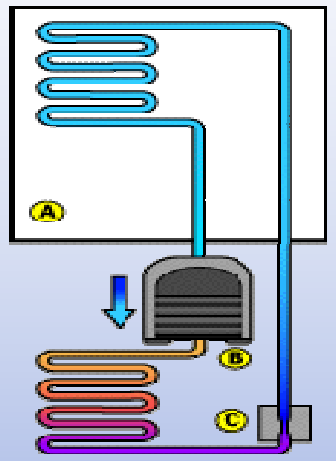
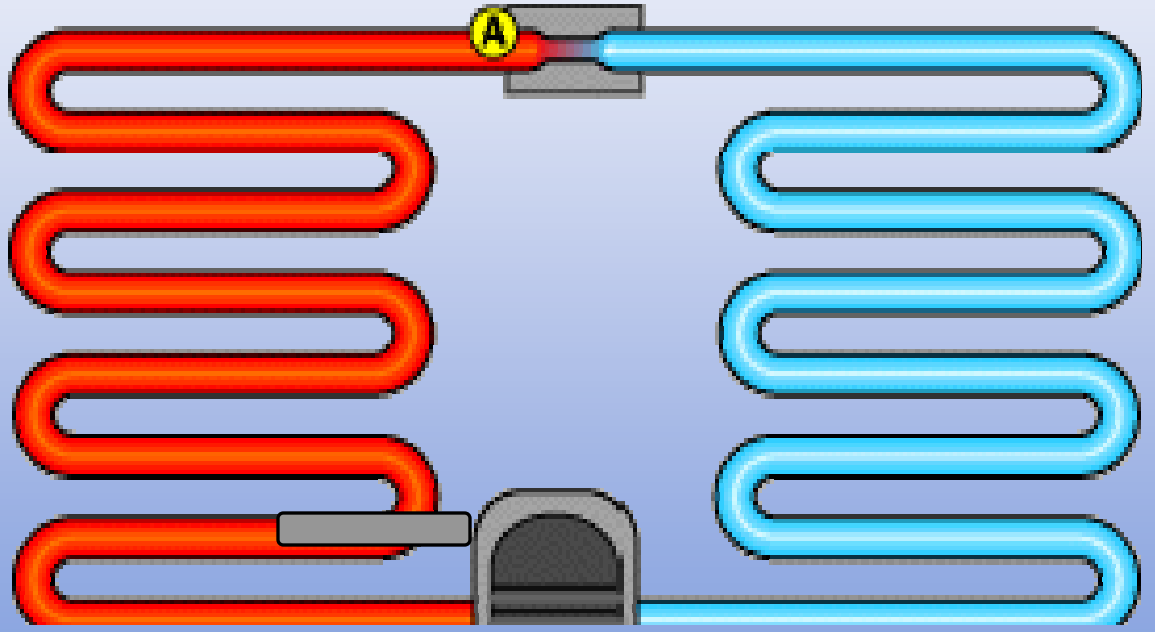
HVAC Fundamentals





When you have completed this section, you will:

- Be familiar with Basic **HVAC** terminology
- Understand the fundamentals of the refrigeration cycle
- Know the four major components of an HVAC system and be able to explain each function
- Be knowledgeable about low voltage controls

When you have completed this section, you will:

- Be aware of workplace safety measures while servicing a system
- Know how to use electrical test equipment
- Have practiced wiring controls and troubleshooting
- Have practiced charging a system

Air Conditioning Theory:

Principle #1:

- **Cold** is defined as “the absence of heat”. Everything above absolute Zero is a measurement of **HEAT**

Principle #2:

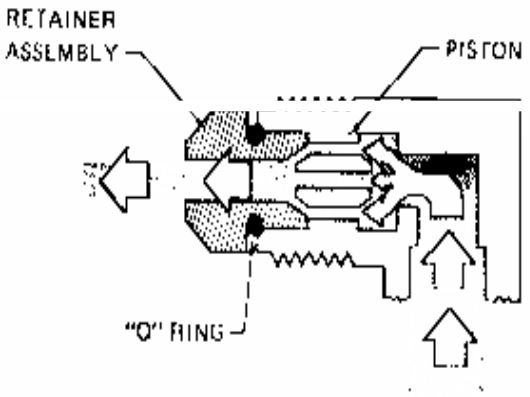
- Heat is ever ready to flow to anything, which contains **Less Heat**.

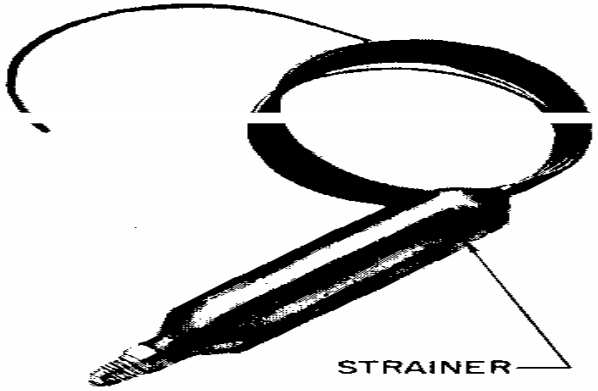
Principle #3:

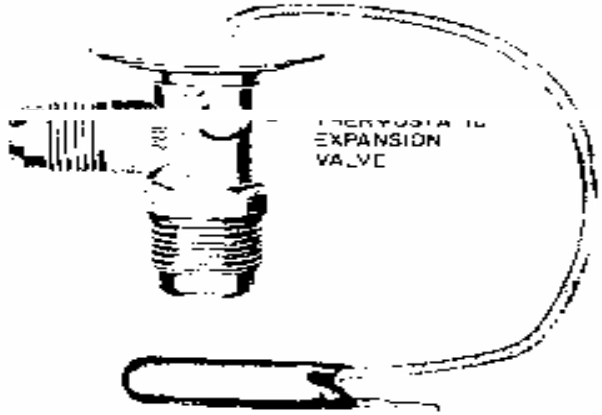
- Anytime a liquids change to a gas vapor, it must give up its heat and the heat is carried off in the **Vapor**.

4 Major Components of an A/C System

- **Compressor:** "compresses" or squeezes low temperature/low pressure vapor in order to raise it to a higher temp and pressure.
- **Condenser:** The condenser is a device that **Expels** heat from the system.
- **Evaporator:** The evaporator is a device for the **Absorption** of heat into the system.
- **Metering Device:** The metering device controls the **Flow** of refrigerant into the evaporator.







