HEAT SYSTEM
THEORY OF OPERATION
FOR ALL HEATED EXTRACTOR MODELS

USE:

The heat exchanger is designed to heat the water that flows into it from the pump. As the heated water is sprayed onto the carpet, cool water from the holding tank is pumped into the heat exchanger. The capacity of the heat exchanger is finite, and the water must remain in the heat exchanger long enough for it to get heated.

After the initial 2 minute warm-up, the heat exchanger will continue to deliver hot water in cycles. That is, some of the heated water in the heat exchanger can be sprayed during each spray cycle. During the recovery cycle, the new water in the heat exchanger is being heated and will be ready for you during the next spray cycle. If all the heated water in the heat exchanger is depleted during one spray period, another 2 minute warm-up period will be required.

A typical spray/recovery cycle takes approximately 8-12 seconds: 3 strokes of spray and then recovery. Exact times may vary depending on a variety of factors including, but not limited to, the length and diameter of the solution hose and the size and number of the spray tip(s). *****

GREEN LIGHT:

The green light on the switch plate is an indicator that the 2 power cords are plugged into separate circuits. The dual circuit sensor board calculates the sum of the AC voltage from both cords. If either of the 2 power cords is missing the ground prong, or if adapters are being used (wiring in adapters may be configured differently than the power cord), the circuit board cannot calculate the true voltage sum. It is then unpredictable whether your green light will accurately reflect two separate circuits or not.

COMPONENTS (Refer to Drawing):

There are several components in the heat system on the extractors. These components work together to turn the heat exchanger on and off.

The **thermistor control** is like the switch. It is a 6-terminal electronic relay that receives power from the heater cord (terminals #2 and #3) and other signals from other devices.

The **thermistor probe** is mounted inside the end of the heat exchanger and acts as a thermometer to tell the control when the heater needs to turn on and when it is hot enough.

A **potentiometer** is mounted to the thermistor control and it is covered with silicone. This potentiometer is calibrated at the factory to a specific value that will allow the heater to reach a maximum temperature. It is not adjustable in the field, and any tampering with the setting voids the warranty of all heat system components. Some extractor models (with adjustable heat) have a variable resistance “in series” with this potentiometer.

The **heat exchanger** has 2 element leads. A **thermal cutout** is in-line between the #1 terminal on the control (which turns on when all signals to the control are correct) and one of the heater element leads. The other heater element lead is connected to an AC power wire (black).

If some components in the system fail and allow the heat exchanger to overheat (for whatever reason), the thermal cutout opens (like a fuse) and cuts off power to the heat exchanger. An open thermal cutout is a symptom of a problem and not, typically, a cause of failure.

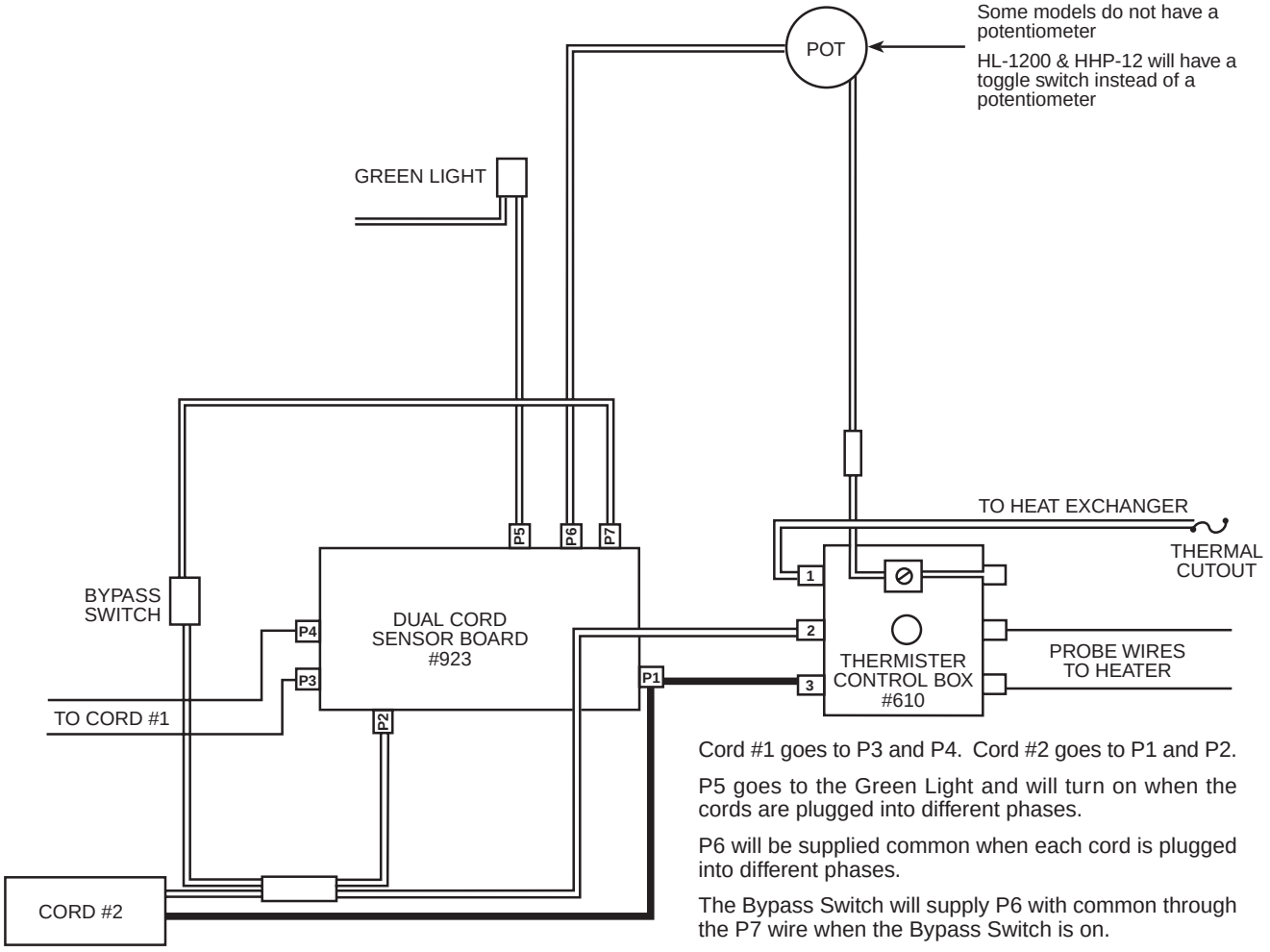
A faulty or damaged thermistor control or probe can allow the temperature to exceed specifications. Neither the thermistor control nor the thermistor probe can be accurately tested in the field.

NOTE: We always advise replacing both the thermistor control (with potentiometer attached and calibrated) and the probe <u>at the same time</u>. We recommend never replacing just the thermistor control or the probe alone.

Always visually inspect all of the heat system components, wires and connections for signs of damage.

***** A heater coil that has a build-up of chemical or mineral deposits will also seem to lose heat quickly. The reason is two-fold: The amount of water capable of being heated at one time in the heat exchanger is reduced by the amount of build-up in the coils, and the water is insulated from the heat source (heating element) by the build-up. Flush your system regularly with our descaler, X-1500 Flush, to prevent a build-up from occurring.

