

Refrigeration & Air Conditioning Technology
SIXTH EDITION

SECTION 3

BASIC AUTOMATIC CONTROLS

UNIT 15

Troubleshooting Basic Controls

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UNIT OBJECTIVES

After studying this unit, the reader should be able to

- Describe and identify power- and non-power-consuming
- Describe how a voltmeter is used to troubleshoot electrical circuits.
- Identify some typical problems in an electrical circuit.
- Describe how an ammeter is used to troubleshoot an electrical circuit.
- Describe how a voltmeter is used to troubleshoot an electrical circuit.

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UNIT OBJECTIVES

After studying this unit, the reader should be able to

- Recognize the components in a heat-cool electrical circuit.
- Follow the sequence of electrical events in a heat-cool electrical circuit.
- Differentiate between a pictorial and a line-type electrical wiring diagram.

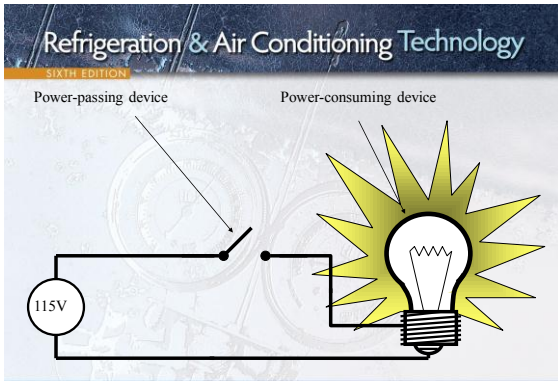
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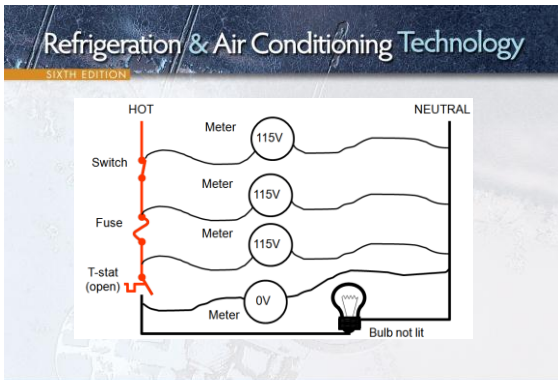
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INTRODUCTION TO TROUBLESHOOTING

- Recognize the control and its purpose in the system
- Controls are either electrical, mechanical or both
- Electrical devices
 - Power consuming devices use power
 - Example of a power consuming device: a light bulb
 - Power passing devices pass power to the power consuming devices without consuming power themselves (ideally)
 - Example of a power passing device: a switch