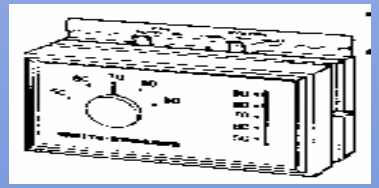
Basic Cooling Cycle

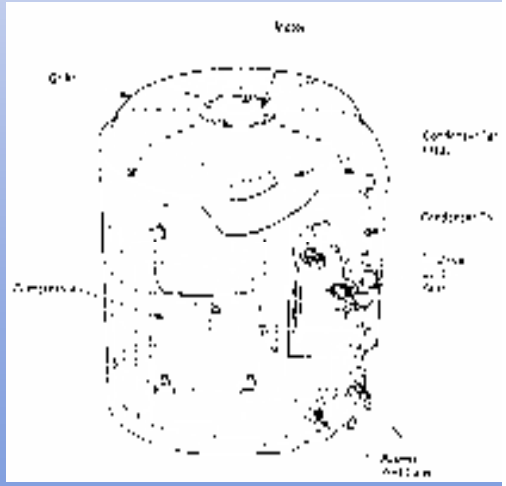
Normally, a refrigerant picks up heat by evaporating and then gives up heat by condensing.

Two important things to remember about Freon refrigerants are:

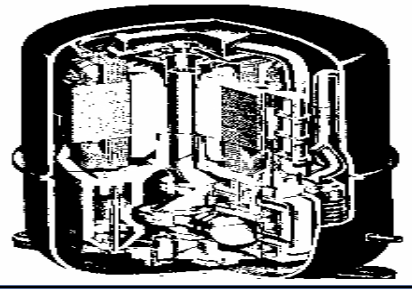
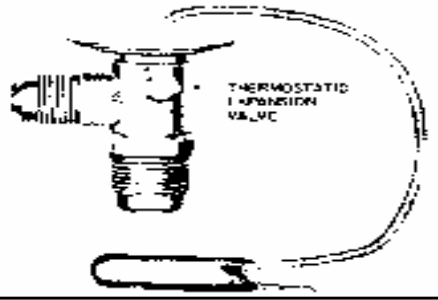
1. Refrigerants boil at a very low temperature.
2. There is a direct relationship between the temperature of a refrigerant and the pressure of a refrigerant.

The condensing unit (located outdoors) contains three basic components. They are the **Compressor**, **Fan Motor**, and the **Coil**.

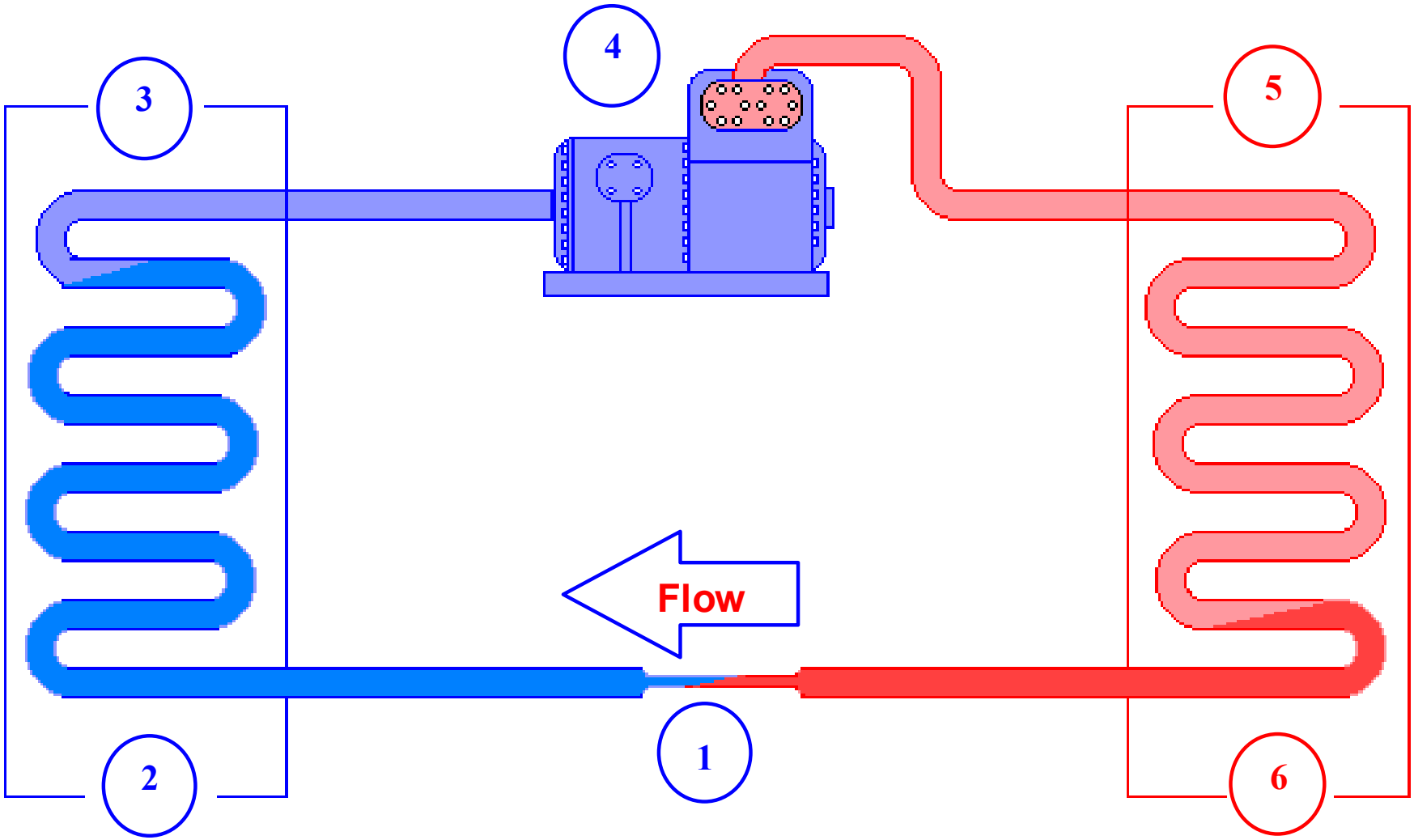




Functions of the 4 Major Components

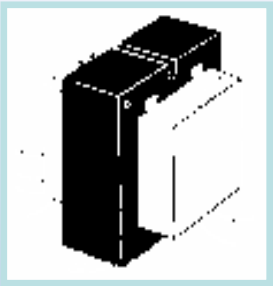
Compressor	*Condenser*	*Metering device*	*Evaporator*
•The **compressor is the workhorse** of the system. • It draws heat-laden gas from the evaporator at low temp/low pressure and compresses this gas, raising its temp/ pressure to the point at which the gas will condense	The condenser is the component in which the **heat absorbed in the evaporator is transferred to the atmosphere through the condenser-** cooling medium. Typically, water or air	The metering device is located before the evaporator coil. It may be a cap tube, expansion valve, or a piston. It meters the proper amount of liquid to the coil and maintains a liquid seal between the high and low side of the system.	The evaporator is the cooling component of the system. In the evaporator, pressure is reduced and the liquid boils to a gas at low temperature as it absorbs heat from the substances surrounding the coil such as conditioned space.
			

