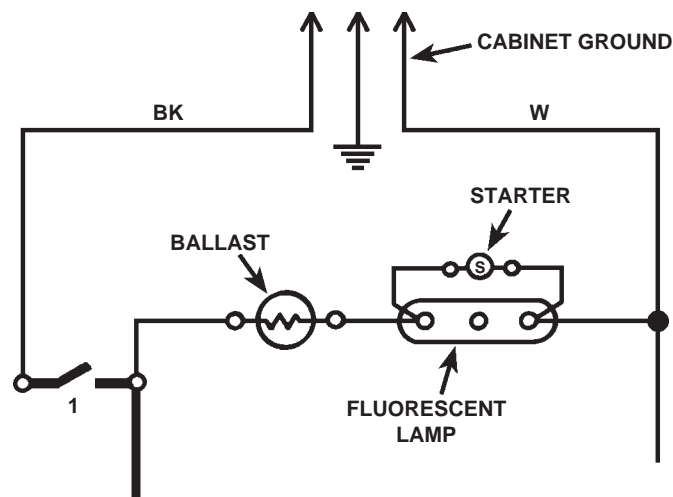


# BASIC ELECTRICITY

## STUDY COURSE for Home Appliances

### HOW TO READ:

- *WIRING DIAGRAM SYMBOLS*
- *TERMINAL CODES*
- *WIRING DIAGRAMS*



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For more help, go to [Fixitnow.com](http://Fixitnow.com) Samurai Appliance Repair Man

# INTRODUCTION

The material presented in this module is intended to provide you with an understanding of the fundamentals of electricity as applied to major appliances.

Major appliances have become more sophisticated, taking them out of the screwdriver and pliers category. Their electrical circuits include several different types of automatic controls, switches, heaters, valves, etc.. Semiconductors, solid-state controls, and other components usually associated with radio and television electronic circuits, are being engineered into automatic washers, dryers, dishwashers, and refrigerators.

The appliance technician is emerging into a professional status of his own. He must prepare himself now to be able to perform his duties today as well as to retain his professionalism in the future.

No longer is on-the-job training sufficient to prepare technicians for the complicated procedures required for today's sophisticated appliances. This training can best be obtained through organized classroom study and application. However, much of the knowledge necessary to service today's appliances can be obtained through study courses. Completion of this and other courses will provide you with sufficient understanding of appliances and their operation to enable you to do minor service. It will also serve as a valuable stepping stone to more advanced study and on-the-job training to improve your servicing skills.

Information contained in this module is used on WHIRLPOOL® appliances.

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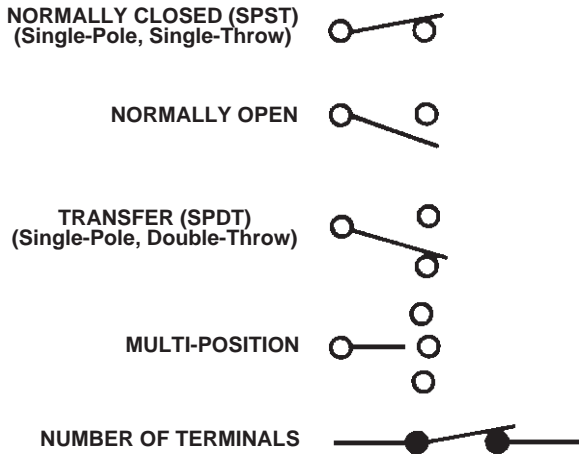
***\*NOTE: We recommend taking the TEST for MODULE 2, right after studying it.***

# CHAPTER 1

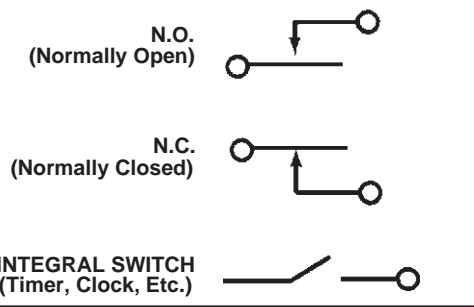
## WIRING DIAGRAM SYMBOLS

These wiring diagram symbols are commonly used in most wiring diagrams. Study each symbol so you can identify them by sight.