HEAT SYSTEM WIRING DIAGRAM FOR ALL HEATED EXTRACTORS



Cord #1 goes to P3 and P4. Cord #2 goes to P1 and P2.

P5 goes to the Green Light and will turn on when the cords are plugged into different phases.

P6 will be supplied common when each cord is plugged into different phases.

The Bypass Switch will supply P6 with common through the P7 wire when the Bypass Switch is on.

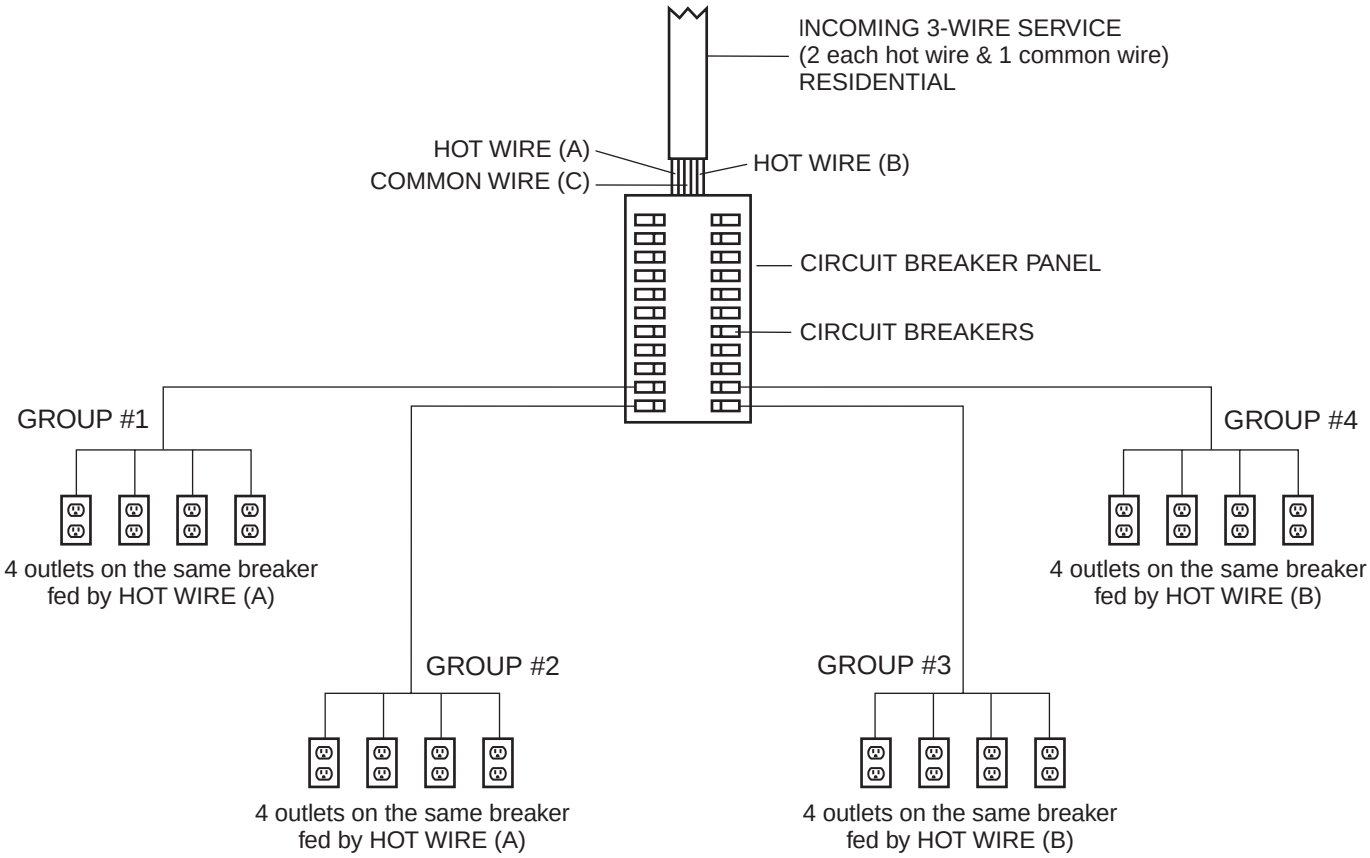
Terminal #2 on the black box is the main common wire. The Internal Switch (TRI AC) will switch common to Terminal #1 when P6 gets power and the Heat Exchanger is cold.

HHP-100, Cobra-H and Cobra-300H models do not have variable heat.

NOTE: HL-1200 and HHP-12 have a toggle switch for high/low heat on the switch plate. These two machines have a Variable Resistor underneath the switch plate that, when heat is set to low, is in series with the small Potentiometer on the Thermistor Control.

Heat adjustment is not available on all models.

DUAL CORD SENSOR SYSTEM
OPERATION



EXAMPLE: If cord #1 is plugged into any of the outlets from group #1 or #2 and cord #2 is plugged into any of the outlets from group #3 or #4 (or vice versa), the green light on the switch plate will turn on. This indicates that each cord is using separate breakers that are fed by separate “hot wires” (A & B) and the heater will turn on.

EXAMPLE: If cord #1 is plugged into any outlets in group #1 and cord #2 is plugged into any outlets in group #2 the green light will not work. Even though the machine is plugged into separate circuit breakers, both breakers are fed by the same hot wire (A). At this time the heater will not work unless you turn on the bypass switch.

BYPASS SWITCH: The bypass switch will bypass the dual cord sensor allowing the heater to work regardless of which circuits or hot wires the cords are connected to. Be aware that if the bypass switch is turned on and both cords are using the same circuit breaker (even if they are on separate outlets), the circuit breaker will “blow” unless it is rated for 30 amps or more. Most homes are rated 15 or 20 amps.

EXAMPLE: Both cords are plugged into 2 separate outlets on the same group. The result is no green light and if you turn on the bypass switch the breaker will trigger because both cords are on the same breaker.

HEAT SYSTEM
PRE-TROUBLESHOOTING
ALL HEATED EXTRACTORS

INSUFFICIENT OR UNSTABLE HEAT:

1. A larger diameter hose, a longer hose, or a spray tip size larger than the original on the machine, will result in a loss of heat at the spray tip. The heater is designed to maintain a constant temperature at a specific volume. If the volume is increased, the heater may not be able to maintain the constant temperature.

2. The heat exchanger system that is built into the U.S. Products extractors is designed to meet the industry standards for spray and recovery time. The length of spray time (using original size equipment) should be approximately 8 to 10 seconds followed by an equal time of recovery. This procedure does not deplete the hot water inside the heat exchanger during the spray cycle, and allows recovery time before the next spray cycle. If, however, the hot water in the heat exchanger is completely used up (due to an incorrect elongated spray period) the heat exchanger is then filled with cold water and will require the 2 minute warm-up period. Refer to Heat System, Theory of Operation.

3. The solution is heated after the pump. To accurately measure the temperature, you must use a thermal couple mounted inside one of the spray tips. As soon as the solution leaves the tip, it **immediately** begins to cool. A thermometer placed in the spray path **will not** give an accurate reading since the solution has already begun to cool before it hits the thermometer.

NO HEAT:

1. The green light will turn on when the dual cord sensor circuit board detects that each power cord is on a separate circuit. The circuit board cannot detect separate circuits if the ground prongs are missing off the cord ends or if plug adapters, with no ground prongs, are being used. Refer to Heat System: Theory of Operation.