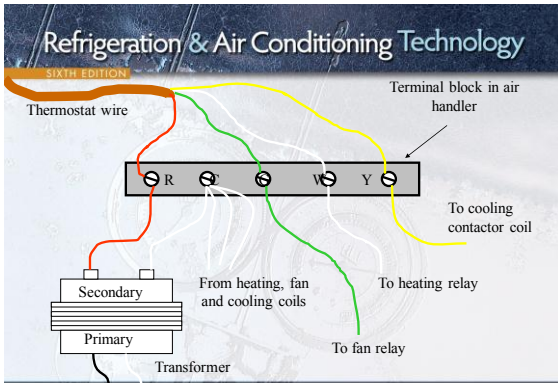


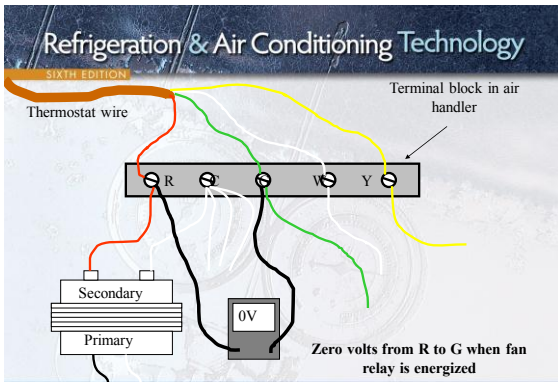
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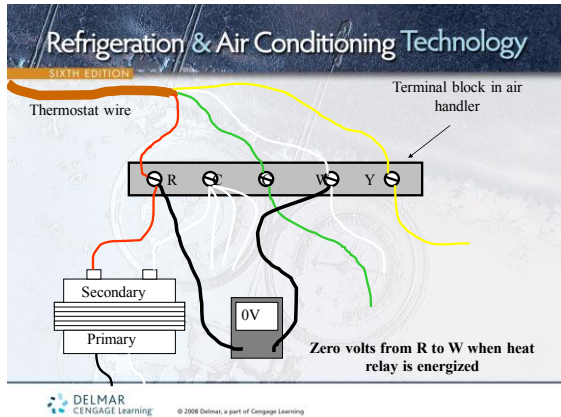
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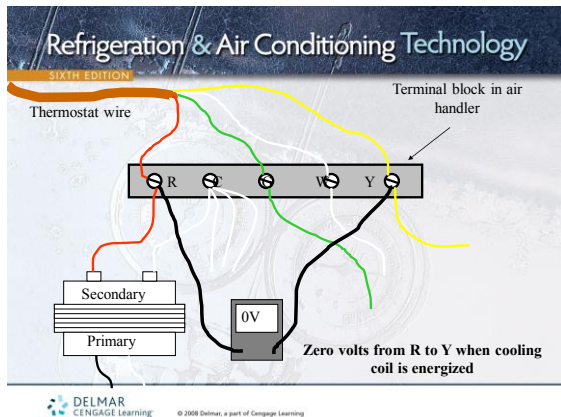
TROUBLESHOOTING COMPLEX CIRCUITS

- Check the thermostat
 - 0 volts from R to W when there is a call for heat
 - The coil of the heating relay should be energized
- Check the fan circuit
 - 0 volts from R to G when the fan relay coil is energized
- Check the cooling circuit
 - The Y terminal controls the cooling circuit
 - 0 volts from R to Y when there is a call for cooling









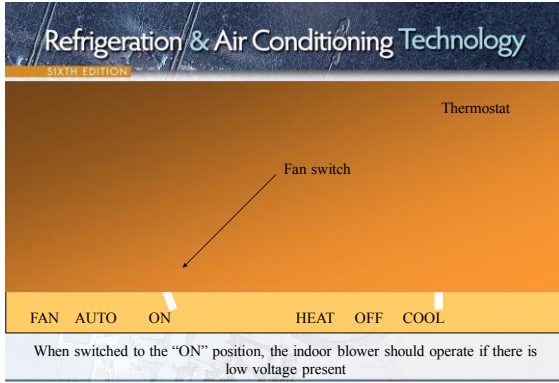
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TROUBLESHOOTING THE THERMOSTAT

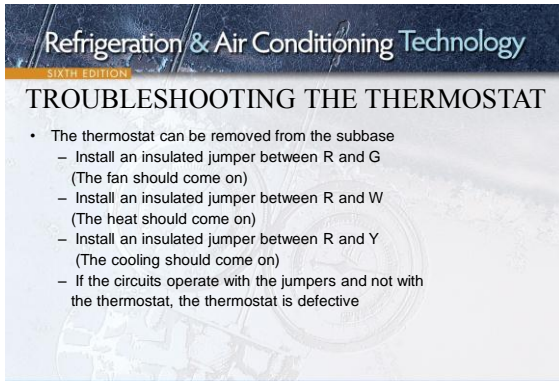
- Control voltage must be present in order for the thermostat to operate
 - Turn the fan switch to the ON position to see if the fan begins to operate
 - If the fan comes on, there is low voltage present
 - If the fan does not operate there may be a low voltage problem
 - Check voltage supplied to the transformer primary
 - Check voltage at the transformer secondary

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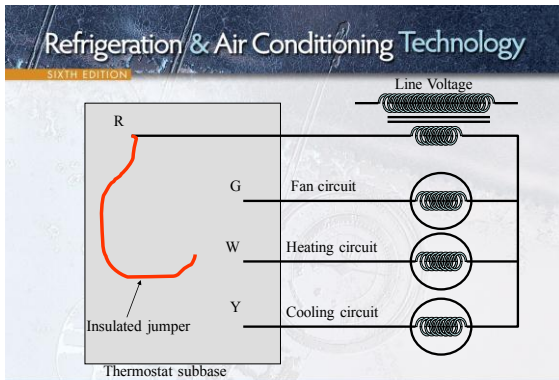
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TROUBLESHOOTING THE THERMOSTAT

