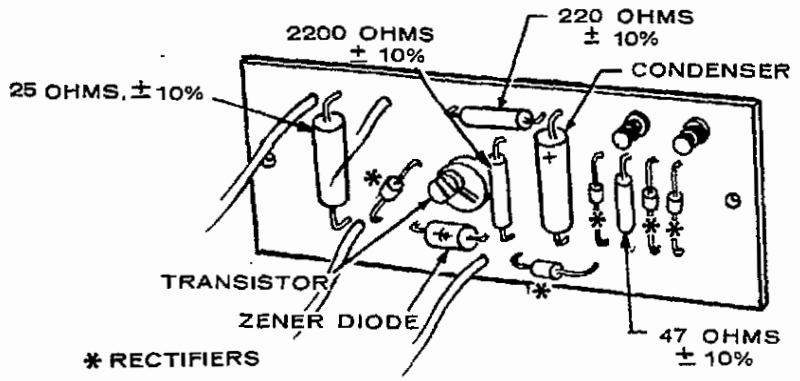

FIGURE 5-21. 300-0573 LOAD SENSOR BOARD

8. Check the two rectifiers (one vertical, one horizontal) the same as other rectifiers. Resistance should be approximately 1150 ohms one direction and approximately 300 ohms in the other.
9. The vertical resistor should be 47 ohms ±10%.
10. Check the two rectifiers on the right side of the board in the same manner as the other rectifiers. Resistance should be high in one direction and low in the other. If zero or extremely low in both directions, replace.

CONNECTIONS FOR BILGE BLOWER OPERATION

CONNECTING AUXILIARY RELAY TO CONTROL-O-MATIC

This circuit allows a separate battery or power source to operate the bilge blower. See Figure 5-22. It also permits use of larger blowers with running currents in excess of 5 amperes. The auxiliary relay should have a 12 VDC coil and contacts heavy enough to carry the current required by the bilge blower.

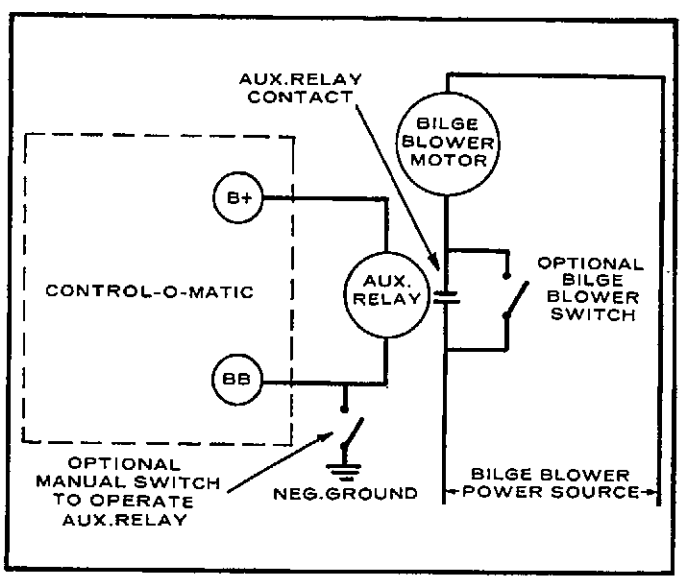

FIGURE 5-22. AUXILIARY RELAY CONNECTIONS

CONNECTING BILGE BLOWER TO CONTROL-O-MATIC

With this circuit, the bilge blower operates on power from the generator set cranking battery (Figure 5-23). The optional switch will run the bilge blower as long as the switch is closed. The bilge blower running current must not exceed 5 amperes.

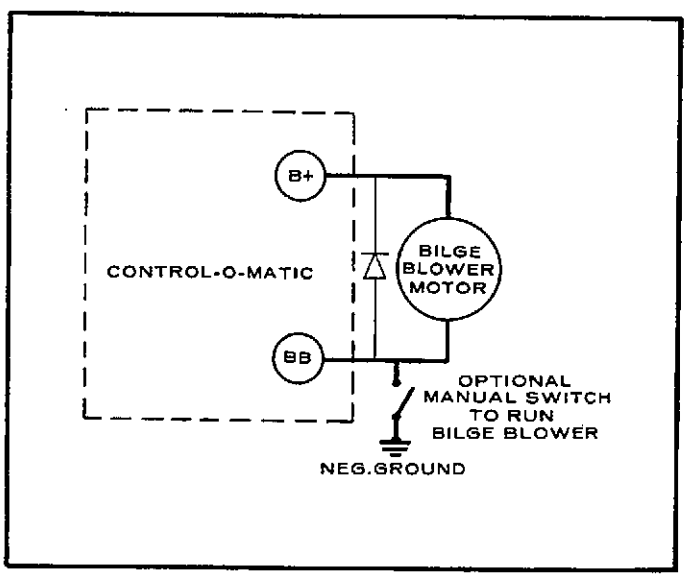

FIGURE 5-23. BILGE BLOWER CONNECTIONS

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