2. If you are unable to locate 2 separate circuits, and the green light does not turn on, press the Bypass Switch (located on the switch plate) to turn on the heat. The Bypass Switch does not turn on the green light.

3. When first plugged in, the “Red Mode” light will turn on indicating the heat exchanger is heating. The green light or Bypass Switch should also be on. Once temperature has been reached, after approximately 2 minutes, the red light will turn off. As you spray and recover, the red light will cycle on and off.

   NOTE: This light is a feature on selected models only.

4. Visually inspect inside the machine to see if there are any damaged components or loose, disconnected, or damaged wires in the heat system.

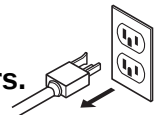
If you are unable to solve the problem using the information in this section, refer to the troubleshooting section for your machine model.

GREEN CIRCUIT LOCATOR LIGHT TESTING

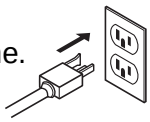
COBRA-H, COBRA-200H, COBRA-300H, HL-1200, HHP-12, HHP-200, HHP-300

(120V)

To test the green light, for the Circuit Locator Indicator ("Cord 2" light), follow these steps to apply voltage to the green light, through the bypass switch:



1. **Unplug the machine before starting repairs.**
2. On the dual cord sensor board (located at the right rear of the machine), remove the red wire from the P6 terminal and let it hang free. See diagram below.
3. Remove the white wire from the P5 terminal and plug it into the P6 terminal. See diagram below.
4. Plug in the #2 cord (no red sleeve). The green light should turn on at this time.



If it does not turn on, the green light should be replaced with part #78.

If the light is now on, but is not turning on when the machine is in use, it may be because:

(A) The machine is not actually on 2 different circuits. Refer to Dual Cord Sensor System Operation.

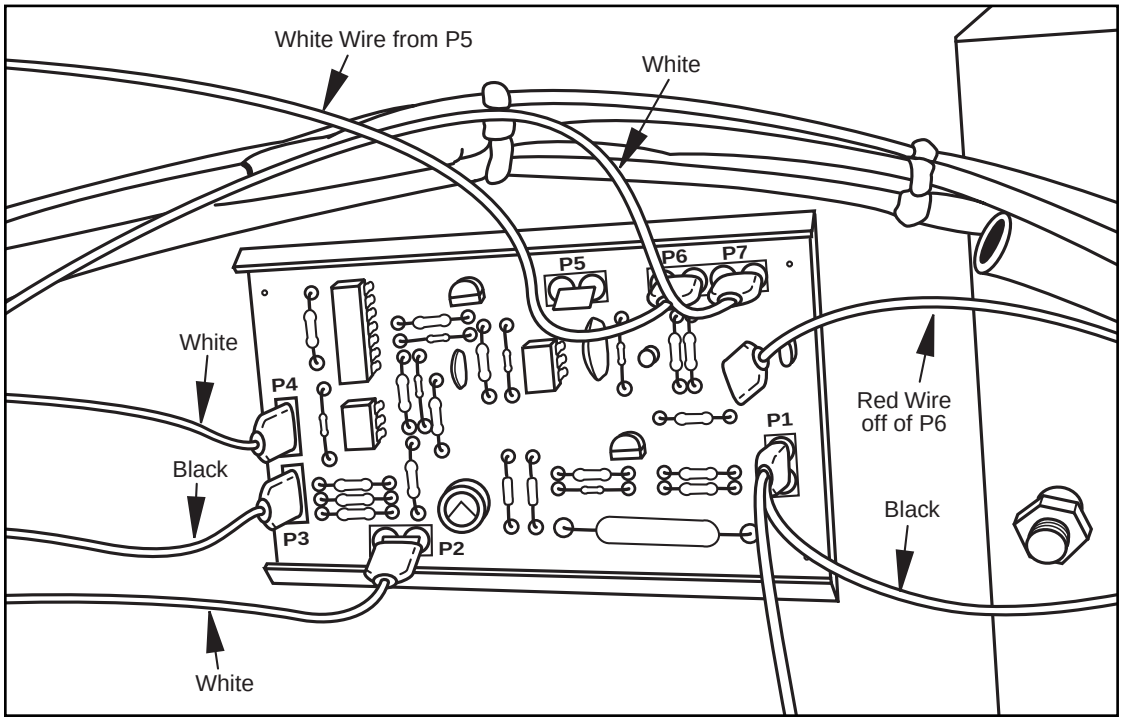
(B) One or both cords, does not have a ground prong.

(C) You are using an adapter or extension cord that does not have a ground prong.

(D) The board may be faulty.

NOTE: The bypass switch does not turn the green light on.

Return the wires at P5 and P6 back to original configuration.



EXTRACTOR HEAT SYSTEM TROUBLESHOOTING

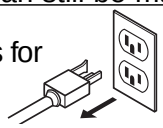
ALL HEATED HHP & COBRA EXTRACTORS

(120V)

NOTE: THE HEATER MUST BE COLD WHEN FOLLOWING THESE STEPS. (Run cold water through the machine). For machines with an ADJUSTABLE HEAT DIAL, turn the dial all the way CLOCKWISE (highest setting) for all the following steps.

Several steps in this troubleshooting procedure call for the use of a multimeter. We recommend using a meter for thoroughness; however, if a meter is **not** available, a general diagnosis can still be made.

1. **UNPLUG THE MACHINE** and prop it open. Visually inspect the components for evidence of damage.

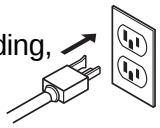


2. A voltmeter is necessary to perform this step. If no meter is available, proceed to Step 4. The meter will be used to measure AC voltage in two places. Test the meter in an AC outlet before continuing. Refer to STEP 2 DIAGRAM below.

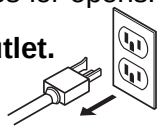
   (A) To check the AC cord for opens, measure for 120V AC at the thermistor control.

   (B) Set the voltmeter to VAC, 150-200 volt setting, and connect the voltmeter to the **center left terminal (#2)** and the **bottom left terminal (#3)**. Do not remove the wires from the terminals on the thermistor control.