- On a call for heat, power is passed through the thermostat to the heating relays
- On electric heating systems, the fan will also be energized on a call for heat
- On a call for cooling, the following system components are controlled
 - Compressor
 - Condenser fan motor
 - Evaporator fan motor

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TROUBLESHOOTING THE THERMOSTAT

- The compressor and condenser fan motor are wired in parallel with each other
 - Controlled by the Y terminal on the thermostat
 - The Y terminal passes power to the contactor coil
 - Contacts close and energize the compressor and condenser fan
- The indoor fan will operate continuously when the fan switch is in the ON position
- The indoor fan will operate only when the compressor is operating when the fan switch is in the AUTO position

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TROUBLESHOOTING AMPERAGE IN LOW-VOLTAGE CIRCUITS

- Transformers are rated in volt-amperes, VA
- VA rating can be used to determine if the control circuit is drawing too much current
- Maximum amperage = VA rating/secondary voltage
- A 40 VA transformer with a secondary voltage can handle a maximum current of 1.67 amps
- Maximum amperage = $40/24 = 1.67$

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TROUBLESHOOTING AMPERAGE IN LOW-VOLTAGE CIRCUITS

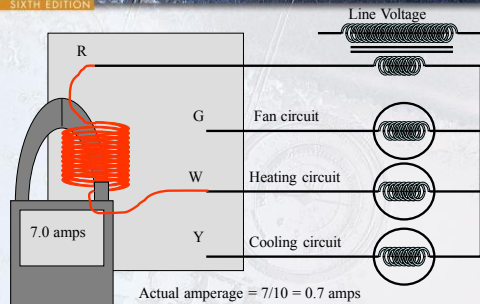
- Using a clamp-on ammeter
 - Coil a jumper wire around the jaws of the meter ten times
 - Place the jumper in series with the circuit being checked
 - Divide the ammeter reading by ten
 - Actual circuit amperage should be lower than the calculated maximum circuit amperage
 - Electronic clamp-on meters can often be used without using the 10-wrap method

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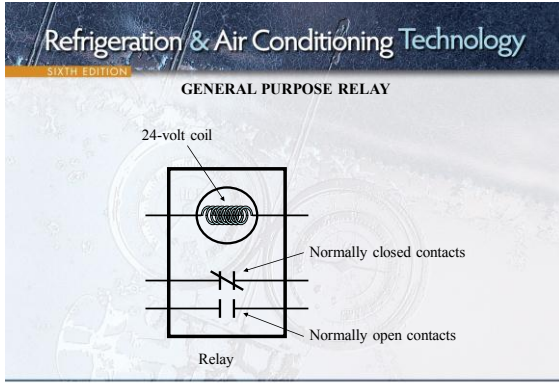
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TROUBLESHOOTING VOLTAGE IN THE LOW-VOLTAGE CIRCUIT

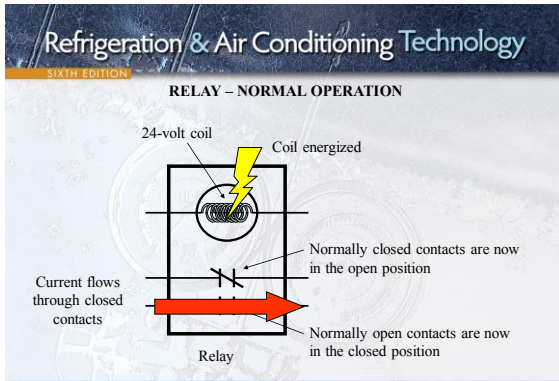
- Power consuming devices need to have the proper voltage supplied to them
 - If a relay's holding coil is rated at 24 volts, there should be 24 volts applied to the coil
 - If there is a reading of zero volts across the coil, the problem is likely not the coil
 - If there is a reading of 24 volts across the coil and the relay contacts do not switch position, the coil is defective and the relay should be replaced

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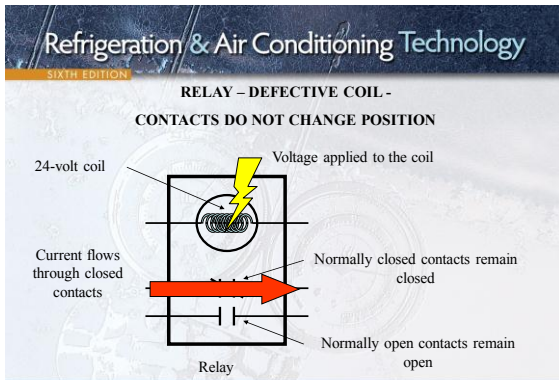
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TROUBLESHOOTING VOLTAGE IN THE LOW-VOLTAGE CIRCUIT