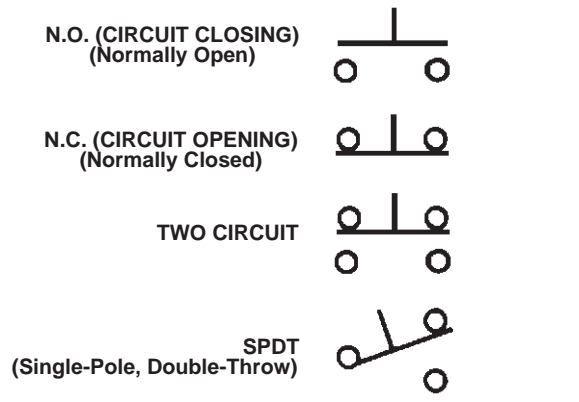
### MANUAL AND MECHANICAL SWITCHES



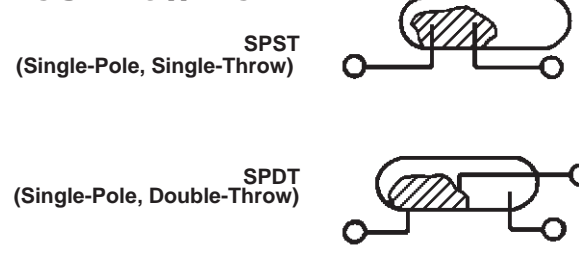
### AUTOMATIC SWITCH



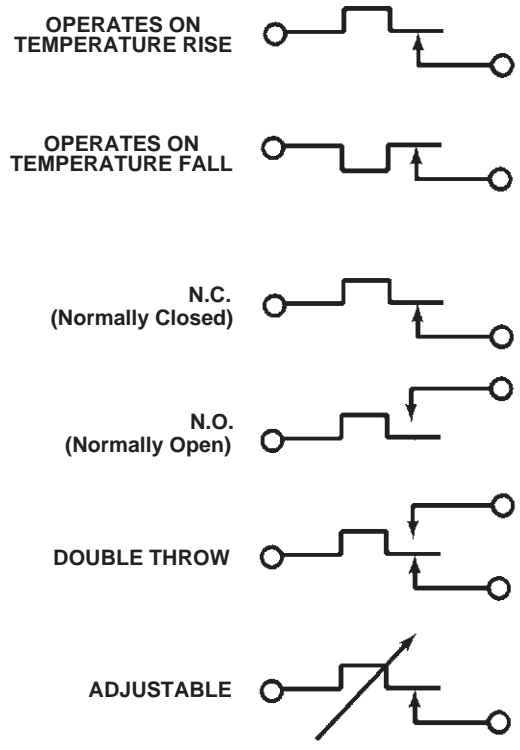
### PUSHBUTTON SWITCH (Momentary or Spring)