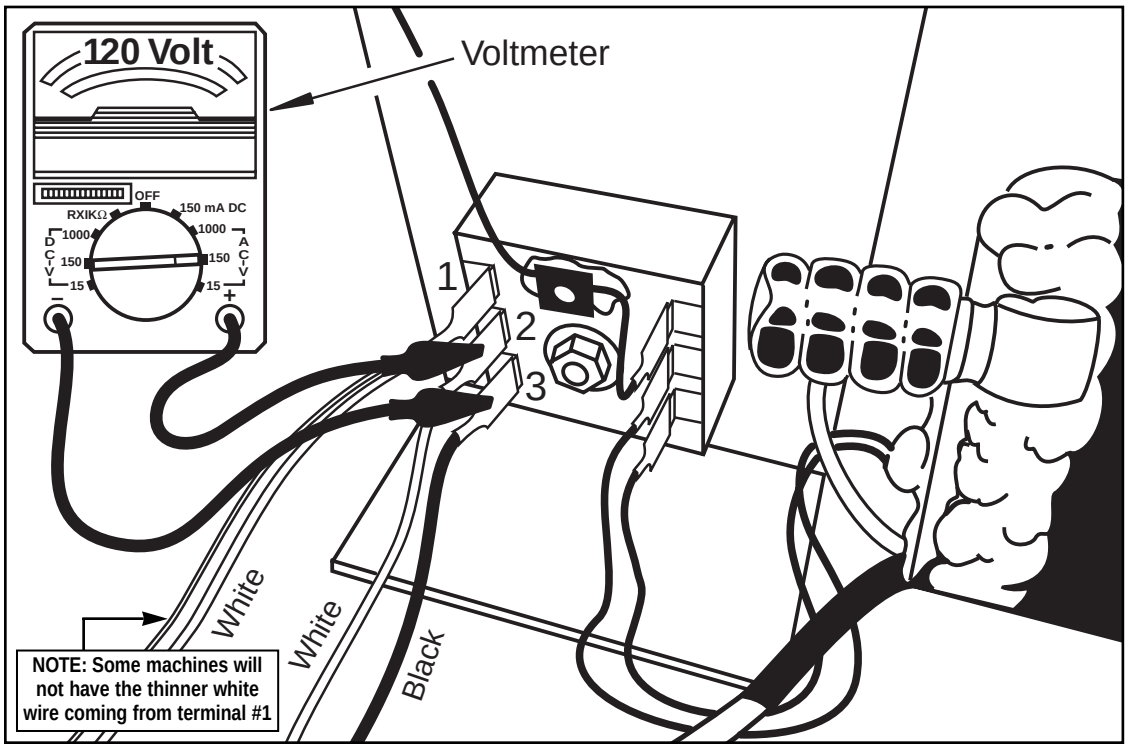
   (C) Plug cord #2 (no red sleeve) into an outlet. If there is no AC voltage reading, check the cord and related wires for opens. Repair as necessary.



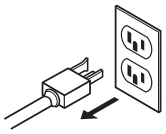
   (D) Remove cord #2 from the outlet.



STEP 2 DIAGRAM



CHECKING THE BYPASS SWITCH:



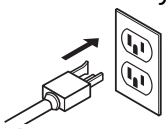
3. To check the bypass switch, first **UNPLUG THE MACHINE.** Refer to STEP 3 DIAGRAM below.

(A) Set the voltmeter to VAC (on a range of 150V).

(B) Remove the wire attached to the P7 terminal.

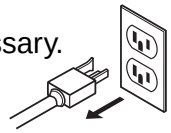
(C) Connect the voltmeter leads to terminal **P1** and the wire just removed from **P7** on the Dual Circuit Sensor Board. **Do not** remove any other wires.

(D) Plug in cord #2 **only** (no red sleeve).

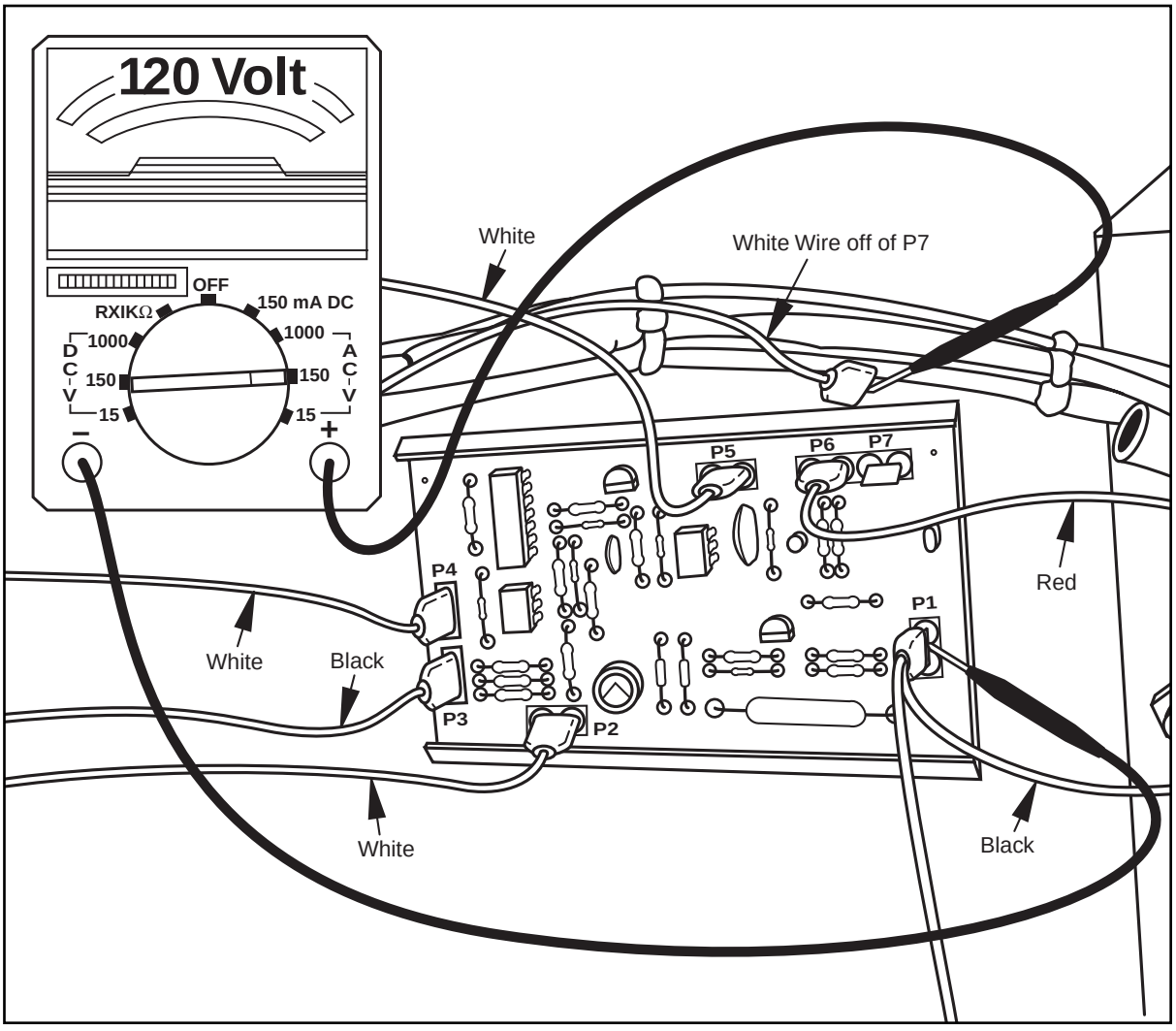


(E) Turn the Bypass Switch **ON**. If there is no AC voltage reading, check the switch and related wiring and the connections at the board for opens.

(F) **Unplug the #2 cord from the outlet.** Repair as necessary.