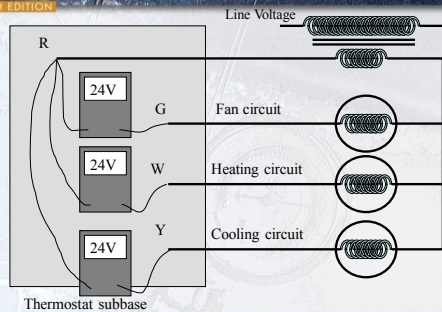
- Thermostats can be removed from the subbase to check the low voltage circuits
 - There should be a reading of 24 volts between the R (hot) terminal and the Y (cooling) terminal
 - There should be a reading of 24 volts between the R (hot) terminal and the W (heating) terminal
 - There should be a reading of 24 volts between the R (hot) terminal and the G (indoor fan) terminal

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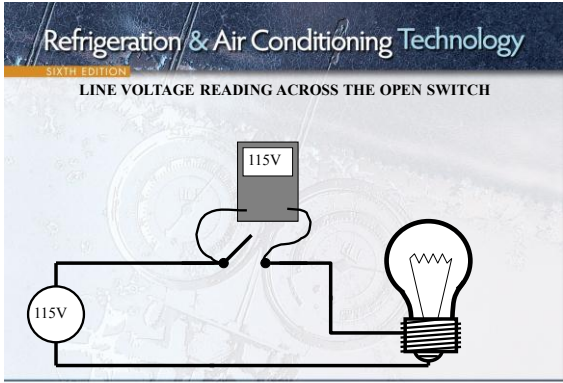
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TROUBLESHOOTING ELECTRICAL SWITCHES AND LOADS

- Switches are wired in series with power-consuming devices (light switch in series with a light bulb)
- When switches are wired in series with a load, all of the switches must be closed for the load to operate
- Switches in parallel provide alternative control sequences for the load
- If there is line voltage supplied to the circuit, there will be line voltage across an open switch

