Onan

Service Manual

HA

Automatic Demand Controls

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6-84
Printed in U.S.A.

Safety Precautions

Before performing maintenance or service on your HA controlled generator set system, read all related manuals and become thoroughly familiar with your system components. Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow simple and fundamental rules or precautions.

This manual includes the following symbols to indicate potentially dangerous conditions to personnel and equipment. Read the manual carefully and know when these conditions exist. Then take the necessary steps to protect personnel and the equipment.

⚠DANGER ***This symbol if used warns of immediate hazards which will result in severe personal injury or death.***

⚠WARNING ***This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.***

⚠CAUTION ***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***

This controller has components with high AC voltages which present potential hazards that can result in severe personal injury or death. For this reason, service personnel should periodically review the following safety precautions and also the safety precautions listed in other equipment manuals.

- During normal operation, keep the controller cabinet closed.
- When performing service or maintenance to your system components, tag the controller with a warning sign to inform others not to operate.
- Before performing maintenance or making adjustments, move the controller switch to MANUAL position and the generator set switch to STOP position. Then disconnect generator set starting batteries to prevent an accidental start-up.
- If adjustment must be made while the system is operating, use extreme caution due to the danger of electrical shock hazards, hot manifolds, moving parts, etc.
- Jewelry is a good conductor of electricity and should be removed when working on the electrical equipment.
- Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.
- Except for allowable adjustments, do not tamper with, alter, or otherwise try to bypass interlock control circuits of your generator set system. Non-prescribed control modifications present potentially hazardous conditions that can result in severe personal injury or equipment damage.
- Follow all state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches.
- Keep your generator set system equipment and their surrounding areas clean and free from obstructions. Remove any debris and keep the area clean and dry.
- Provide appropriate fire extinguishers and install them in convenient locations. Consult your local fire department for the correct type of extinguisher to use. Do not use foam on electrical fires. Use extinguisher rated ABC by NFPA
- Do not work on equipment when mentally or physically fatigued.
- Onan suggests copying and posting these suggestions in potential hazard areas of the vessel. Most important, exercise caution and use common sense.

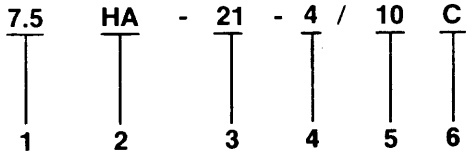
HA AUTOMATIC DEMAND CONTROLS

INDEX

GENERAL INFORMATION

The HA automatic demand control provides automatic starting of a generator set when a load (lighting, motor, or other electrical device) is switched on. When the electrical load is removed, it automatically stops the generator set. It is designed to operate an Onan generator set as the only power source, not as a standby unit during commercial power outages. Therefore, if an AC load demand is intermittent, the generator set does not need to run continuously.

INTERPRETATION OF MODEL AND SPEC FROM NAMEPLATE



1. Watt Rating. Number 7.5 designates 7.5 kilowatts, 15.0 designates 15.0 kilowatts.
2. Series Designation.
3. Frequency and Voltage Code.

   Tens digit 2 designates 50- or 60-hertz operation. A number 5 designates 50-hertz only. No number designates 60-hertz operation only.

   Units digit 1 designates voltage, wire, and phase. Number 1 indicates 120 volts, single-phase, two-wire. See nameplate for specific voltage.
4. Engine-Cranking Voltage Code. Number 3 = 24-volt cranking, 4 = 32-volt cranking, no code number = 12-volt cranking.
5. Code for Start Time Delay. Number 10 indicates 20-second time delay for diesel, number 12 indicates a 5-second time delay for gasoline. No code number indicates use for an exciter-cranked gasoline generator set.
6. Specification Letter. Advances with production modification.

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

BASIC PRINCIPLES OF OPERATION

When the generator set is not running, the DC starting battery is connected across the line (in place of AC voltage). When a load is connected across the line (when a light is turned on for example), the small amount of current flowing through the 120-volt bulb (from the battery) operates a sensitive relay to the generator set start circuit. When the generator set starts and reaches full speed, another relay disconnects the battery from the line and connects the 120-volt output of the generator set to the line (load).

The generator set will continue to run if engine AC current flows through the load from the generator set. In general, a 40-watt load keeps a 120-volt generator set running (100 watts for a 240-volt generator set).

The HA automatic demand control requires little attention, but if difficulties arise, use the operation description, service information, and troubleshooting chart to diagnose and locate the trouble. Circuit descriptions first cover the Spec D models, then the Spec C models, and finally the Spec A and B models.

SPEC D MODELS

PILOT CIRCUIT

The pilot circuit initiates generator crank and start when there is a demand for electric power (Figure 4-1). If an AC load is connected to the generator set, DC current from the B+ terminal flows through safety breaker contacts K3, auto-manual switch S1 (in AUTO position) rectifier A1CR1, one-half the relay coil A1K1, fuse A1F1, contact K2, and the AC load to common ground and battery to energize the start-stop relay A1K1.

BILGE BLOWER

When start-stop relay A1K1 energizes to close its normally-open contacts A1K1 (3-2), it completes a circuit from transistor A2Q1, resistor A2R1, normally-closed contacts A2K1 through the A1K1 contacts, auto-manual switch S1 to ground. Transistor A2Q1 turns on to conduct B+ through F1, A2Q1 to terminal 5 for operation of the bilge blower (Figure 4-2).

Contacts A1K1 (3-2) also connect a ground to the bilge blower control relay A2K1 and relay K5. Relay K5 begins a five-minute delay while the bilge blower operates to evacuate explosive vapors from the bilge.