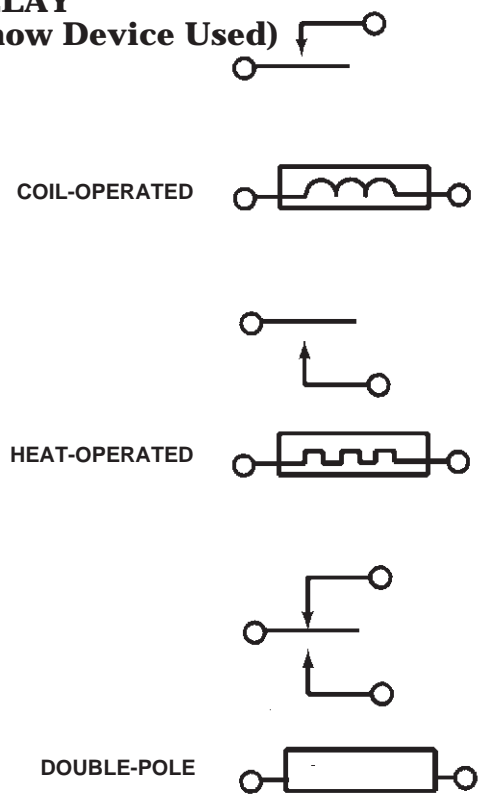
### MERCURY SWITCH



### THERMOSTAT

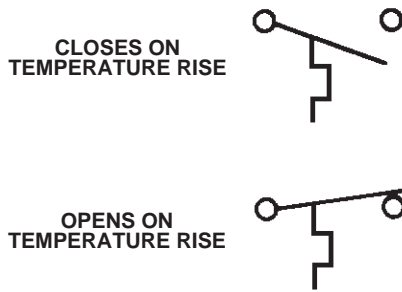


### RELAY (Show Device Used)



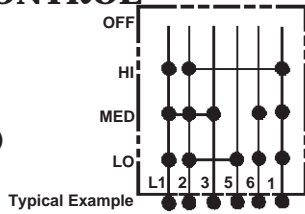
# WIRING DIAGRAM SYMBOLS

## TEMPERATURE ACTUATED

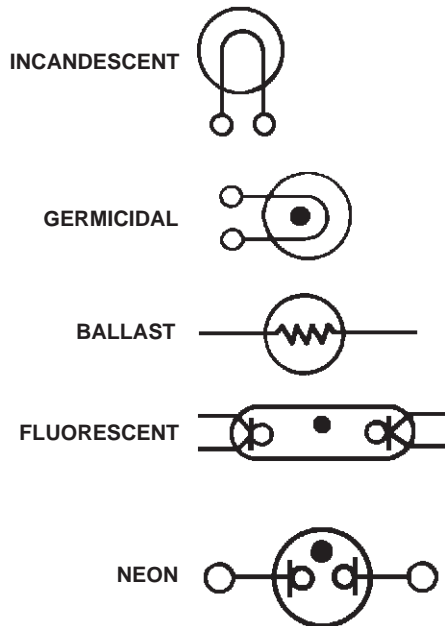


## MASTER OR CONTROL SWITCH

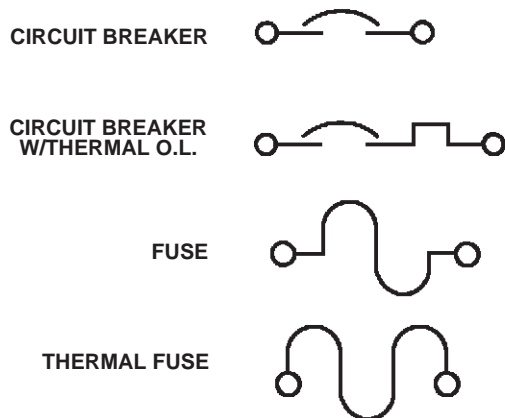
(Number of Positions and Internal Contact Operation as Required)



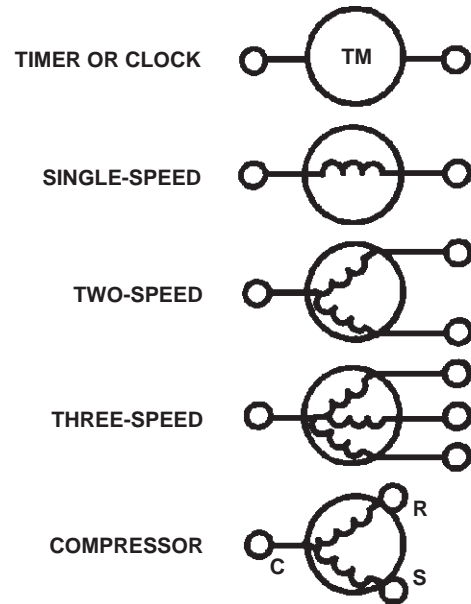
## LAMPS



## CIRCUIT PROTECTORS

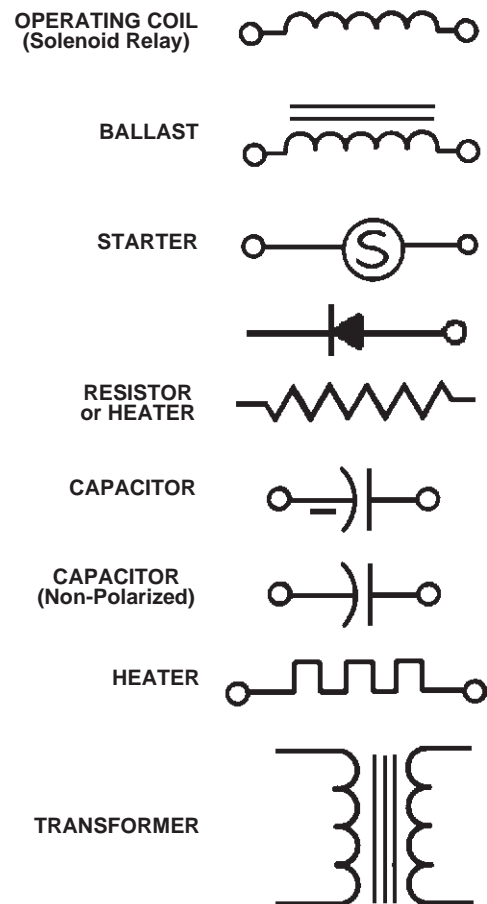


## MOTORS



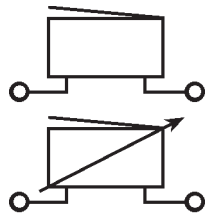
## MISCELLANEOUS

ADJUSTABLE COMPONENT  
(Arrow Drawn thru Component at Approx. 45°)