Summary of the Cycle

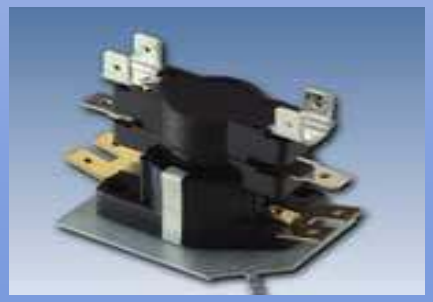


Low Voltage Controls

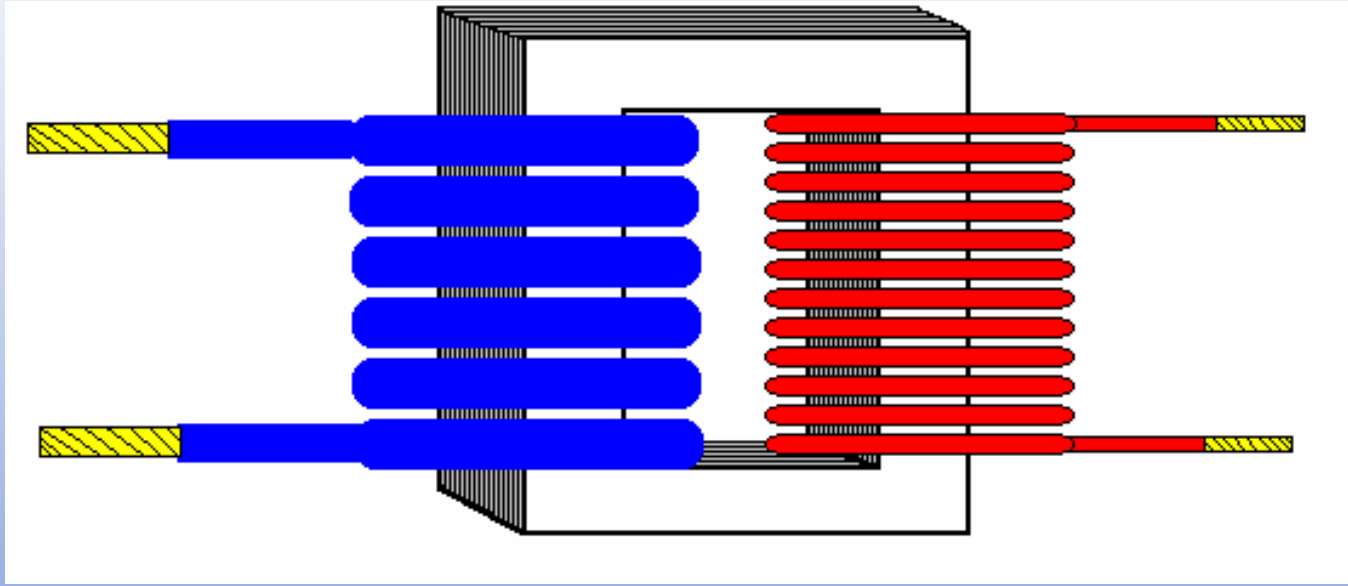
- Typically 24 volts is the operating voltage for HVAC controls.
- 240 volts is delivered to a **Transformer**, there it is stepped down to 24 volts A/C



- After that, one common wire is connected to one side of the coil on all of the controls.
- The **Thermostat** determines which wires will complete a circuit while delivering 24 volts to a relay, contactor, or sequencer.

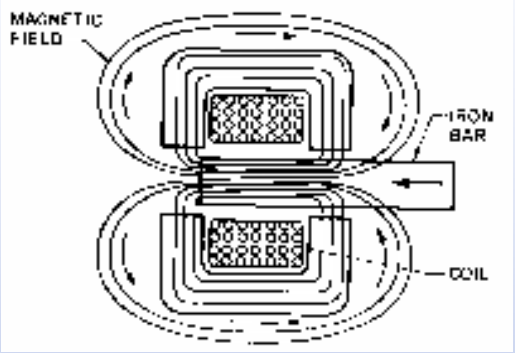


Transformers



Transformers

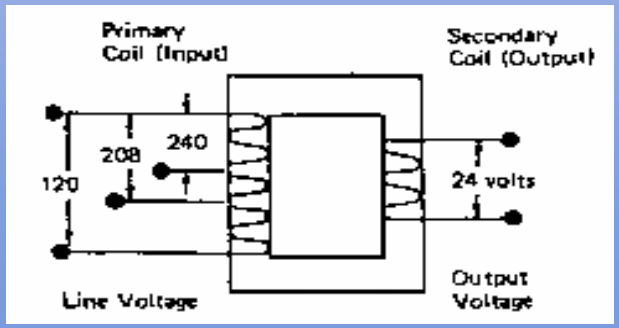
- A transformer produces an electrical
- current through electromagnetic **Induction**



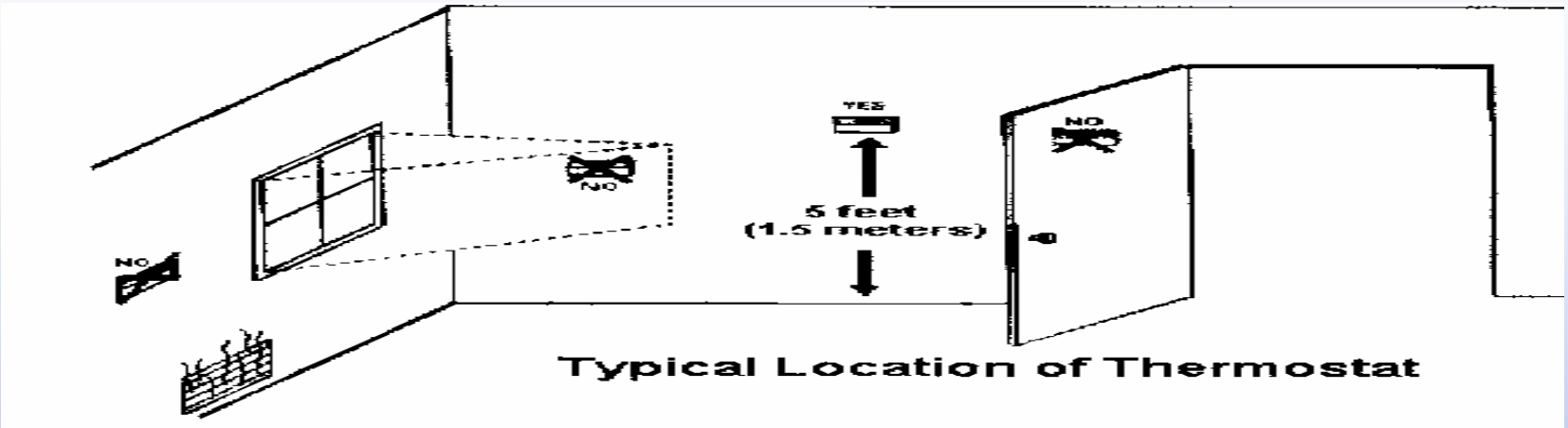
- A step-down transformer has more turns of wire on the **Primary** and less on the **Secondary** coil