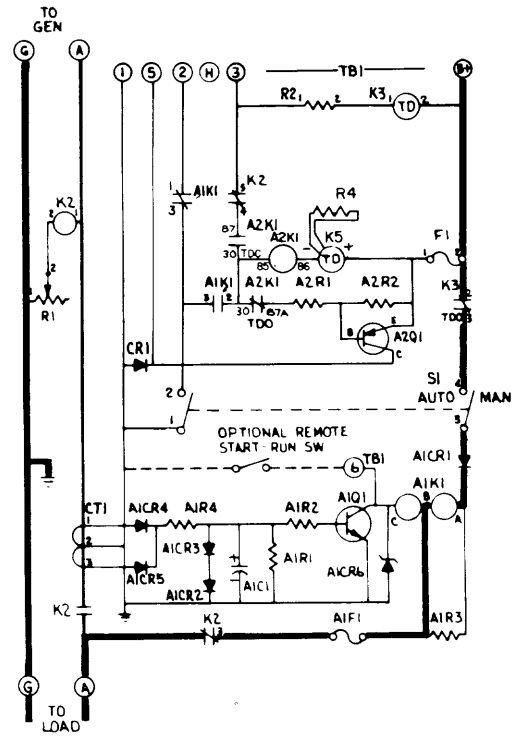


FIGURE 4-1. PILOT CIRCUIT

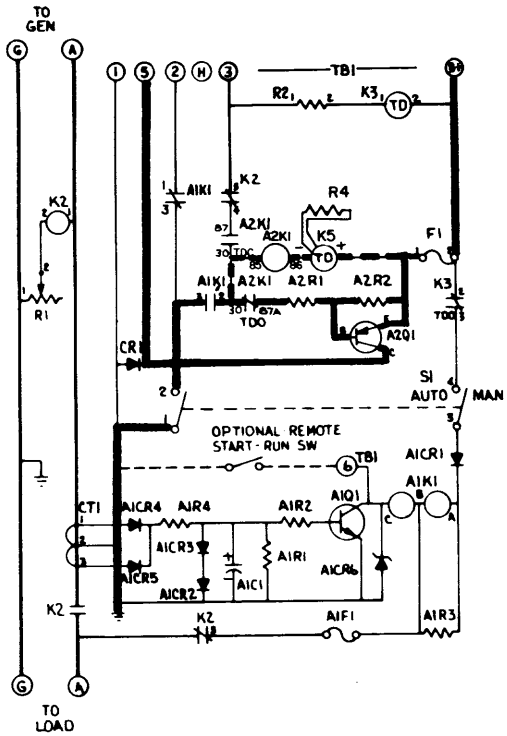


FIGURE 4-2. ENERGIZATION OF BILGE BLOWER CIRCUIT

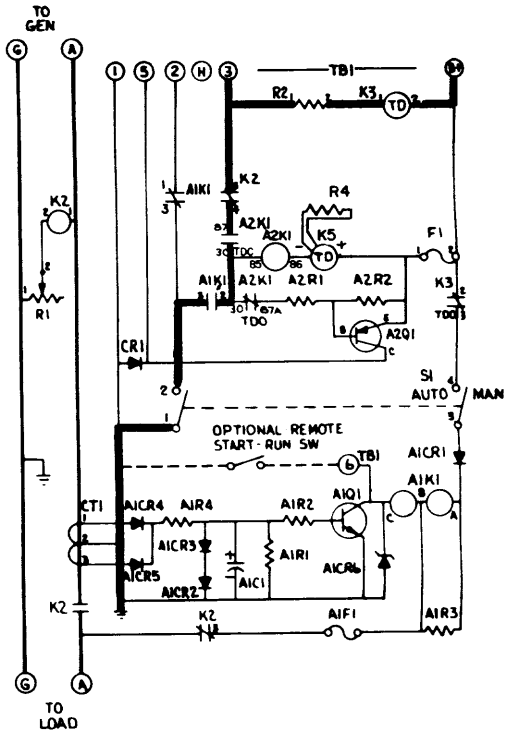


FIGURE 4-3. CRANKING LIMITER

CRANKING CIRCUIT

At the end of the five-minute delay, bilge blower relay A2K1 opens its normally-closed A2K1 contacts (30-87A) to remove battery ground from transistor A2Q1. Transistor A2Q1 turns off removing B+ from terminal 5 for the bilge blower operation. Relay A2K1 also closes its normally open contacts A2K1 (30-87) to connect battery ground through K2 contacts (5-4) to terminal 3. Terminal 3 connects to the generator set start circuit.

DC current from B+ terminal flows through cranking limiter K3, resistor R2, normally-closed K2 contacts, A2K1 contacts (30-87), A1K1 contacts (3-2) and auto-manual switch S1 to ground (Figure 4-3). If the generator set does not start within 45 to 90 seconds, the heat produced by the element in the cranking limiter causes relay K3 contacts (2-3) to open the circuit to start-stop relay A1K1. Relay A1K1 is deenergized to open its normally-open contacts which removes battery ground from start terminal 3. Wait at least one minute before resetting the breaker. This time allows the material in the breaker to solidify and hold the contacts closed so cranking can resume.

GENERATOR RUN CIRCUIT

When the engine starts and the generator AC voltage builds up to approximately 210 volts on 240-volt units, line contactor K2 is energized (Figure 4-4). Resistor R1 adjusts the line contactor pick-up voltage.

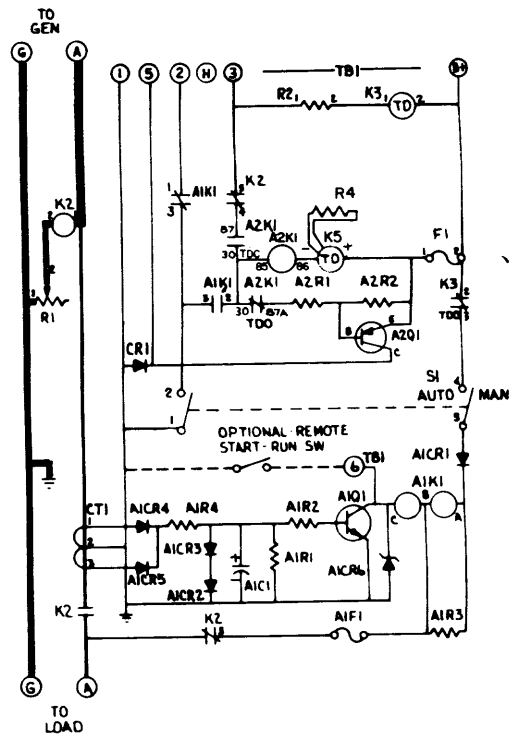


FIGURE 4-4. GENERATOR RUN CIRCUIT

POWER CIRCUIT

When the contactor K2 energizes, the pilot circuit interlock contacts open just before the power contacts close (Figure 4-5). The closed K2 contacts open to break the grounding circuit from control terminal 3. The circuit to the coil of A1K1 opens and prevents application of generator voltage to the low voltage control circuit.

Load current passes through the primary of the current transformer CT1 to induce a voltage in the transformer secondary. Current and voltage from the CT1 secondary turn on transistor A1Q1. Current flows from B+ through normally-closed K3 contacts, auto-manual switch S1, rectifier A1CR1, both coils of start-stop relay and the transistor to ground. The relay A1K1 remains energized as long as a load is connected keeping normally-closed A1K1 contacts open to prevent generator set shutdown.

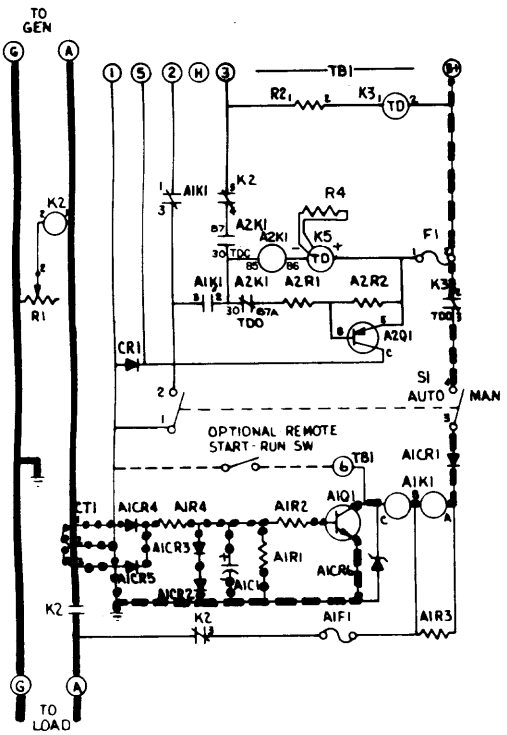


FIGURE 4-5. POWER CIRCUIT

STOP CIRCUIT

When the AC load is removed, there is no current flow through transformer CT1 and transistor A1Q1 switches off. The start-stop relay A1K1 is deenergized and its contacts return to their original positions. Normally-open A1K1 contacts open and normally-closed A1K1 contacts close to connect terminal 2 through the auto-manual switch S1 to ground (Figure 4-6). Terminal 2 is an extension of the generator set stopping circuit. The control grounds the ignition to stop the generator set. When the generator set shuts down, the K2 contacts return to their original positions.