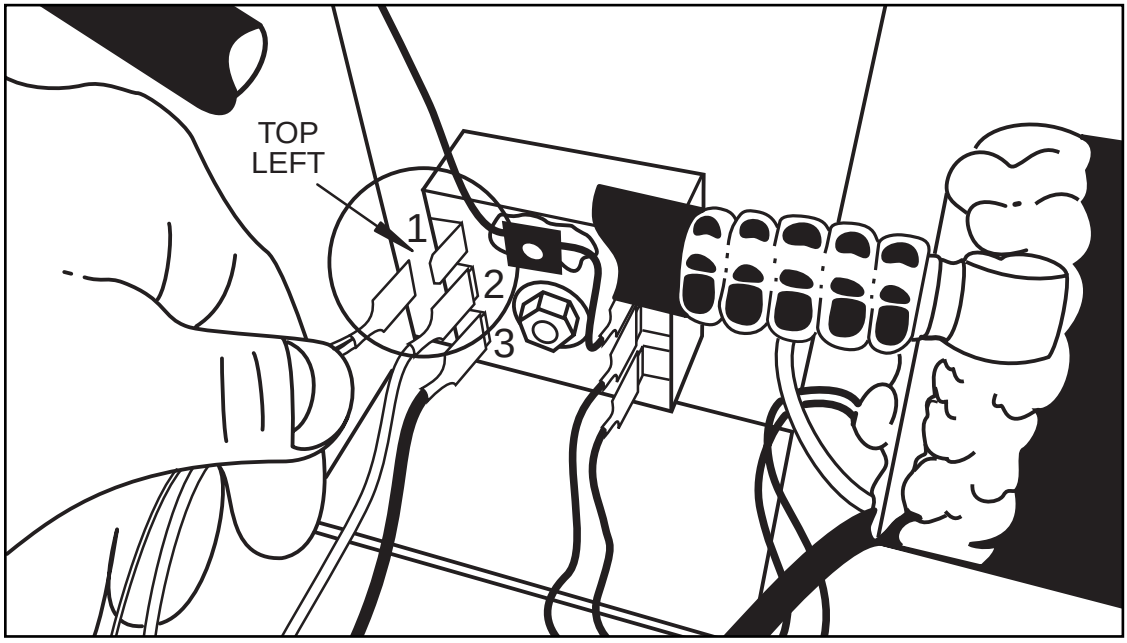
STEP 3 DIAGRAM



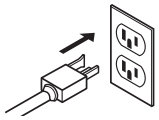
TESTING THE THERMISTOR CONTROL:

4. Remove the white wire(s) from the **top left terminal (#1)** on the thermistor control and let it hang free. Refer to STEP 4 DIAGRAM below.

STEP 4 DIAGRAM



5. (A) Plug the #2 cord (no red sleeve) into the outlet.

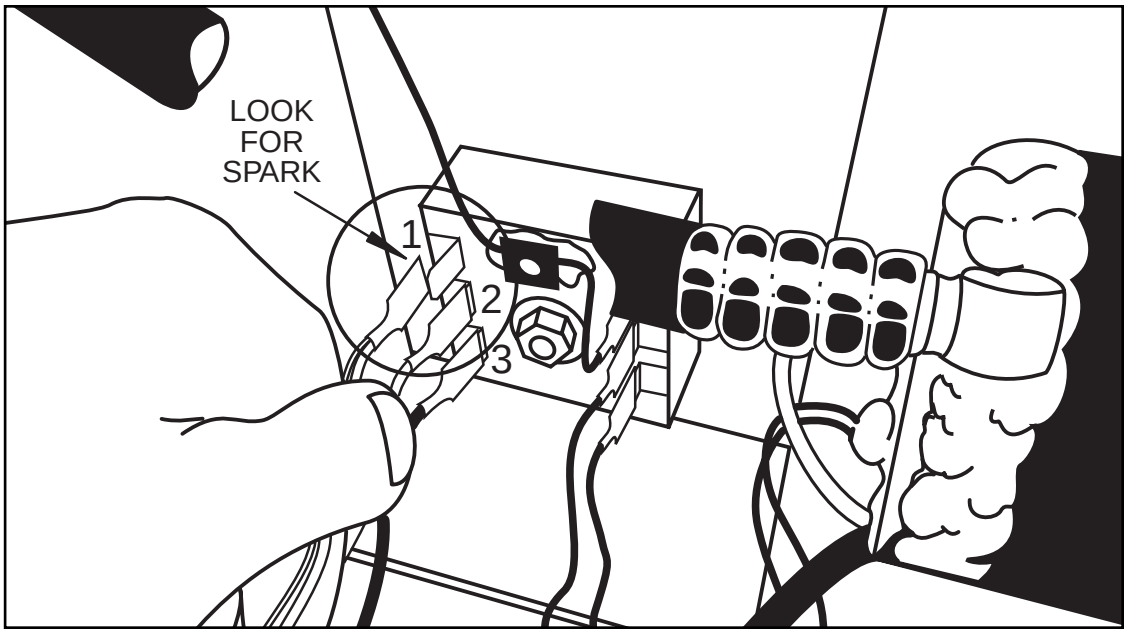


(B) Turn the Bypass Switch ON (at the switch plate).

(C) Watch for a spark while striking the white wire(s) (just removed in step 4) to the **top left terminal (#1)** on the thermistor control. Refer to STEP 5 DIAGRAM.

(D) If there is **no spark** proceed to #6. If there is a **spark**, proceed to #8.

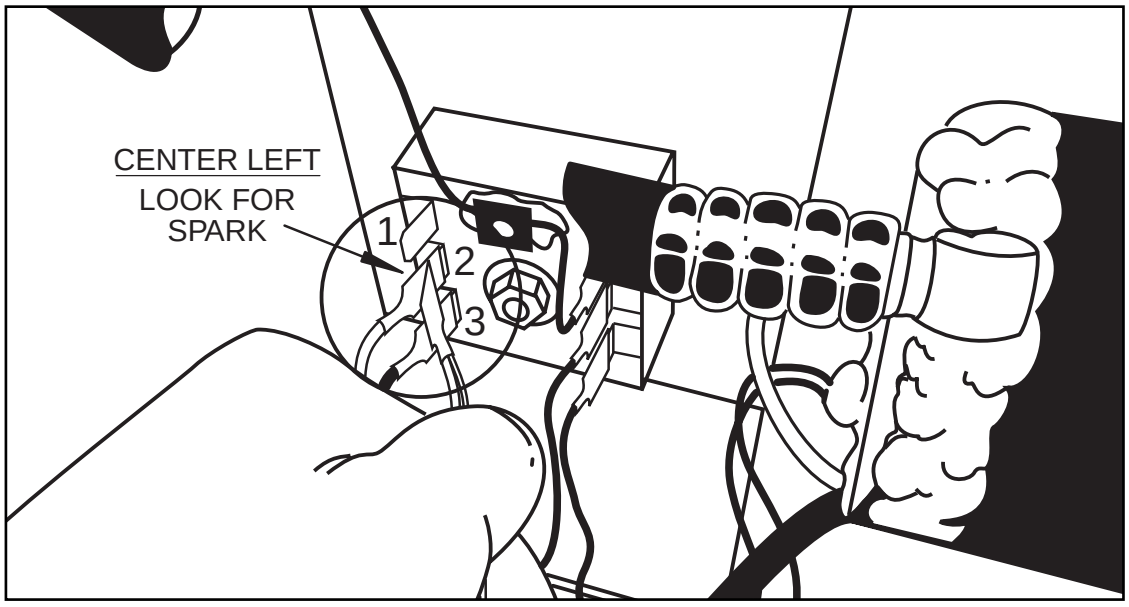
STEP 5 DIAGRAM



6. If you did not see a spark in step #5, strike the white wire connector against the **center left terminal (#2)** while looking for a spark. Refer to STEP 6 DIAGRAM below.

If there is **no spark**, proceed to #7. If there is a **spark**, proceed to #12.