Transformers

- A transformer can be diagnosed by checking for ___Voltage___ and/or ___Continuity___
- In a good transformer there should be continuity between ___All___ wires on each coil.
- There is ___No Continuity___ between the primary coil and the secondary coil.
- If there is no continuity between any wires on the same coil the transformer is ___Bad___.



Thermostats



Typical Location of Thermostat

The simplest way to test a thermostat is to **use a Jumper**

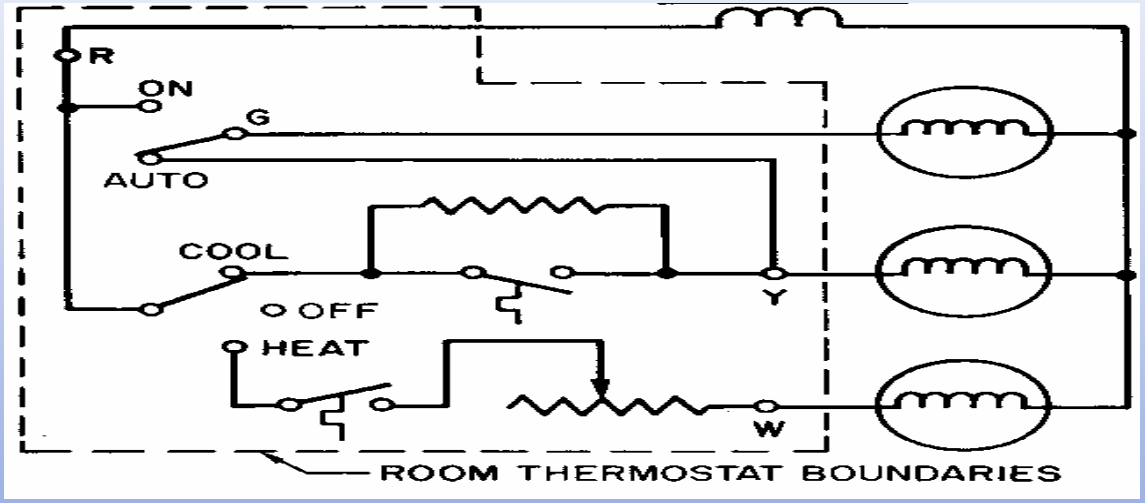
R to Y will energize the **Cooling Cycle**

R to G will energize the **Evaporator Fan Motor**

R to W will energize the **Heat Cycle**

Thermostats

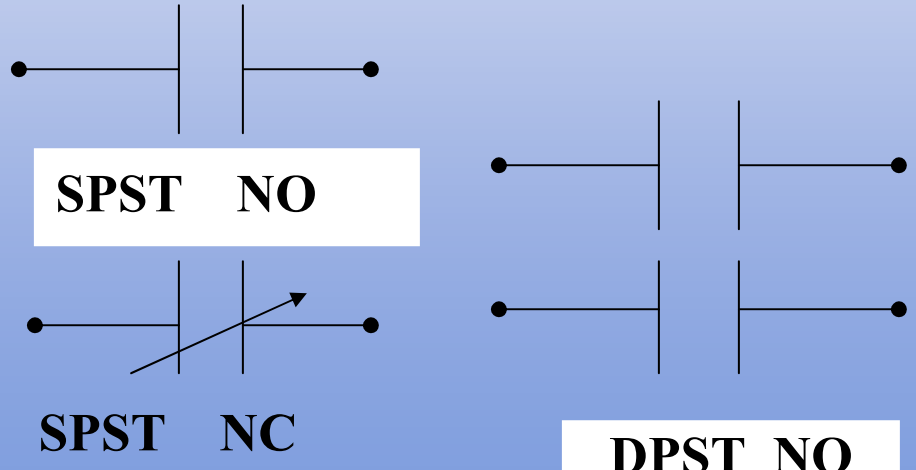
- If a thermostat **works with** a jumper wire and does **not work without** the jumper the **thermostat is bad.**



- If **24 Volts** is present and the jumper does not turn on the air handler or condenser it is time to troubleshoot the air handler or condenser to determine the problem.

Relays

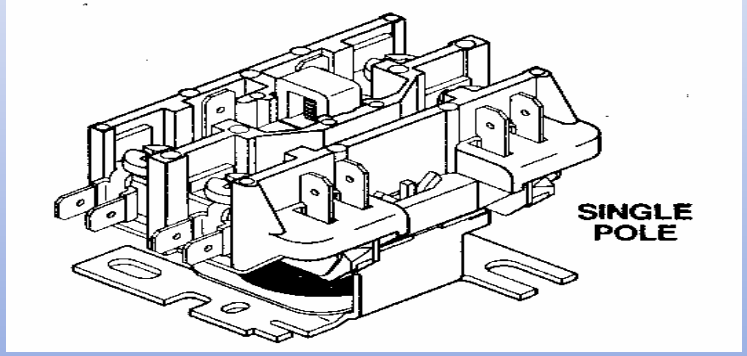
- The purpose of a relay is to control a Switch, Motor or Valve.
- A relay is designed for Light Duty starting applications.
- The simplest way to check a relay is to listen for a click and then 24 Volts.
- If no click, check to see if 24 V is present to activate the coil.



- It is not uncommon for a relay contact to stick due to Overload.

Contactors

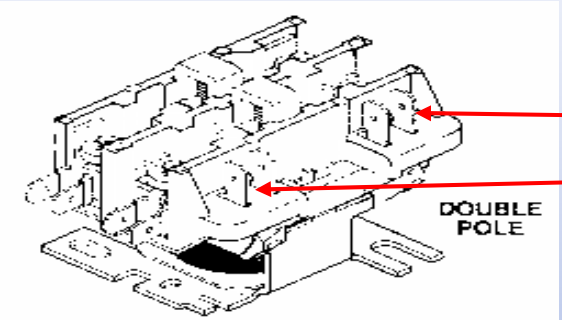
- A contactor is a large version of a relay designed for a heavier duty.
- Since a motor in start mode draws up to **4 Times** more current than while in run mode a contactor is used.