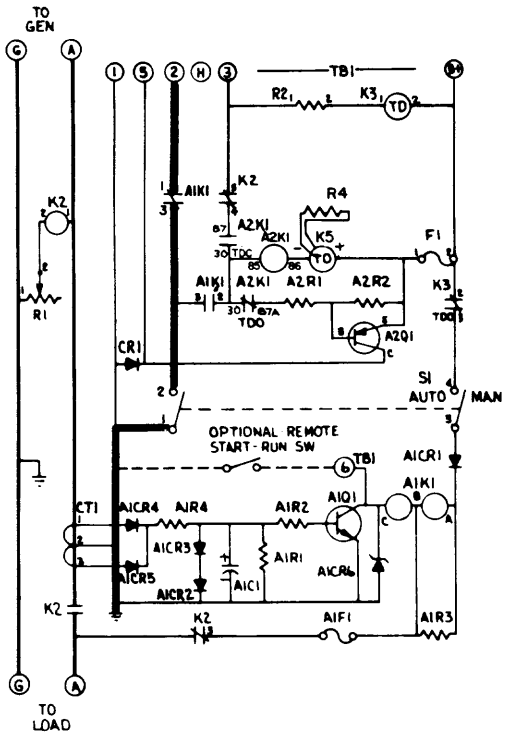


FIGURE 4-6. STOP CIRCUIT

SPEC C MODELS

PILOT CIRCUIT

The pilot circuit initiates the generator set crank and start when there is a demand for electric power (Figure 4-7). If an AC load switch is turned on demanding power, DC current from the B+ terminal flows through safety breaker contacts K2, auto-manual switch (in auto position), rectifier A1CR1, one-half the coil of relay A1K1, fuse A1F1, contact K1 and the AC load circuit to the common ground and battery to energize the start-stop relay.

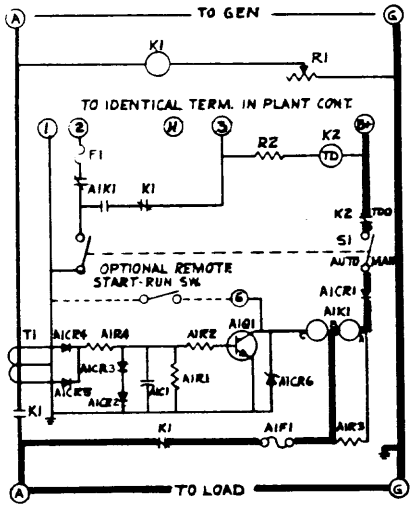


FIGURE 4-7. PILOT CIRCUIT

CRANKING CIRCUIT

When the pilot circuit (Figure 4-8) energizes start-stop relay A1K1, normally open contacts A1K1 close the circuit from terminal 3 through the closed auto-manual switch to ground (Figure 4-8). Terminal 3 connects to the generator set start circuit.

DC current from B+ terminal flows through the cranking limiter relay K2, resistor R2, normally-closed contacts K1, normally-open A1K1 contacts and auto-manual switch to ground. If the generator set does not start within 45 to 90 seconds, the heat produced by the element in the cranking limiter causes relay K2 contacts to open the pilot circuit to stop cranking. Wait at least one minute before resetting the breaker. This time allows the eutectic material to solidify and hold the contacts closed so cranking can resume.

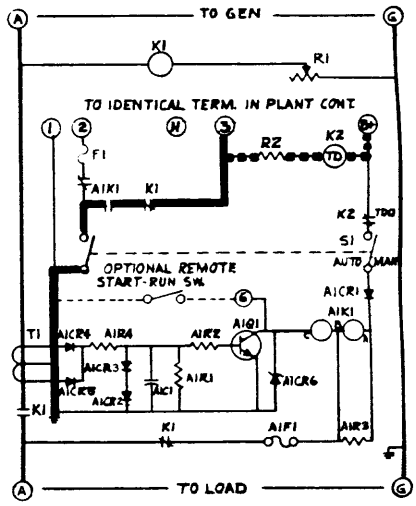


FIGURE 4-8. CRANKING CIRCUIT

GENERATOR-RUN CIRCUIT

When the engine starts and the generator AC voltage builds up to approximately 105 volts on 120-volt units or approximately 210 volts on 240-volt units, line contactor K1 is energized (Figure 4-9). Resistor R1 adjusts the line contactor pickup voltage.

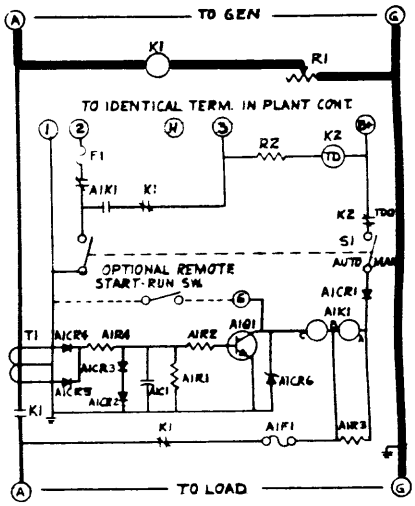


FIGURE 4-9. GENERATOR-RUN-CIRCUIT

POWER CIRCUIT

When the contactor K1 energizes, the pilot circuit interlock contacts open just before the power contacts close (Figure 4-10). The closed K1 contacts open to break the grounding circuit from control terminal 3. The circuit to the coil of A1K1 opens and prevents application of generator voltage to the low voltage control circuit.

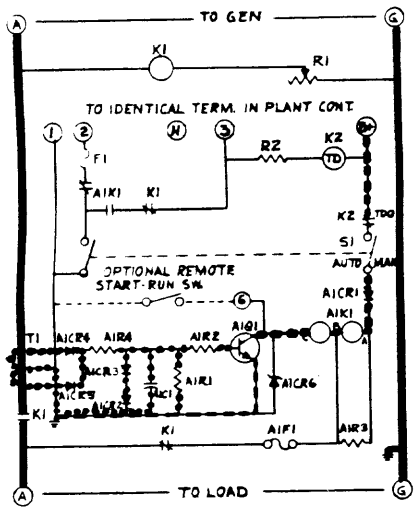


FIGURE 4-10. POWER CIRCUIT

The load current passes through the primary of the current transformer T1 to induce a voltage in the transformer secondary. Current and voltage from the T1 secondary turn on transistor A1Q1. Current flows from B+ through normally closed contact K2, the auto-manual switch, rectifier A1CR1, the coils of the start-stop relay and the transistor to ground. The relay A1K1 remains energized as long as a load is connected keeping normally closed A1K1 contacts open to prevent generator set shutdown.

STOP CIRCUIT

When the AC load is disconnected (Figure 4-11), there is no current flow through transformer T1 and transistor A1Q1 switches off. The start-stop relay is de-energized and its contacts return to their original position. Normally-open contacts A1K1 open and normally-closed A1K1 close to connect terminal 2 through the closed auto-manual switch to ground. Terminal 2 is an extension of the generator set stopping circuit. The control grounds the ignition to stop the generator set. When the generator set shuts down, the K1 contacts return to their original position.