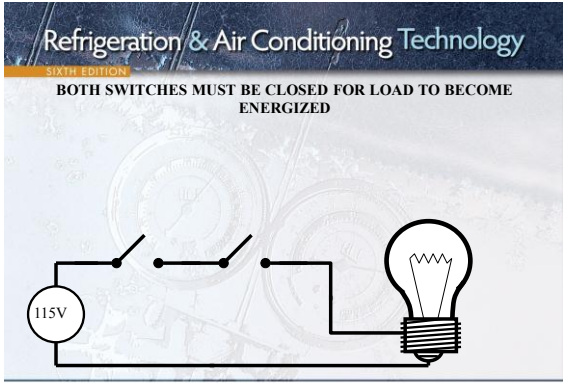
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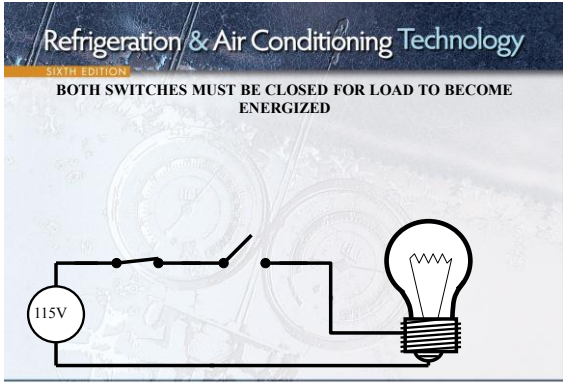
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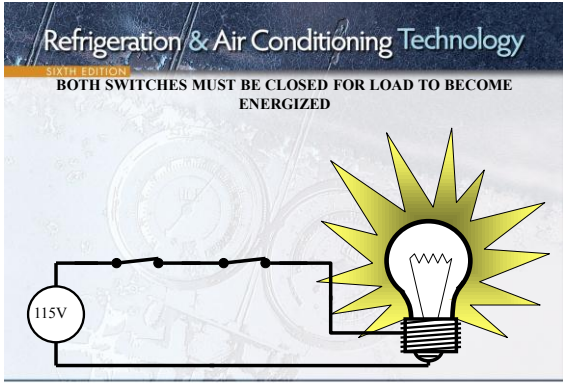
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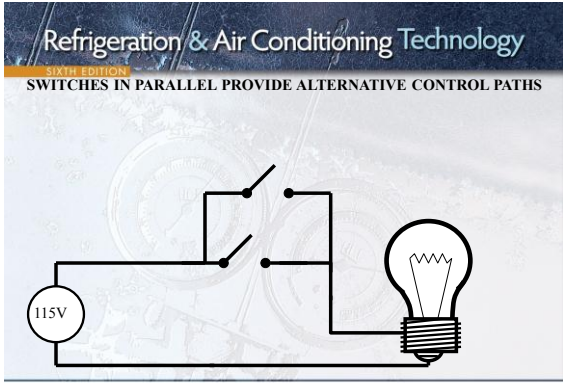
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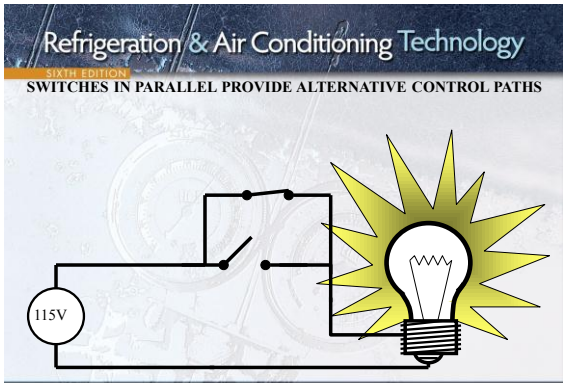
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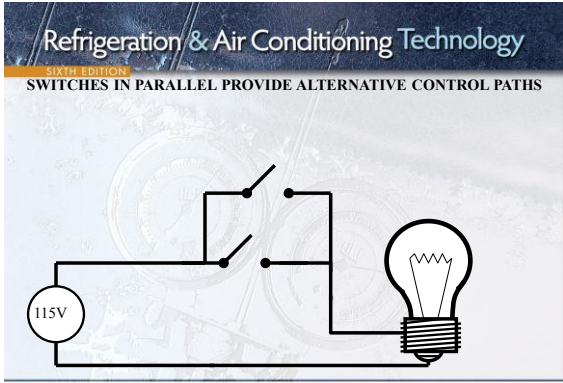
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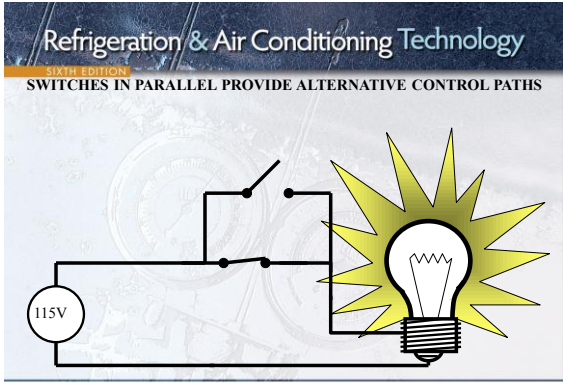
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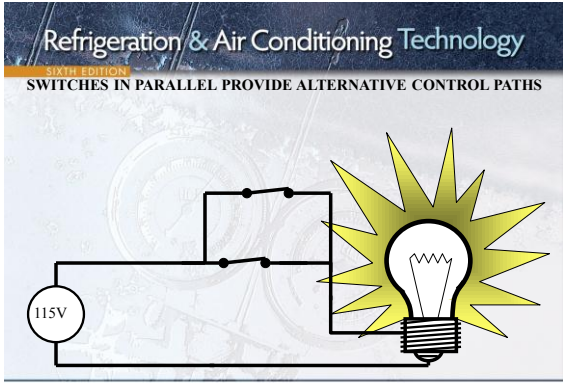
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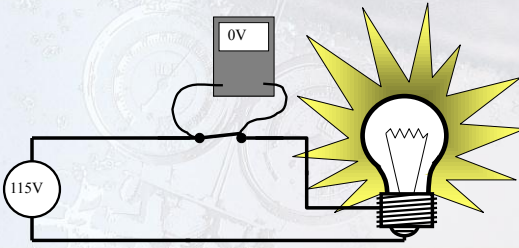
TROUBLESHOOTING ELECTRICAL SWITCHES AND LOADS