STEP 6 DIAGRAM



7. If no spark was observed in Steps #5 and #6, replace with Kit #FP194B (120V). The Kit consists of the following:

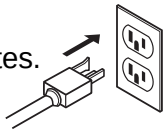
1 ea Thermistor Control . . . . . .#610
1 ea Thermistor Probe . . . . . .#133
1 ea Potentiometer . . . . . .#134
1 ea Thermal Cutout . . . . . .#FP187B
1 ea 1/3 roll heat tape . . . . . .#FP198

Parts will be assembled and preset at the factory.

8. If you observed a spark from step #5, continue with the following steps:

(A) Turn the Bypass Switch OFF.

(B) Plug in both cords so that the green light on the switch plate illuminates. THE GREEN LIGHT MUST BE ON BEFORE YOU PROCEED!



(C) Make sure the heater is cold and REPEAT STEP #5.

If a **spark was observed** when repeating step #5, then continue troubleshooting with step #8(D), below. If **no spark was observed** when repeating step #5, then replace the Dual Cord Sensor, part #923

(D) Test the heater amperage, see step 9A or 9B depending on what type of ammeter you have. Continue with step 8(E), below, after testing the heater amperage

(E) If the amperage is above 13 amps then go to step #8(F). If the amperage is below 13 amps, then go to step 10A or 10B depending on what type of ammeter you have.

(F) If the amperage of the heat exchanger is above 13 amps then cool off the heat exchanger by running cold water through it. Connect the ammeter back into the circuit (shown in step 9A or 9B). Plug in the power cord (no red sleeve) and count how many seconds it takes before the ammeter shuts off (zero reading).

Step #8 continues on next page.

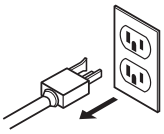
Step #8 continued:

(F-1) If the heater stays on for at least 50 seconds then the heat system is working correctly. Check or modify your method of operation, make sure all hoses and cleaning tool tip sizes are original from the factory.

(F-2) If the heater is on only for a few seconds before it shuts off, make sure the heat exchanger is cold and retest. If the cold heater initially turns on for only a few seconds again then replace with Kit #FP194 (120V). The Kit consists of the following:

1 ea Thermistor Control . . . . . .#610
1 ea Thermistor Probe . . . . . .#133
1 ea Potentiometer . . . . . .#134

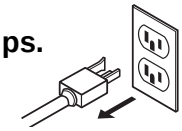
Parts will be assembled and preset at the factory.



UNPLUG BOTH CORDS. Repair and re-test.

9A. USING A DIGITAL OR ANALOG "IN-SERIES" STYLE METER. (See step 9B for "Clamp-Over" styled meter).

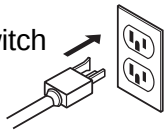
NOTE: Ammeter must be rated for and set to 20+ Amps.



(A) UNPLUG BOTH CORDS FROM THE OUTLET.

(B) Connect the ammeter "in series" between the **top left terminal (#1)** on the thermistor control box and the **white wire(s)** that connect to that terminal. See diagram below.

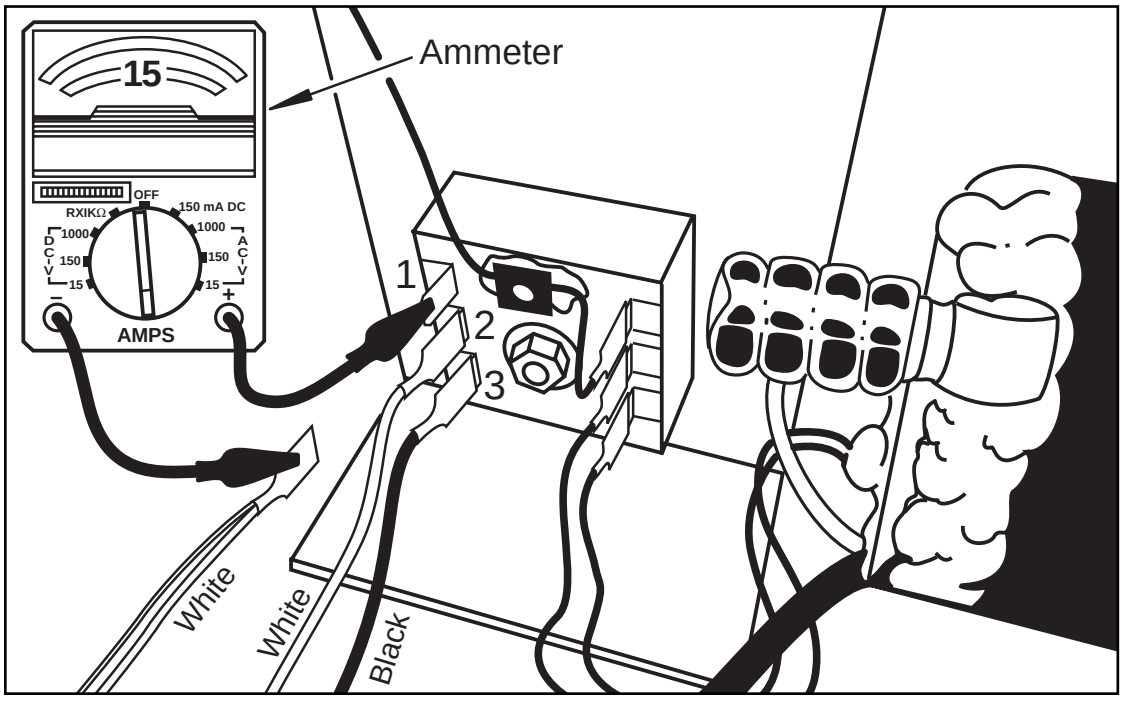
(C) Plug the #2 cord (no red sleeve) into the outlet and turn the Bypass Switch ON at the switch plate.



(D) Measure the current draw of the heater.

(E) Return to step 8(E).

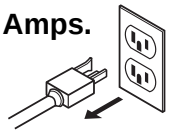
STEP 9A DIAGRAM



9B. USING A “CLAMP-OVER” STYLE METER.

NOTE: Ammeter must be rated for and set to 20+ Amps.

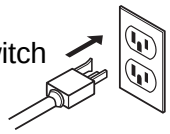
(A) UNPLUG BOTH CORDS FROM OUTLET.



(B) Reconnect the white wire(s) to the **top left terminal (#1)** on the thermistor control.

(C) Place the Ammeter around the thicker white wire extending from the #1 terminal of the thermistor control. NOTE: Cobra-H will have only one wire (the thicker wire) coming from terminal #1. Refer to STEP 9B DIAGRAM below.