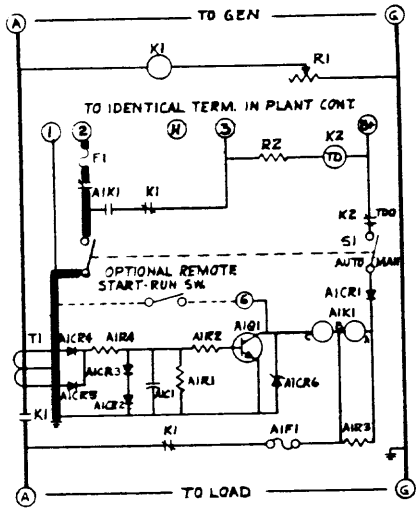


FIGURE 4-11. STOP CIRCUIT

SPEC A AND B MODELS

PILOT CIRCUIT

The pilot circuit initiates the generator set crank and start when there is a demand for electric power. If an AC load switch is turned on demanding power (Figure 4-12), DC current from the B+ terminal flows through safety breaker contacts K3, auto-manual switch (in auto position), one-half the coil of relay K1, contact K2 and the AC load circuit to the common ground and battery to energize the start-stop relay.

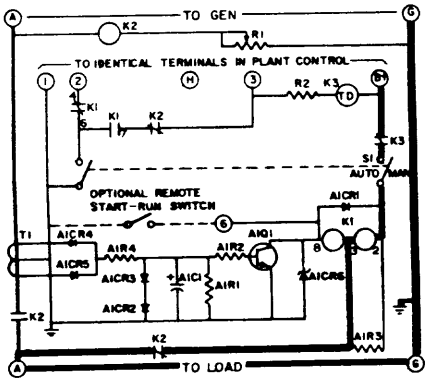


FIGURE 4-12. PILOT CIRCUIT

CRANKING CIRCUIT

When the pilot circuit energizes start-stop relay K1, contacts K1 (6,7) close (Figure 4-13). The circuit from terminal 3 through contacts K2 and K1 (6, 7) is now closed through the closed auto-manual switch to ground. Terminal 3 connects to the generator set start circuit.

DC current from B+ terminal flows through the cranking limiter relay K3, resistor R2, normally closed contacts K2, K1 (6, 7) and auto-manual switch to ground. If the generator set does not start within 45 to 90 seconds, the heat produced by the element in the cranking limiter causes relay K3 contacts to open and de-energize the pilot circuit which prevents further cranking. Wait at least one minute before resetting the breaker. This time allows the eutectic material to solidify and hold the contacts closed so cranking can resume.

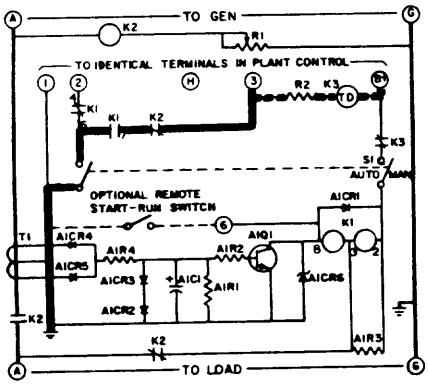


FIGURE 4-13. CRANKING CIRCUIT

GENERATOR-RUN CIRCUIT

When the engine starts and the generator AC voltage builds up to approximately 105 volts on 120-volt units or approximately 210 volts on 240-volt units (Figure 4-14), line contactor K2 is energized. Resistor R1 adjusts the line contactor pickup voltage.

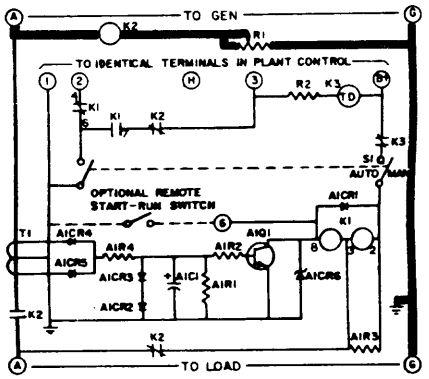


FIGURE 4-14. GENERATOR-RUN CIRCUIT

POWER CIRCUIT

When line contactor K2 energizes, the pilot circuit interlock contacts open just before the power contacts close (Figure 4-15). The closed K2 contact opens to break the grounding circuit from control terminal 3. The closed K2 contact opens the circuit to the coil K1 and prevents generator voltage from being applied to the low voltage control circuit.

The load current passes through the primary of the current transformer T1 to induce a voltage in the

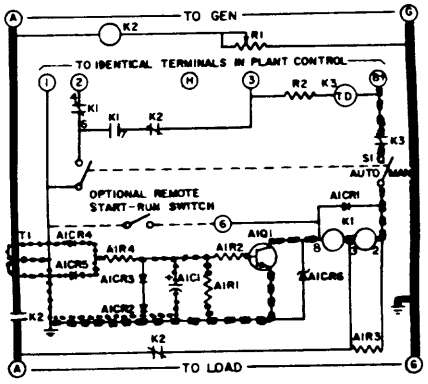


FIGURE 4-15. POWER CIRCUIT

transformer secondary. Current and voltage from the T1 secondary turn on transistor A1Q1. Current flows from B+ through normally closed contact K3, the auto-manual switch, the coils of the start-stop relay and the transistor to ground. The relay A1K1 remains energized as long as a load is connected keeping K1 contacts (4, 6) open to prevent generator set shutdown.

STOP CIRCUIT

When the AC load is disconnected, there is no current flow through transformer T1 and transistor A1Q1 switches off. The start-stop relay is de-energized and its contacts return to their original position. Contacts K1 (6, 7) open and K1 (4, 6) close to connect terminal 2 through the closed auto-manual switch to ground. Terminal 2 is an extension of the generator set stopping circuit. The control grounds the ignition to stop the generator set. When the generator set shuts down, the K2 contacts return to their original position.

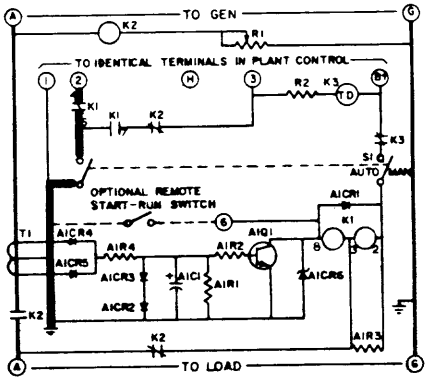


FIGURE 4-16. STOP CIRCUIT

CONTROL COMPONENTS

AUTO-MANUAL SWITCH

For normal operation, keep the auto-manual switch in the "AUTO" position. Whenever you do not want automatic starting or you want to service the generator set, set the switch at "MANUAL". In the "MANUAL" position, the generator set will start only from its start-stop switch or by hand cranking.

LINE CONTACTOR

The line contactor connects the generator AC output to the load after generator voltage builds up. It has auxiliary contacts to disconnect the pilot and cranking circuits after the generator set starts. Both the contacts and coil of the contactor are replaceable.

Contacts on the contactor may require cleaning if operated in extremely dusty or dirty environments. If so, remove the plastic hood (Figure 4-17). Pull a medium grade and weight paper (if a burnishing tool isn't available) between the closed contacts.

Silver contacts will discolor with use but still operate efficiently.

If the contact points become badly burned or pitted, replace them as follows:

1. Remove plastic hood.
2. Remove spring and washer from each contact guide post.
3. Lift contacts from guide post. Curved silver contact surfaces face inward when replacing.
4. Take out stationary contacts by removing screws holding them to the plastic body.