- Typically a **Single Pole** or a **Double Pole** is used in residential HVAC systems.

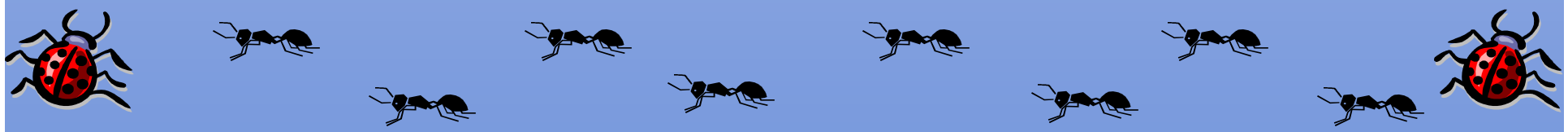
Contactors

- A simple way to test a contactor is to push the **High Voltage** contacts together or check for voltage when the contacts are pulled in



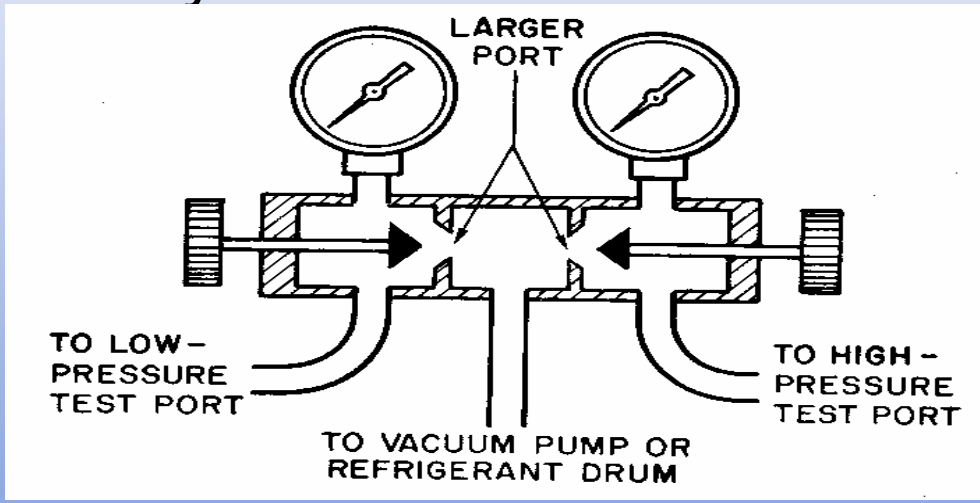
Check for continuity
Or check if **24 volts** is present

- Why is it important to be certain that a replacement contactor has the same amperage rating?
  Prevent Fire/ Damage/ Overload
- It is not uncommon to find ants covering the contacts



Manifold Gauges

- Gauges measure input pressure, output pressure, and the related temperature.
- A set of gauges will **Confirm** what is taking place within the field system.