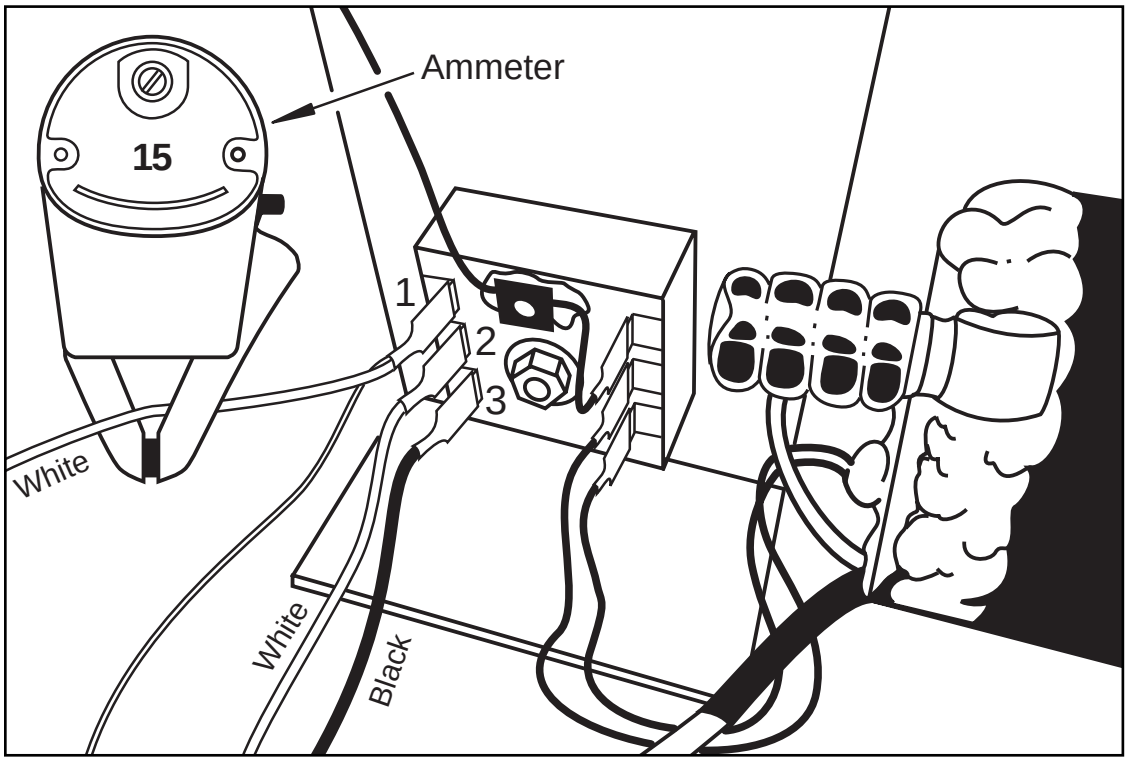
(D) Plug the #2 cord (no red sleeve) into the outlet and turn the Bypass Switch ON at the switch plate.



(E) Measure the current draw of the heater.

(F) Return to step 8(E).

STEP 9B DIAGRAM

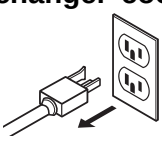


TESTING IF CURRENT READING IS LOW:

10A. When using an “IN-SERIES” type Ammeter:

NOTE: Remember to let the heat exchanger cool down. Current testing must be done when the heater is cold.

(A) UNPLUG THE POWER CORD.

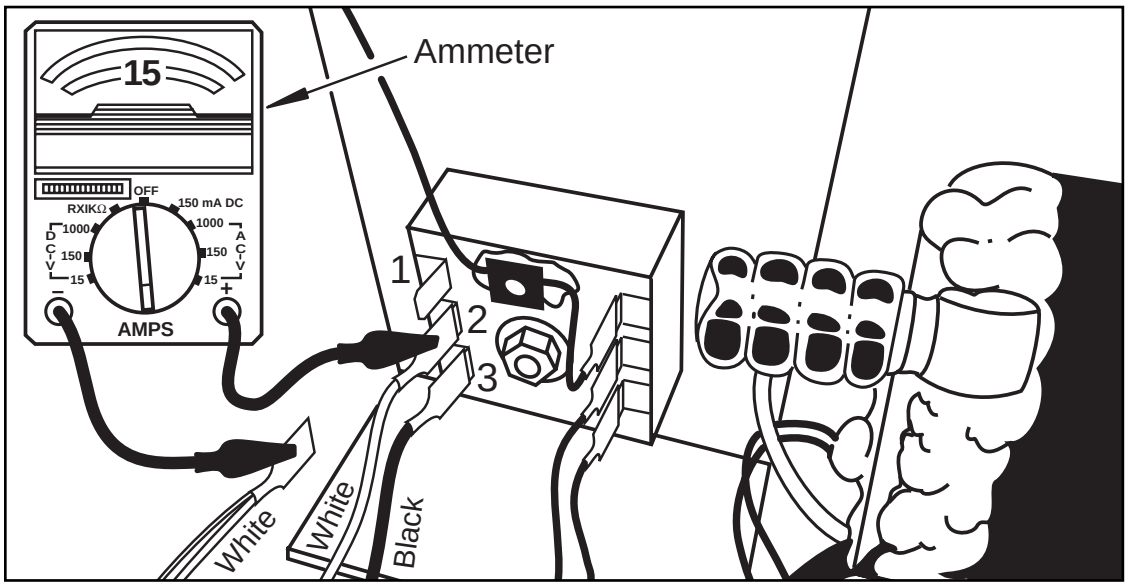


Step 10A continues on next page.

10A continued:

(B) Leave 1 Ammeter lead connected to the white wire(s), removed from the **#1 terminal** on the thermistor control. **DO NOT** reconnect the white wire(s) to the terminal. Connect the other Ammeter lead to the **center left terminal (#2)**. Leave this wire connected to the terminal. See STEP 10A DIAGRAM below. Go to step 11.

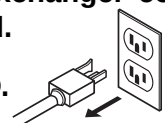
STEP 10A DIAGRAM



10B. When using a "CLAMP-OVER" type Ammeter:

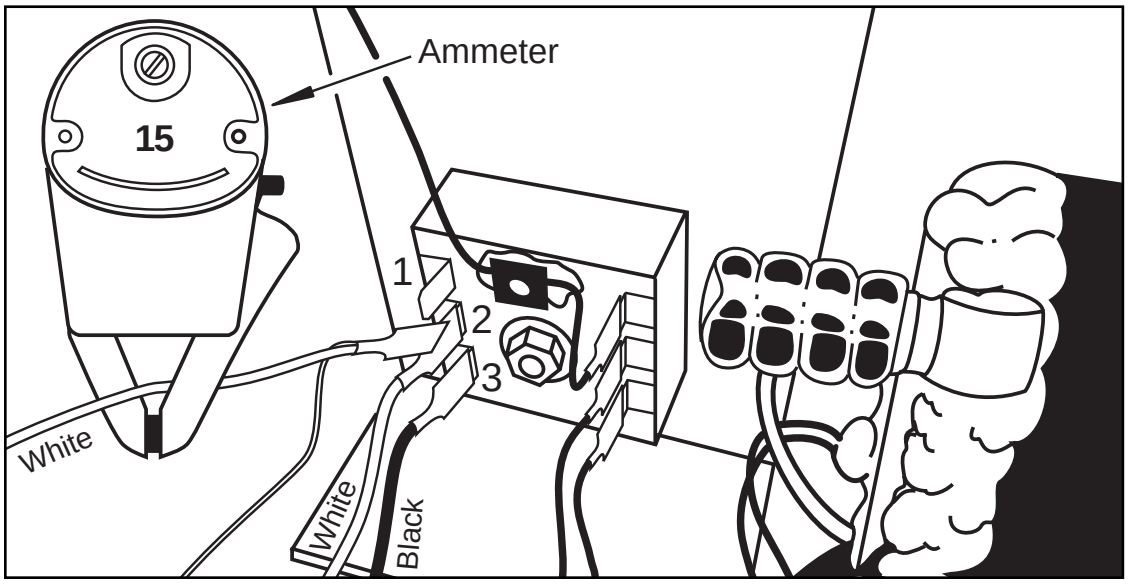
NOTE: Remember to let the heat exchanger cool down. Current testing must be done when the heater is cold.