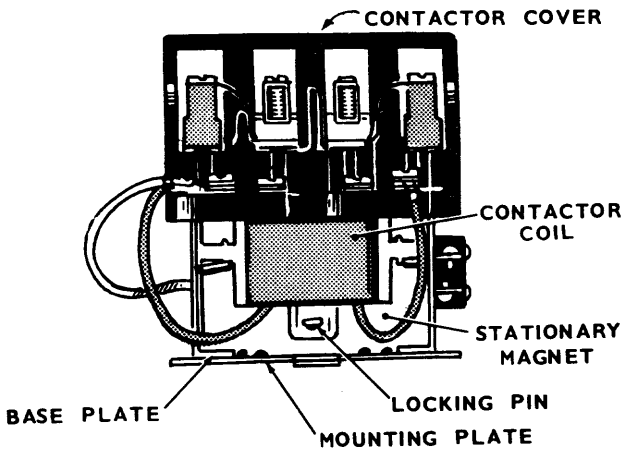


FIGURE 4-17. HA LINE CONTACTOR

CURRENT TRANSFORMER

The current transformer senses AC load current flow. Load current through the transformer produces a small AC output to the load sensor.

If the transformer is believed defective, check continuity between all three leads. Replace the coil if continuity does not exist between all windings.

CRANKING LIMITER

The cranking limiter is a safety device to control the maximum cranking time. If the engine will not start after 45 to 90 seconds cranking, the breaker opens removing battery voltage from the pilot circuit and start-run relay.

The limiter can be tested by checking continuity of the heater and checking for heating during a starting cycle. To test circuit breaking, disconnect the generator set remote start lead (terminal 3, remote) and apply a load. The start-run relay should operate immediately. After any start time delay and bilge blower time delay (begin Spec D only), the cranking limiter should heat. After 45 to 90 seconds, the limiter should open.

TIME DELAY RELAY

The time delay is a thermostatic relay with a delay between heater energization and contact pull-in. Energized by the pilot circuit, it starts preheat immediately by grounding remote terminal H. After the prescribed delay, the relay contacts close starting the cranking cycle.

To test this relay, apply a load to the control and watch contact operation. One contact should bend to close the circuit with the time delay. If the contacts do not close, check voltage at the heater terminals of the relay socket and check continuity of the heater.

BILGE BLOWER TIME DELAY (BEGIN SPEC D)

This solid state time delay relay is an in-line type and delays starting of the generator set for about five minutes while the bilge blower operates. It is energized by completion of a ground circuit through the start-run relay contacts. After the time delay period, it opens the bilge blower circuit by deenergizing a transistor, and it closes a circuit for a start time delay (if used) or for beginning of engine cranking.

Before testing the timer, always check the 6.25-ampere fuse to see if it has blown. If the fuse is okay, connect a DC voltmeter between B+ and time delay terminal 3 on the terminal block. At the end of the time delay, the voltmeter should indicate battery voltage. The DC voltmeter connected between B+ and time delay terminal 2 should now read zero volts.

LOAD SENSOR

The load sensor amplifier rectifies and regulates the AC voltage from the current transformer. Rectifiers on the printed circuit board convert the AC voltage into DC. The capacitors and resistors filter and regulate the voltage.

If the load sensor is believed to be the source of a control malfunction, use the troubleshooting procedures for checking components. Potentiometers (Spec A only) for adjusting starting and running are mounted on the board.

STARTING RESISTOR ADJUSTMENT (SPEC A ONLY)

If the control will not start the generator set when minimum load is applied, adjust the variable resistor (Figure 4-18) on the terminal board (left side—two wire models). Turn the adjustment screw with a Phillips screwdriver clockwise to increase minimum starting load, counterclockwise to decrease minimum starting load.

Adjust starting resistor in small steps and check adjustments often to avoid cycling (alternate starting and stopping).

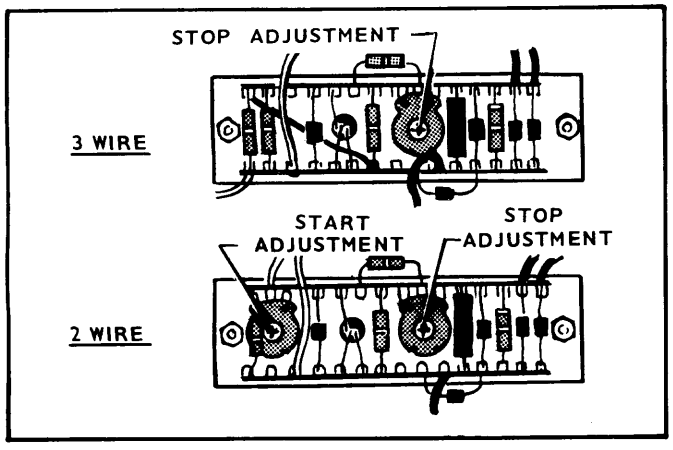


FIGURE 4-18. STARTING RESISTOR ADJUSTMENTS (SPEC A ONLY)

RUNNING RESISTOR ADJUSTMENT (SPEC A ONLY)

If the demand control will not keep the generator set running with the minimum load, adjust the variable resistor on the terminal board (Figure 4-18). Turn the adjustment screw with a Phillips screwdriver counterclockwise to decrease load required for operation.

STARTING-STOPPING

Spec B and C load demand controls are not adjustable. Proper automatic generator set operation is assured by fixed factory calibration.

LINE CONTACTOR PULL-IN VOLTAGE ADJUSTMENT

An adjustable resistor in series with the line contactor coil adjusts the contactor pull-in voltage (Figure 4-19). This is factory adjusted to pull in when the generator voltage reaches 102 to 108 volts (204 to 216 volts on 240-volt models). Do not adjust this resistor unless the line contactor will not pull in when the generator set starts or if it pulls in at too low a voltage causing the generator set to cycle.

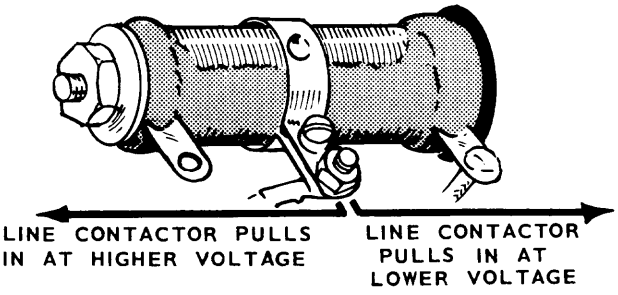


FIGURE 4-19. LINE CONTACTOR ADJUSTMENT

TROUBLESHOOTING

Find the trouble listed, then perform the checks in order given. Tests for the load sensor boards (Spec A and B) and printed circuit boards (Spec C and D) are given after the troubleshooting procedures.

SPEC D MODELS

BILGE BLOWER DOES NOT OPERATE WHEN LOAD IS CONNECTED (SPEC D)

1. Check switch positions. Auto-manual switch should be at "AUTO", elec-start switch at "ELEC START."
2. Battery terminals may be incorrect. Should have negative ground only.
3. Check 6.25-ampere fuse. If open, check for short circuit. Remedy and replace fuse.
4. Check fuse on load sensor printed circuit board and replace if open. Make sure incoming wires from generator aren't connected to the load side of the contactor.
5. With a hydrometer, check battery specific gravity. Check battery voltage at control B+ terminal.
6. Check load circuits. Disconnect load wires from control and substitute another load (such as a 100-watt lamp). If generator set starts with this load, check for problem in load circuits.
7. Jumper a wire from terminal TB1-B+ to terminal TB1-5. If bilge blower does not operate, problem is in bilge blower or its circuitry.