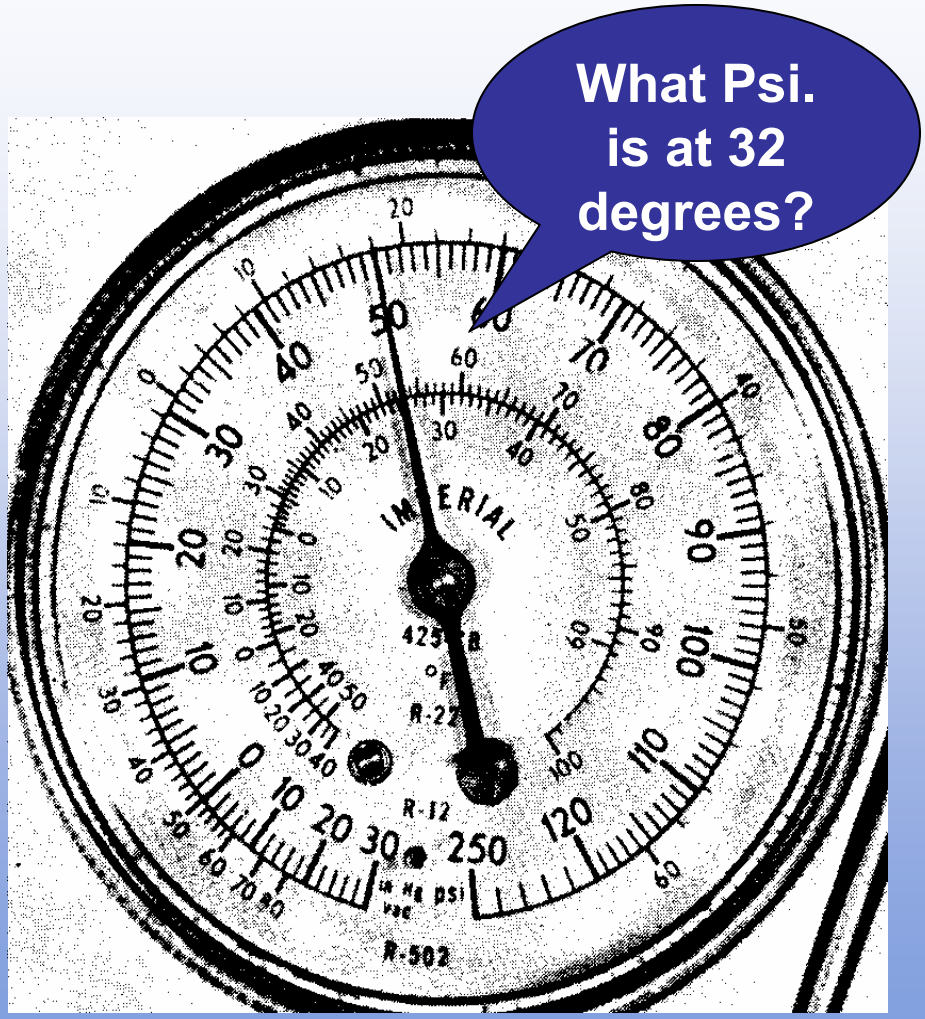


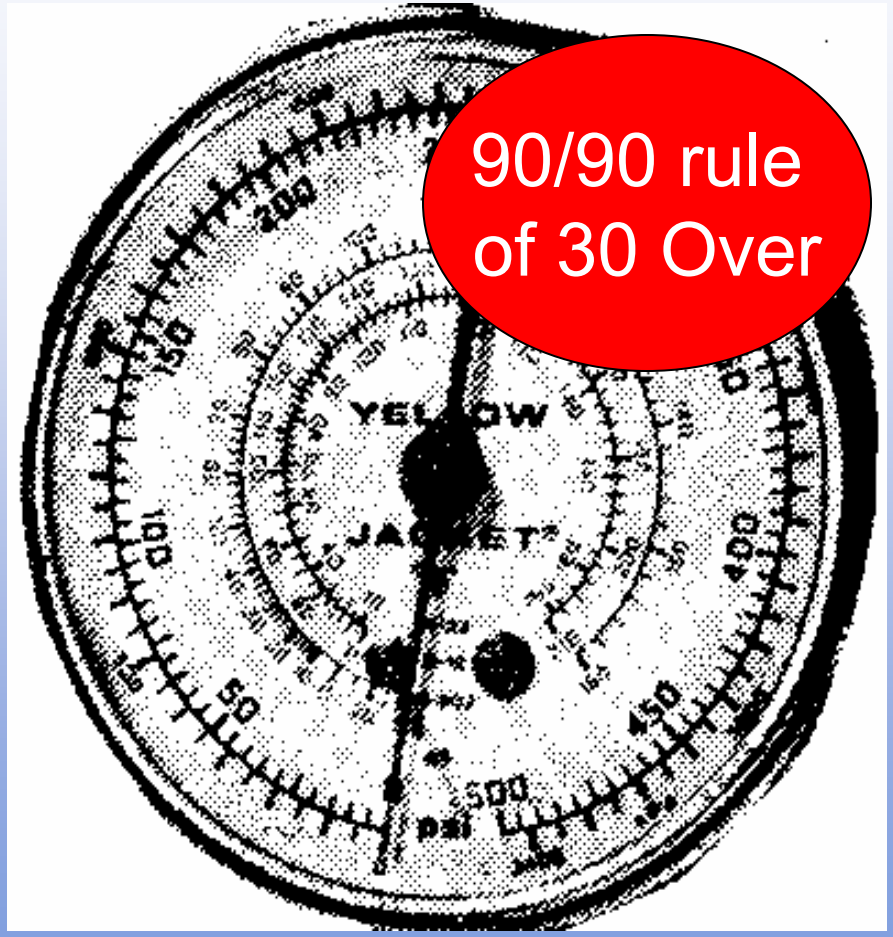
- Without a set of gauges one may only guess what is taking place in the sealed system.

Manifold Gauges

- **Compound gauge: Blue** - This is on the **Low** side of the system!
- **High pressure gauge: Red** - This is on the **High** side of the system and is used to measure pressure per square inch.
- The service port is to add or remove refrigerant and **Pull a Vacuum**.
- The manifold has three ports compound, pressure, and service.

Temperature and Pressure





Troubleshooting

- **Example one:** Compound gauge reads 80 psig and the pressure gauge reads 130 psig.

  Washout Bad - Compressor

- **Example two:** Very high pressure one the high side and low pressure on the low side.

  Restriction – Cap Tube

- **Example three:** Low pressure on the high side and low pressure to a vacuum on the low side.

  Low Refrigerant Charge

Troubleshooting

- **Example four:** Compound gauge rises steadily and then falls off rapidly. This continues through several system cycles.

  Dirty Drier or Evaporator Coil

- **Example five**: A near normal low pressure and an unusually high head pressure.

  Dirty Condenser Coil

- If a gauge is out if adjustment or does not measure well, replace the gauge. You'll know when your gauges are faulty when

  Disconnected there is a reading

  Cannot be calibrated to zero

Proper Charging Procedures

1. **Always purge lines** - To prevent moisture from entering the system.

2. **Charge with vapor only** - Do not turn the tank over. It will “slug” the compressor (fill it with liquid) and ruin it.

3. **Charge on vapor side only** - Using the compound gauge’s service port.

4. **Charge unit only while it is running** - Because the suction pressure will be low enough to allow refrigerant to enter the system. If it is NOT running you cannot know if it has a low charge as the pressure is equalized.

Proper Charging Procedures

5. **To avoid freezing condensate water** - Always attempt to charge to a desired evaporator temperature (36° or above) regardless of temperature outside.

6. **A desirable difference in temperature is 15-20° F** - Take the time to explain to the resident that the maximum differential is 20° to the ambient temperature outside.

Review Questions

1. What is the definition of law two?

   Heat is always ready to transfer something that has less heat

2. What are the four major components of an A/C system?

   Compressor, Condenser, Metering Device, and Evaporator

Review Questions

3. In which component of the A/C system is heat absorbed?

   Evaporator

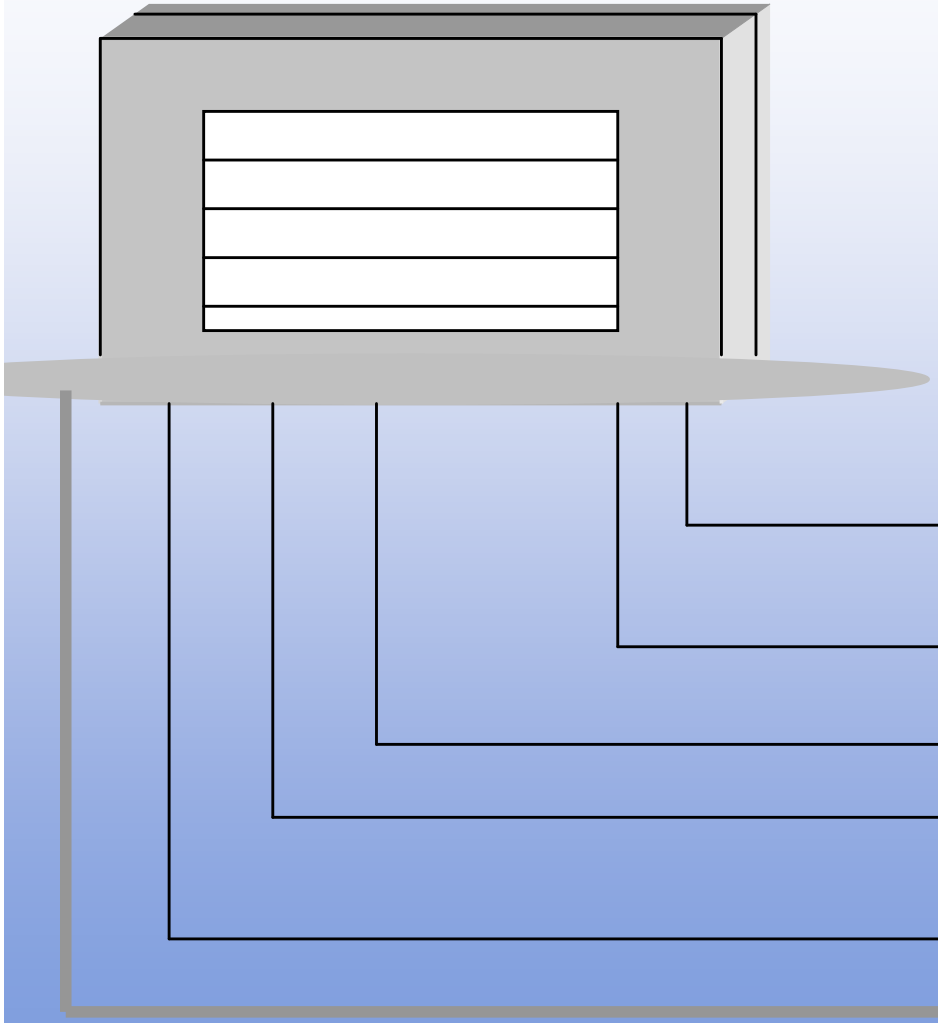
4. What is the function of the thermostat?