(A) UNPLUG THE POWER CORD.



(B) Leave the meter clamped around the thicker white wire from terminal #1. **DO NOT** connect the wire to terminal #1. NOTE: Cobra-H will have only one wire coming from terminal #1. Hold the white wire connector from **terminal #1** to the **center left terminal (#2)**, on the thermistor control. See diagram below. Go to step 11.

STEP 10B DIAGRAM



11.(A) Plug in cord #2 (no red sleeve) and measure amperage.

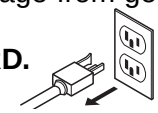
(B) If the heater is now drawing around 15 Amps, replace the thermistor control with part #610 and the potentiometer with part #134 (KIT #FP194 - 120V).

(C) If the current draw is under 12 Amps, test your Ammeter for accuracy. If your Ammeter is accurate, then replace the heat exchanger. Check the parts break-down for your extractor for the correct part number.

TESTING FOR OPENS IN THE WIRING:

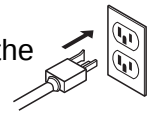
12. If a **spark was observed** in Step 6, but not from Step 5, the thermistor control is not turning on. This may be the result of a bad thermistor control or an open wire which prevents the correct signal or voltage from getting to the thermistor control.

(A) UNPLUG THE POWER CORD.

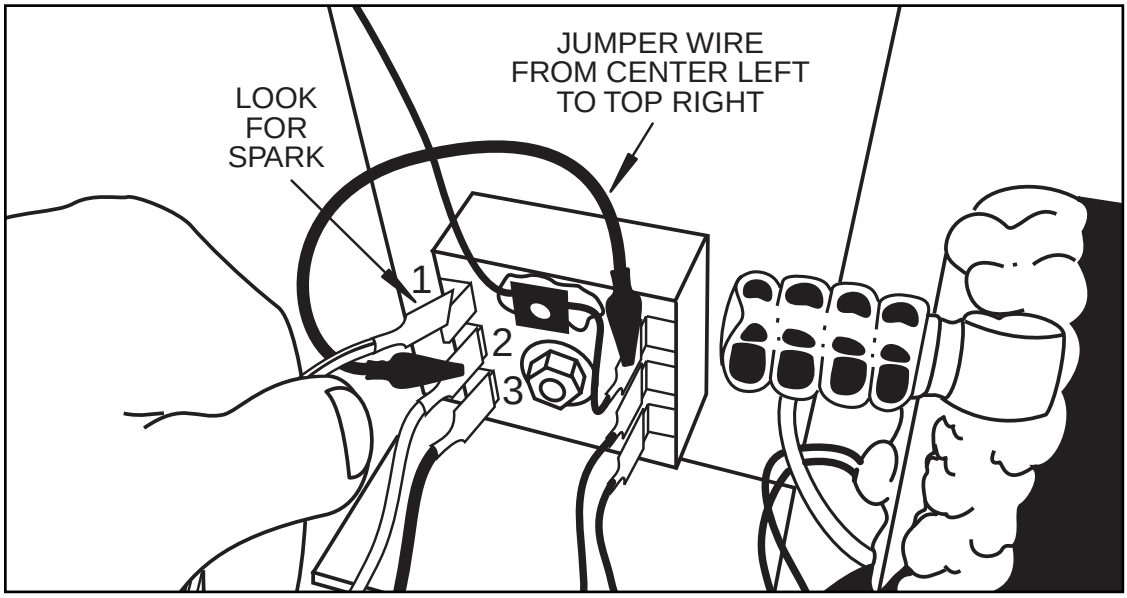


(B) Begin the testing by connecting a jumper wire from the **center left terminal** of the thermistor control to the **top right terminal** of the thermistor control. See STEP 12 DIAGRAM below.

(C) Plug in cord #2 (no red sleeve) and turn the Bypass Switch ON at the switch plate.



STEP 12 DIAGRAM



(D) While looking for a spark, strike the white wire connector, from terminal #1, to the **top left terminal (#1)**. See STEP 12 DIAGRAM above.

(E) If **no spark**, replace with Kit #FP194 (120V). The Kit consists of the following:

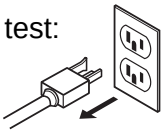
1 ea Thermistor Control . . . . . .#610
1 ea Thermistor Probe . . . . . .#133
1 ea Potentiometer . . . . . .#134

Parts will be assembled and preset at the factory.

(F) If there is a **spark**, this indicates that some wiring is open. Continue with Ohm meter or Voltmeter tests, on next page, to isolate the faulty wiring or switch.

OHM METER TEST:

13. Use an **OHM METER** for the following test:



(A) UNPLUG THE POWER CORDS.

(B) Disconnect the red wire at **P6** on the top of the **Dual Cord Sensor Board** (refer to wiring illustration, Step 3). Measure from the red wire to the **top right terminal** on the thermistor control.

NOTE: The resistance from the top right terminal of the thermistor control box to the red wire (unplugged) from P6 on the Dual Cord Sensor Board, should measure approximately between 4K ohm (heat adjusted to high on all machines) and 15K ohm (heat adjusted to low, not applicable on machines without adjustable heat).

(C) If the resistance measurement is correct, reconnect the red wire to the P6 terminal on the circuit board and continue with the VOLTMETER TEST.

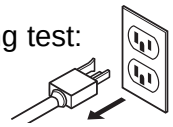
NOTE: Infinite resistance indicates a bad potentiometer (small blue box mounted to the thermistor control), a bad heat adjustment potentiometer or heat toggle switch (on machines with adjustable heat), or an open wire. Refer to wiring diagram, for the particular machine being worked on, to further isolate the open.**

**** HL-1200 & HHP-12 have a potentiometer located under the switch plate. Refer to the wiring diagram for the machine being serviced.**

Isolate the faulty part(s) and replace, or continue testing for possible open wires, by following the VOLTMETER TEST below.

VOLTMETER TEST:

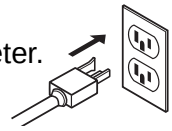
14. Use a **VOLTMETER** for the following test:



(A) Unplug the AC cords.

Set the voltmeter to AC voltage (120+ volts), and connect the meter to the following points.

(B) Plug the cord(s) in **only after** connections are made with the voltmeter. Refer to Step 3, of these instructions, for wiring connections.



(C) 120 VAC should be present between P1 and P2 on the Dual Cord Sensor Board when cord #2 (heater cord, no red sleeve) is connected to the outlet.

(D) 120 VAC should be present between P1 and the P7 wire on the Dual Cord Sensor Board when cord #2 is plugged into an outlet and the Bypass Switch is **ON**.

(E) 120 VAC should be present between P3 and P4 at the Dual Cord Sensor Board when cord #1 (red sleeve) is connected to the outlet.

(F) If any wiring is found to be open (no AC voltage reading), test the meter for proper operation in an AC outlet. Check the connections of the meter and the wiring connections at the board. Replace any wiring or components that test open. Refer to the schematic and parts list for your particular machine.

NOTE: Replace any faulty wires with the same gauge and color wire.