   Bilge blower operates: Check for battery voltage between B+ and relay A2K1 terminal 30. If battery voltage is absent, see *Printed Circuit Boards Tests (Spec C and D).*
8. For 120/240-volt HA controls, jumper K1 terminals 6 and 7. For other HA controls, jumper relay A1K1 terminal 2 to 3. If bilge blower operates, replace K1 or A1K1relay, whichever applies. Remove jumper wire.
9. Jumper terminal 87A of relay A2K1 to a good ground. If the bilge blower operates, check relay A2K1 and replace if necessary.
10. Check power transistor A2Q1 and replace if necessary (see Figure 4-20).
    a. Unsolder the wire and resistor connections to A2Q1. Do not take so much time to unsolder that you damage A2Q1 with the heat.
    b. With an ohmmeter or multitester, check the resistance readings between B,C, and E. Use the metal bracket or A2Q1 mounting hardware for the C connection during the tests. B is the top transistor pin, and E is the bottom pin.

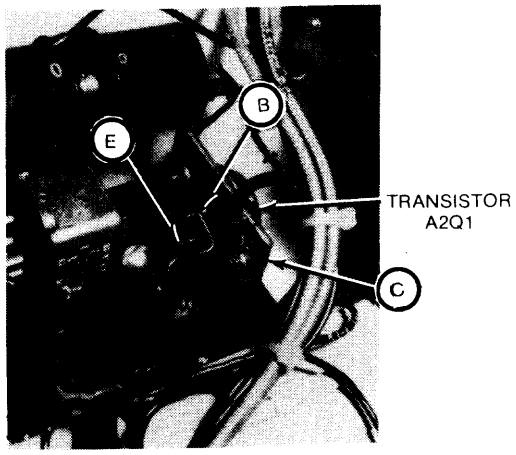


FIGURE 4-20. LOCATION OF TRANSISTOR A2Q1

c. Between B and C: infinity in one direction, about 11 ohms with the ohmmeter leads reversed.
d. Between B and E: infinity in one direction, about 11 ohms when you reverse the ohmmeter leads.
e. Between C and E: infinity in both directions.

If A2Q1 is defective, check CR1 before replacing A2Q1 or before starting operation again. With the ohmmeter leads on TB1 terminals 1 and 5, you should get a low resistance reading in one direction, infinity when reversing the ohmmeter leads.

AUTOMATIC DEMAND CONTROL WILL NOT START GENERATOR SET WITH LOAD (SPEC D)

1. Check switch positions. Auto-manual switch should be set at "AUTO," elec-start switch at "ELEC START."
2. Check battery terminals. Must be connected negative ground.
3. Check cranking limiter. If tripped, push reset button after waiting one minute. Before restarting, check for cause.
4. Check 6.25-ampere fuse. If open, check for short circuit. Remedy and replace fuse.
5. Check fuse on load sensor printed circuit board and replace if open. Before restarting, make sure incoming wires from generator aren't connected to the load side of the contactor.
6. With a hydrometer, check battery specific gravity. Check battery voltage at control B+ terminal.
7. Check load circuits. Disconnect load wires from control and substitute another load (such as a 100-watt lamp). If generator set starts with this load, check for problem in load circuits.
8. Check if bilge blower is operating. If it is, wait until the end of bilge blower operation to see if unit starts.

   If bilge blower does not operate when a load is connected to the generator set, see *Bilge Blower Does Not Operate when Load is Connected (TROUBLESHOOTING, Spec D models).*

9. Check generator set operation without automatic demand control. Disconnect demand control from generator set. Start generator set with start-stop switch on set controls. If set doesn't operate properly, reconnect demand control and refer to the generator set operator's manual or service manual.
10. Jumper A2K1 terminal 30 to TB1-3, then remove jumper. Remove quickly if unit starts.

    WARNING **Before performing this test, make sure the bilge blower has operated. Otherwise, any gas accumulations could ignite resulting in fire and explosion.**

11. If HA has a start time delay relay, note if the contact has bent to close the circuit with the time delay. If you are not sure, repeat Step 10 again and note the start time delay contact. Replace if necessary.
12. Remove the load, stop the generator set, and disconnect battery ground cable. With an ohmmeter, check for continuity across contactor K2 contacts C-NC for the 120/240 volt HA controls, across contactor K2 contacts 4-5 for the other HA controls.
13. Replace the bilge blower time delay A2K1.

GENERATOR SET STARTS BUT DOES NOT ASSUME LOAD (SPEC D)

1. Check generator output voltage. See generator set operator's manual.
2. Check the automatic control contactor coil. If malfunctioning, see *Line Contactor Pull-in Adjustment* under *CONTROL COMPONENTS.*
3. Check pull-in voltage and change setting (if necessary) of adjustable resistor for contactor pull-in. See See *Line Contactor Pull-in Adjustment* under *CONTROL COMPONENTS.*

GENERATOR SET STARTS BUT STOPS WHEN LINE CONTACTOR PULLS IN (SPEC D)

1. Move auto-manual switch to "MANUAL" position. Connect a jumper from terminal 6 to terminal 1. Move auto-manual switch to "AUTO" position. Generator set should start and run.
2. Apply a load and remove jumper while generator set is running with switch at "AUTO". If generator set stops, remove printed circuit board from control.
3. See *Printed Circuit Board Tests (Spec C and D).*

GENERATOR SET WILL NOT STOP WHEN LOAD IS REMOVED (SPEC D)

1. Put auto-manual switch in "MANUAL" position and stop generator set with start-stop switch on engine control.
2. Remove the lead from the load side of the contactor in the demand control.
3. Move the auto-manual switch to "AUTO."
4. If engine cranks, proceed to Step 5. If engine doesn't crank, put auto-manual switch to "MANUAL" position. Start engine with engine start-stop switch. Move auto-manual switch to "AUTO" position and generator set should stop. This indicates there was sufficient load to keep the control energized. Check load circuit for loads.
5. See *Printed Circuit Board Tests (Spec C and D).*

SPEC C MODELS

AUTOMATIC DEMAND CONTROL WILL NOT START GENERATOR SET WITH LOAD (SPEC C)

1. Check switch positions. Auto-manual switch should be set at "AUTO," elec-start switch at "ELEC START."
2. Check battery terminals. Must be connected negative ground.
3. Check cranking limiter. If tripped, push reset button after waiting one minute. Before restarting, check for cause.
4. Check fuse on load sensor printed circuit board and replace if open. Before restarting, make sure incoming wires from generator aren't connected to the load side of the contactor.
5. Check 3-ampere fuse from terminal 2. Fuse blows if B+ generator set lead touches terminal 2 while auto-manual switch is in "AUTO" position. Remedy and replace fuse.
6. With a hydrometer, check battery specific gravity. Check battery voltage at control B+ terminal.
7. Check load circuits. Disconnect load wires from control and substitute another load (such as a 100-watt lamp). If generator set starts with this load, check for problem in load circuits.
8. Check generator set operation without automatic demand control. Disconnect demand control from generator set. Start generator set with start-stop switch on set controls. If set doesn't operate properly, reconnect demand control and refer to the generator set operator's or service manual.
9. See *Printed Circuit Board Tests (Spec C and D).*

GENERATOR SET STARTS BUT DOES NOT ASSUME LOAD (SPEC C)

1. Check generator output voltage. See generator set operator's manual.
2. Check the automatic control contactor coil. If malfunctioning, see *Line Contactor Pull-in Adjustment* under *CONTROL COMPONENTS.*
3. Check pull-in voltage and change setting (if necessary) of adjustable resistor for contactor pull-in. See *Line Contactor Pull-in Adjustment* under *CONTROL COMPONENTS.*

GENERATOR SET STARTS BUT STOPS WHEN LINE CONTACTOR PULLS IN (SPEC C)