- There will 0 volts across a closed switch
- The voltage reading across the windings of a de-energized motor will be 0 volts
- An ohmmeter can be used to check switches and loads if all power and wires are disconnected
- Infinite resistance reading indicates an open circuit
- Never use an ohmmeter on energized circuits

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READING OF ZERO VOLTS ACROSS THE CLOSED SWITCH



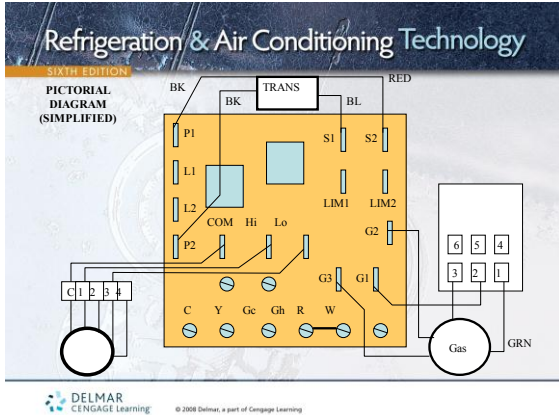
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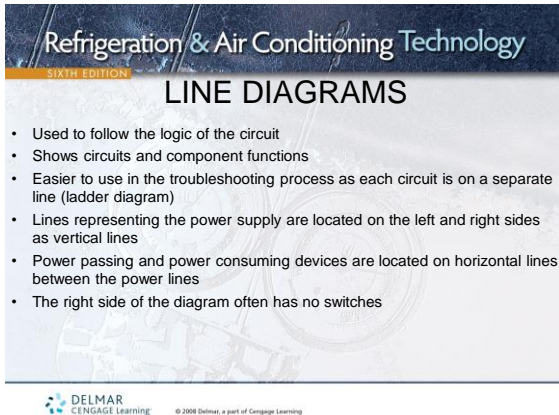
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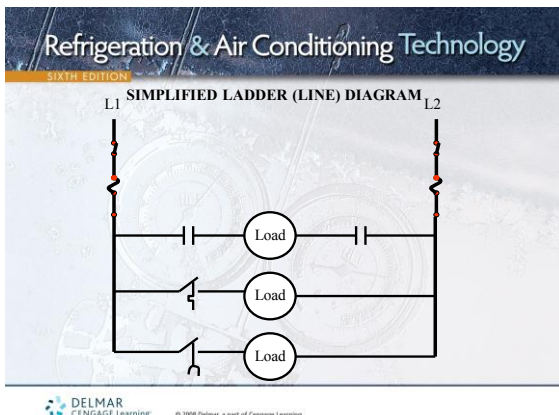
PICTORIAL WIRING DIAGRAMS

- Schematic diagram
- Used to show the location of circuit components
- Diagram configured to show the circuits as they are seen in the actual unit
- Wires are color coded in the diagram to make wire identification easier
- All wires and connections are included

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UNIT SUMMARY - 1

- Recognize each control and its purpose in the circuit
- Electric components can be power consuming or power passing devices
- A measurable voltage reading across a switch indicates that the switch is in the open position
- A reading of zero volts across a switch in an energized circuit indicates that the switch is in the closed position
- The thermostat can be evaluated by removing it from the subbase
- Jumper wires at the subbase can be used to check the individual circuits
- Control voltage must be present in order for the system to operate

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UNIT SUMMARY - 2

- If the system does not operate, the voltage at the primary and secondary of the transformer should be checked
- The indoor fan motor will operate if the fan switch is turned to the ON position
- The indoor fan motor will cycle on and off with the compressor (in the cooling mode) when the fan switch is turned to the AUTO position
- Max. control circuit amps = VA rating/secondary voltage
- Control circuit amperage is measured with an ammeter
- Power consuming devices must be supplied the proper voltage

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UNIT SUMMARY - 3

- If proper voltage is supplied to a component and it fails to operate, the component should be evaluated
- Switches are wired in series with the power consuming device in the circuit
- Multiple switches can be wired in series
- Switches in parallel provide alternate control sequences
- Pictorial diagrams show component locations, color-coded wires, and all electrical connections
- Line or ladder diagrams show each circuit on a separate line and make the troubleshooting process easier

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