   To complete or interrupt a control circuit

5. What units of measure are used for a vacuum?

   Inches of Mercury hg

Wiring a Transformer

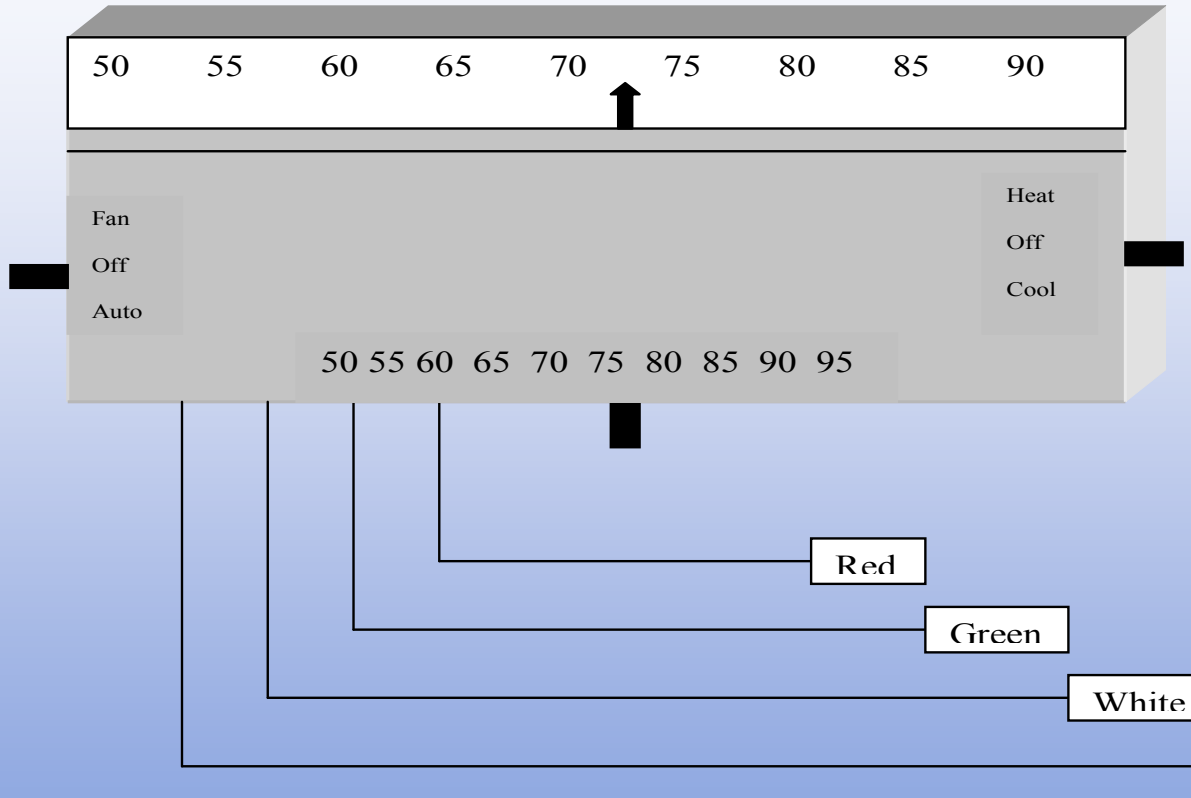


- Blue and Yellow = 24 volts
- Orange And White = 24o volts
- Red and Black = 208 volts
- Black and White = 120 volts

Blue		
	24 volts A/C	Secondary Winding
Yellow		

Orange	240 Volts	
Red	208 Volts	
		Primary Winding
Black	120 Volts	
White	Common	

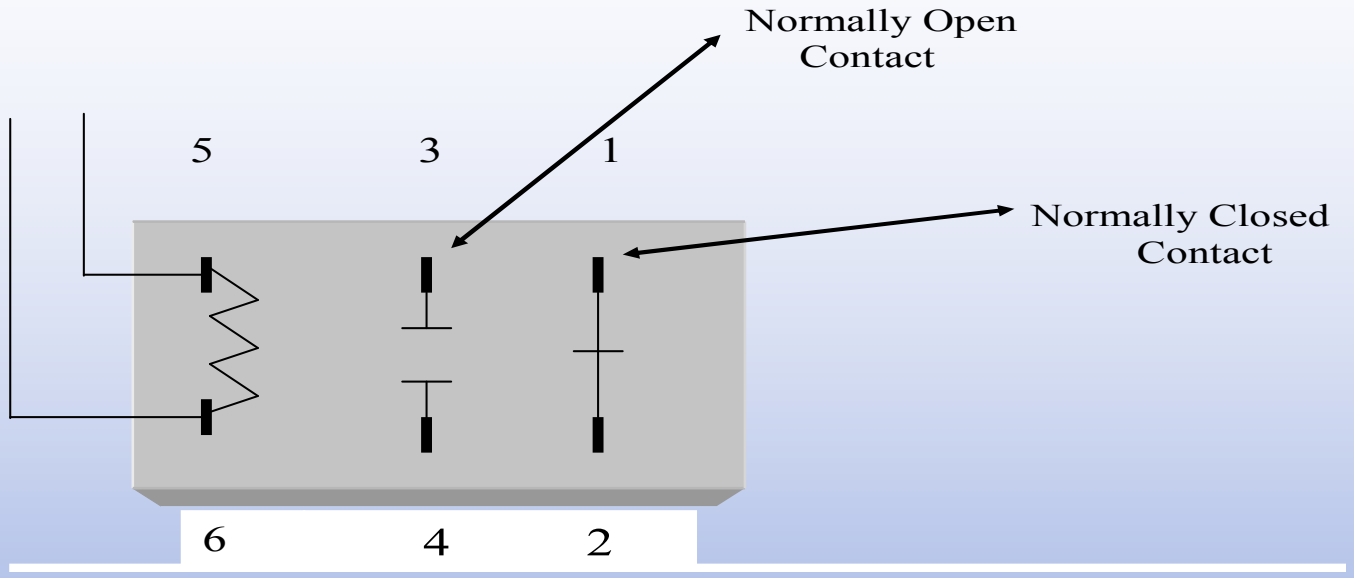
Wiring a Thermostat



What does each color control?