1. Move auto-manual switch to "MANUAL" position. Connect a jumper from terminal 6 to terminal 1. Move auto-manual switch to "AUTO" position. Generator set should start and run.
2. Apply a load and remove jumper while generator set is running with switch at "AUTO". If generator set stops, remove printed circuit board from control.
3. See *Printed Circuit Board Tests (Spec C and D).*

GENERATOR SET WILL NOT STOP WHEN LOAD IS REMOVED (SPEC C)

1. Put auto-manual switch in "MANUAL" position and stop generator set with start-stop switch on engine control.
2. Remove the lead from the load side of the contactor in the demand control.
3. Move the auto-manual switch to "AUTO."
4. If engine cranks, proceed to Step 5. If engine doesn't crank, put auto-manual switch to "MANUAL" position. Start engine with engine start-stop switch. Move auto-manual switch to "AUTO" position and generator set should stop. This indicates there was sufficient load to keep the control energized. Check load circuit for loads.
5. See *Printed Circuit Board Tests (Spec C and D).*

SPEC A AND B MODELS

AUTOMATIC DEMAND CONTROL WILL NOT START GENERATOR SET WITH LOAD (SPEC A AND B)

1. Check switch positions. Auto-manual switch should be set at "AUTO," elec-start switch at "ELEC START."
2. Battery terminals may be incorrect. Should have negative ground only.
3. Check cranking limiter. If tripped, push reset button after waiting one minute. Before restarting, check for cause.
4. Check generator set battery condition with a hydrometer. Check battery voltage at control B+ terminal.
5. Disconnect load wires from control and substitute another load. If generator set now starts, check for defective load circuits.
6. Disconnect control from generator set. Start engine using generator set controls. If it doesn't operate properly, refer to generator set operator's or service manual.
7. If the generator set stops with a 100-watt load (generator set connected to automatic control), move auto-manual switch to "MANUAL." Connect a jumper from terminal 6 to the ground terminal (in the automatic control). If the generator set doesn't start, check continuity of K1 relay coil terminals 2-3 and 8. 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 6-7 close.
8. If relay is okay, check following voltages.
   a. Ground to B+ terminal should equal battery voltage. From ground to terminal 2 of K1 relay socket, voltage should equal battery voltage.
   b. Load side of contactor to terminal 3 of start-run relay should be zero if K2 contact is closed properly.
   c. Measure transformer T1 output voltage at terminals on load sensor amplifier. It should read 2 to 3 volts AC.
9. See *Load Sensor Board Component Tests (Spec A and B).*

GENERATOR SET STARTS BUT DOES NOT ASSUME LOAD (SPEC A AND B)

1. Check generator output voltage. See generator set operator's manual.
2. Check the automatic control contactor coil. If malfunctioning, see *Line Contactor* under *CONTROL COMPONENTS.*
3. Check pull-in voltage and change setting (if necessary) of adjustable resistor for contactor pull-in. See *Line Contactor Pull-in Adjustment* under *CONTROL COMPONENTS.*

GENERATOR SET STARTS BUT STOPS WHEN LINE CONTACTOR PULLS IN (SPEC A AND B)

1. Move auto-manual switch to "MANUAL" position. Connect a jumper from terminal 6 to terminal 1. Move auto-manual switch to "AUTO" position. Generator set should start and run.
2. Apply a load and remove jumper while generator set is running with switch at "AUTO." If generator set stops, place switch to "MANUAL" and restart.
3. While generator set is running with a 100-watt minimum load, measure output voltage of transformer T1 at terminals on load sensor amplifier. Should be 2 to 3 volts AC.
4. Shut off generator set and use procedures under *Load Sensor Board Component Tests (Spec A and B).*

GENERATOR SET WILL NOT STOP WHEN LOAD IS REMOVED (SPEC A AND B)

1. Put auto-manual switch in "MANUAL" position and stop generator set with start-stop switch on engine control.
2. Remove the lead from the load side of the contactor in the demand control.
3. Move the auto-manual switch to "AUTO."
4. If the engine cranks, proceed to Step 5. If the engine doesn't crank, move auto-manual switch to "MANUAL" position. Start engine with engine start-stop switch. Move auto-manual switch to "AUTO" position and generator set should stop. This indicates there was sufficient load to keep the control energized.
5. Remove the ground lead from the battery and the lead from terminal 3 to the engine. Check for continuity from the ground terminal in the automatic control to terminal 3 with the switch in "AUTO" position. This circuit should be open. If it is not, remove start-run relay. Check continuity from terminal 6 to 7. This should be open. Check continuity with 1-1/2 volts or less from socket pin 8 to ground. Circuit should show high resistance (approximately 20,000 ohms) with positive on pin 8 and show a low resistance (approximatley 20 ohms) with negative to pin 8.
6. See *Load Sensor Board Component Tests (Spec A and B).*

PRINTED CIRCUIT BOARD TESTS (SPEC C AND D)

300-0740 AND 300-0743 PRINTED CIRCUIT BOARDS

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 4-21, 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.
9. *300-0743 Board Only:* Resistance of resistor R5 (by start-run relay) and R6 (below fuse) should be approximately 1500 and 160 ohms respectively.

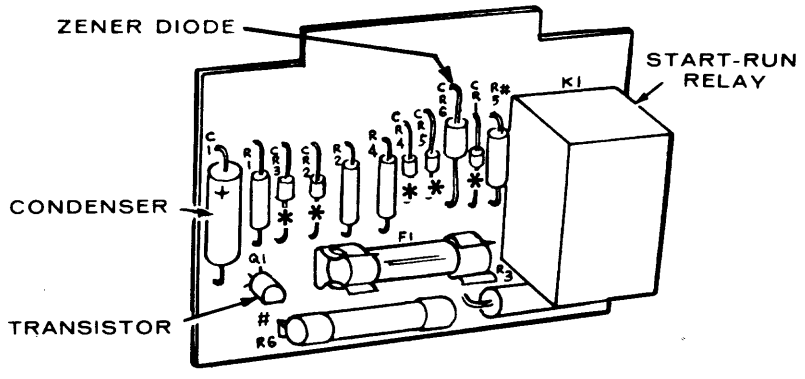
300-0741 PRINTED CIRCUIT BOARD

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 4-22, start the tests on the left. All readings given are approximate.

1. Condenser C1 and resistor R1 have a resistance of approximately 2100 ohms in one direction and 900 ohms in the other direction.
2. Rectifiers CR2 and CR3 normally have resistance of 3700 ohms in one direction and 650 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 - 700 ohms, infinity; B to E - 750 ohms, 2100 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.



* RECTIFIERS
\# For 300-0743 ONLY

FIGURE 4-21. 300-0740 AND 300-0743 PRINTED CIRCUIT BOARDS

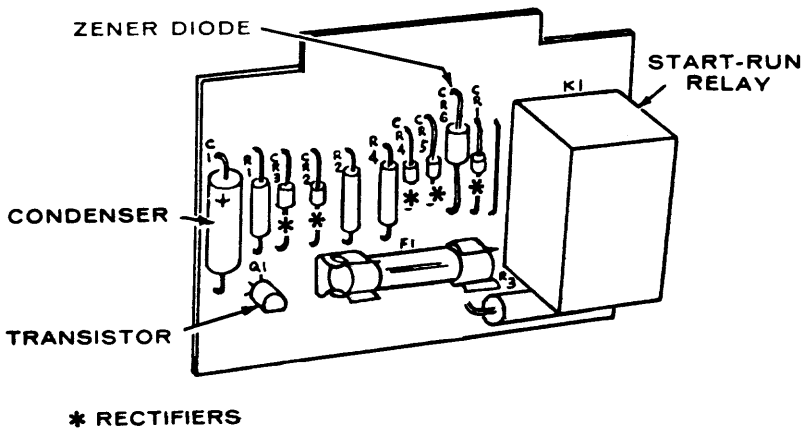


FIGURE 4-22. 300-0741 PRINTED CIRCUIT BOARD

6. Resistance of Zener diode CR6 should be 700 ohms in one direction, infinity in the other.
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 55 ohms.

300-0747 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 4-23, start the tests on the left. All readings given are approximate.

1. Condenser C1 and resistor R1 have a resistance of approximately 2100 ohms in one direction and 900 ohms in the other direction.
2. Rectifiers CR2 and CR3 normally have resistance of 3700 ohms in one direction and 600 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 - 700 ohms, infinity; B to E - 700 ohms, 2300 ohms; C to E - 900 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 600 ohms in one direction, infinity in the other.
7. Resistance of resistors R6, R5, and R3 should be 200, 100, and 200 ohms respectively.
8. Rectifier CR1 normally has 600 ohms in one direction, infinity in the other direction.

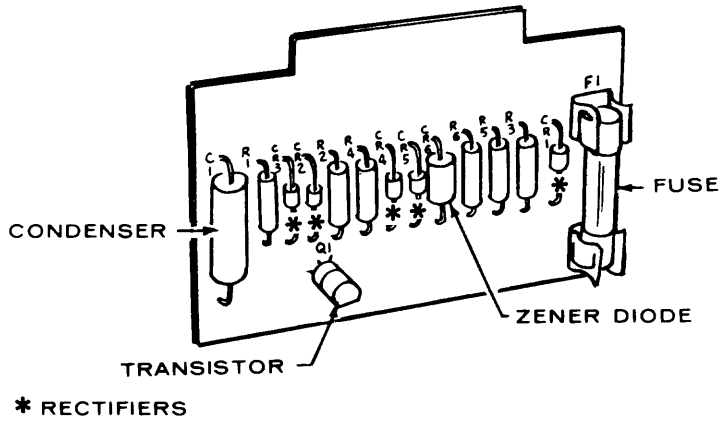


FIGURE 4-23. 300-0747 PRINTED CIRCUIT BOARD

LOAD SENSOR BOARD COMPONENT TESTS (SPEC A AND B)

Check the load sensor board components using the wiring diagrams and Figure 4-24 as references.

1. Place the control in the "MANUAL" position 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 680 ohms ±10% (Spec A). Spec B resistor (R3) should be 47 ohms ±10% (240-volt control) or 24 ohms ±10% (120-volt control).
3. The rheostat (Spec A only) should range between 0 and 2000 ohms depending on the position of the slider (usual resistance setting is 800 to 1000 ohms).
4. 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 resistance is zero or the same in both directions, replace rectifier.
5. The Zener diode (hangs below board, Spec A, mounted on board Spec B) 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.
6. 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.
7. The vertical resistor to the right of the transistor should be 2,200 ohms ±10%. The horizontal resistor should be 220 ohms ±10%.
8. The rheostat (Spec A only) has a variable resistance and depends on setting (should be approximately 1000 to 1200 ohms).
9. The condenser (+ mark up) should indicate resistance of approximately 750 ohms in one direction and approximately 340 ohms in the other.

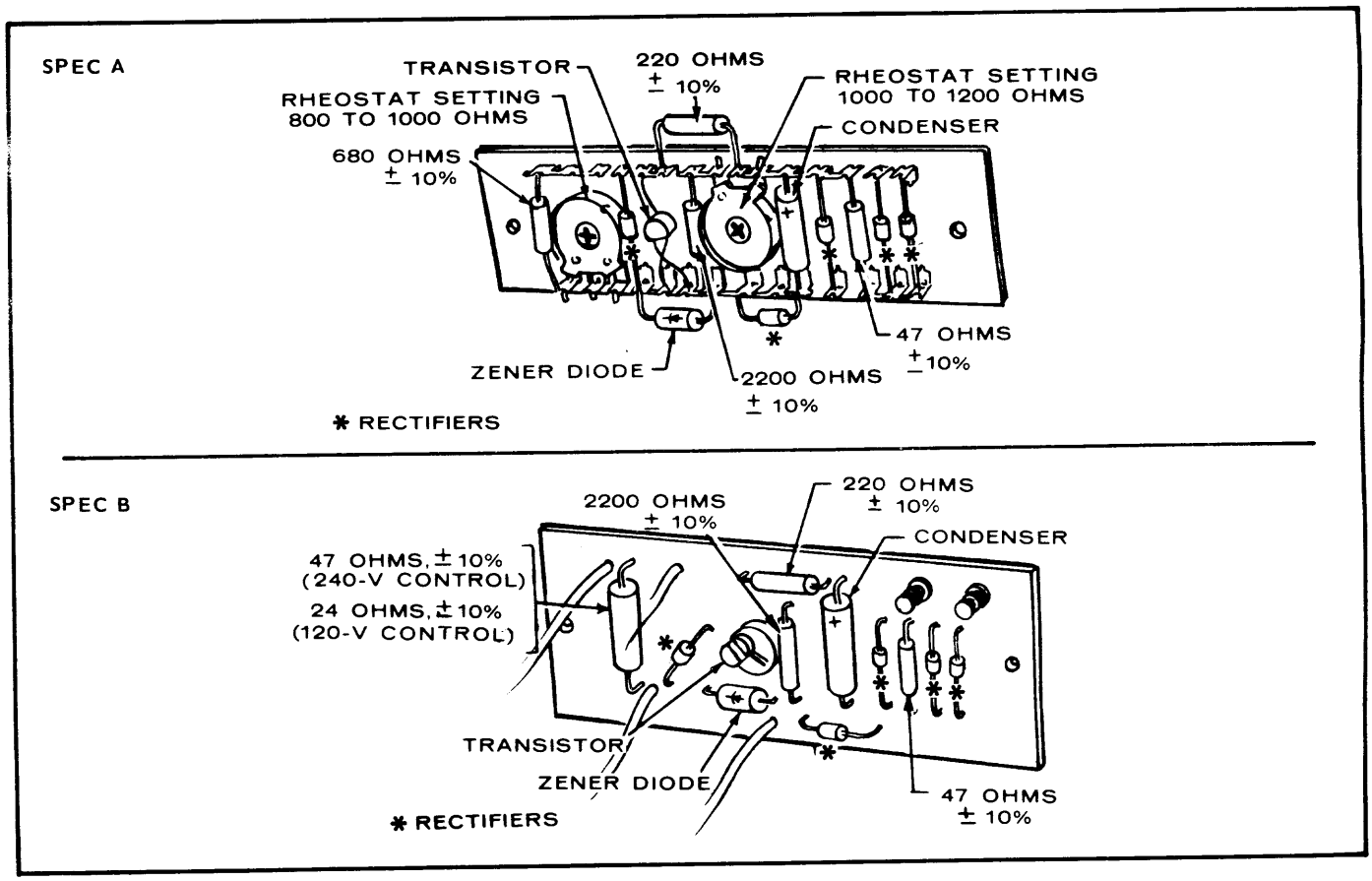


FIGURE 4-24. LOAD SENSOR BOARD COMPONENTS

10. 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.
11. The vertical resistor should be 47 ohms ±10%.
12. 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 resistance is zero or extremely low in both directions, replace.

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