- **Red = 24 Volts**
- **Green = Indoor Fan**
- **White = Heat**
- **Yellow = Cooling**

Wiring a Relay

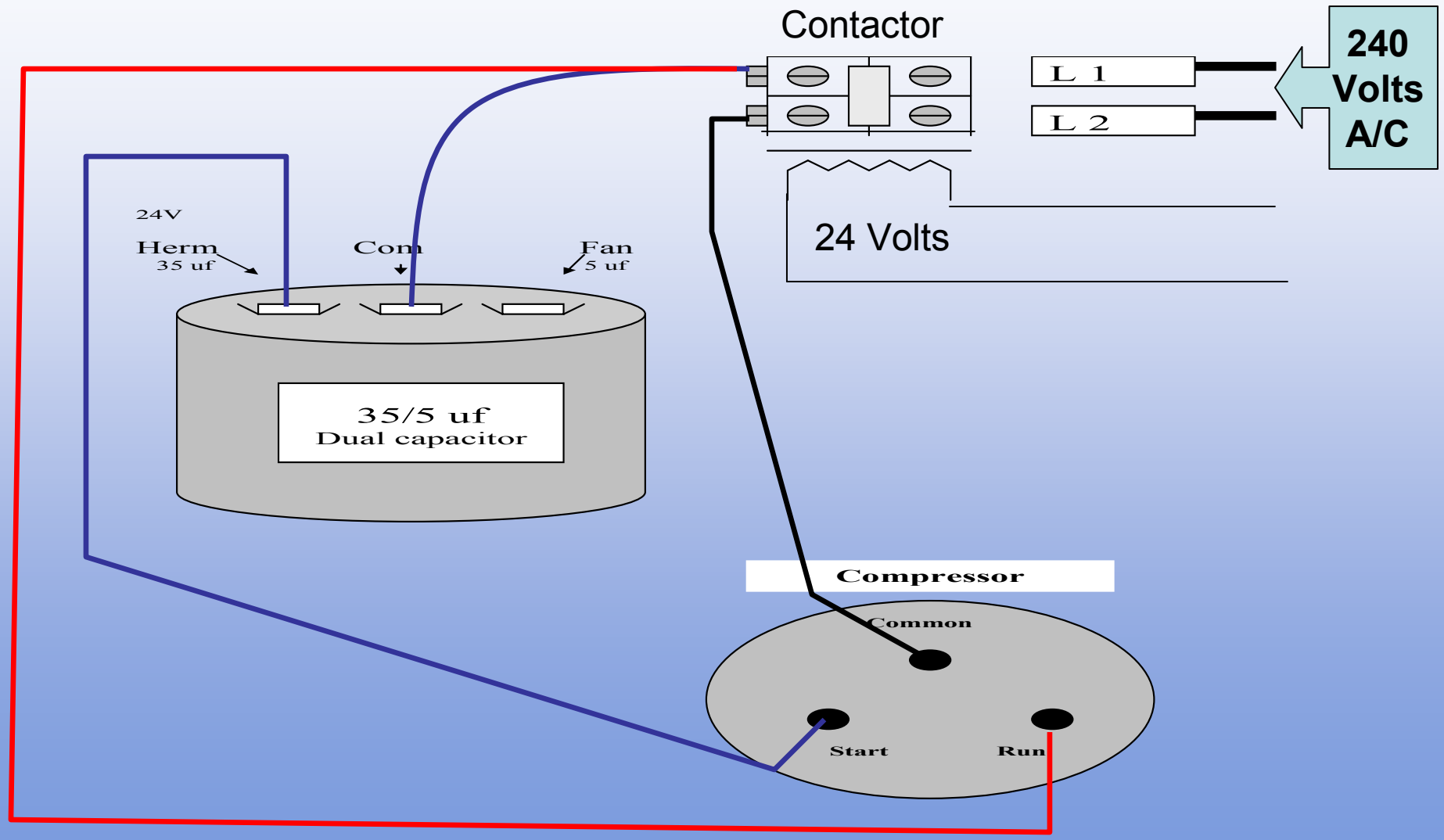


A/C Connects to the **NO** Contact with terminal numbers **3 & 4**

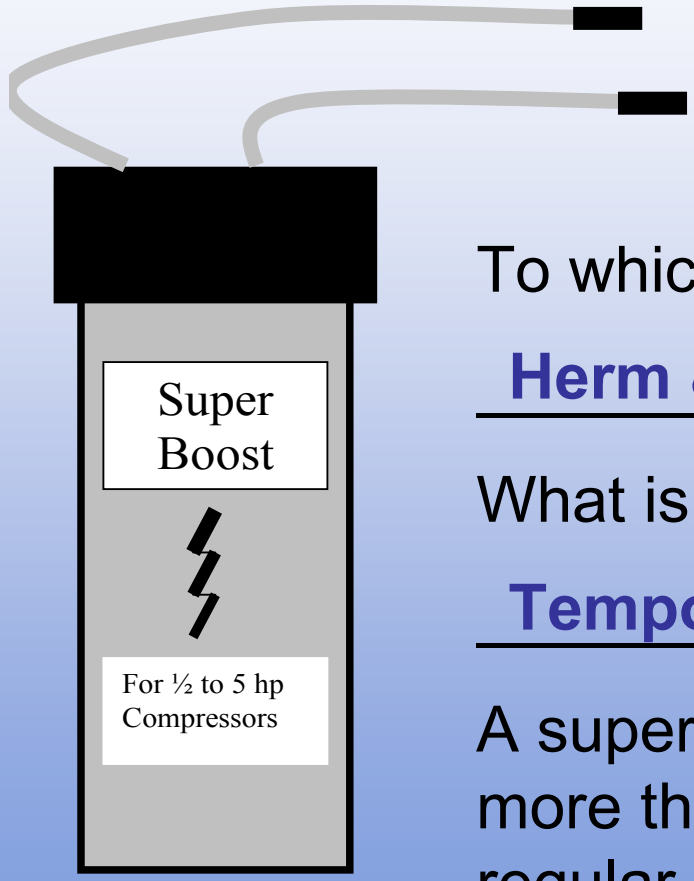
Heat Connects to the **NC** Contact with terminal numbers **1 & 2**

A/C should be on **High** speed Heat should be on **Low** speed

Wiring a Compressor



Wiring a Hard Start Capacitor



To which terminals do the leads connect?

Herm & Common

What is the purpose of this component?

Temporary extra Start Power

A super boost provides **4 Times** more than the amount of power of a regular capacitor.