# WIRING DIAGRAM SYMBOLS

## BUZZERS



ADJUSTABLE

## BELL



## SENSOR (Moisture)



## THERMOCOUPLE



## CENTRIFUGAL SWITCH



## PRESSURE SWITCH S.P.D.T.



## HUMIDISTAT



## MAGNETRON



## THERMISTOR



## LINES AND CONNECTIONS

INTERNAL CONDUCTOR



EXTERNAL or HARNESS WIRE



OPTIONAL or ALTERNATE CIRCUIT



CROSSOVER



JUNCTION



PERMANENT CONNECTION



TERMINAL



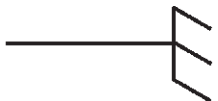
SHIELD



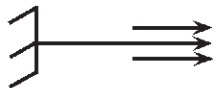
GROUND (EARTH)



GROUND (CHASSIS)



GROUNDING SERVICE CORD (3-Prong Plug)



SERVICE CORD (2-Prong Plug)



MECHANICAL CONNECTION



SEPARABLE CONNECTION



## LIMIT SWITCH

N.O.  
(Normally Open)



N.C.  
(Normally Closed)



## CHAPTER 2

# TERMINAL CODES

Terminal codes are found on all wiring diagrams. To help you identify the color codes, see the list below.

<b><u>Terminal Color Codes</u></b>	<b><u>Harness Wire Color</u></b>
BK .....	Black
BK-Y .....	Black with Yellow Tracer
BR .....	Brown
BR-O or BR-OR .....	Brown with Orange Tracer
BR-R .....	Brown with Red Tracer
BR-W .....	Brown with White Tracer
BL or BU .....	Blue
BL-BK or BU-BK .....	Blue with Black Tracer
BL or BU-G or BL or BU-GN .....	Blue with Green Tracer
BL or BU-O or BL or BU-OR .....	Blue with Orange Tracer
BL-Y or BU-Y .....	Blue with Yellow Tracer
G or GN .....	Green
G-BK or GN-BK .....	Green with Black Tracer
G-Y or GN-Y .....	Green with Yellow Tracer
GY .....	Gray
GY-P or GY-PK .....	Gray with Pink Tracer
LBU .....	Light Blue
O or OR .....	Orange
O-BK or OR-BK .....	Orange with Black Tracer
P or PK .....	Pink
P or PR .....	Purple
P-BK or PR-BK .....	Purple with Black Tracer
R .....	Red
R-BK .....	Red with Black Tracer
R-W .....	Red with White Tracer
T or TN .....	Tan
T-R or TN-R .....	Tan with Red Tracer
V .....	Violet
W .....	White
W-BK .....	White with Black Tracer
W-BL or W-BU .....	White with Blue Tracer
W-G or W-GN .....	White with Green Tracer
W-O or W-OR .....	White with Orange Tracer
W-R .....	White with Red Tracer
W-V .....	White with Violet Tracer
W-Y .....	White with Yellow Tracer
Y .....	Yellow
Y-BK .....	Yellow with Black Tracer
Y-G or Y-GN .....	Yellow with Green Tracer
Y-R .....	Yellow with Red Tracer



# CHAPTER 3

## WIRING DIAGRAMS

Appliance circuits can be complex. In order to construct a diagram of these circuits, the different components and switches must be represented by symbols. The ability to read the symbols and a wiring diagram is one of the most important diagnostic tools for an appliance technician.



This lesson is designed to instruct in the reading, interpretation, and construction of wiring diagrams. It is in the form of programmed instructions, which allows the student to work at their own pace and correct any errors immediately.

The answers to the following questions are found on pages 17-19.




**1**

A wiring diagram is similar to a road map. The lines on a road map show you where you can travel. The lines on a \_\_\_\_\_ diagram show where electric current can travel.

**2**

When this *symbol*  appears on a bottle of iodine or other medicine, we know its contents to be poison. The skull and crossbones may alert us to caution before we notice the word "POISON." The *symbol* may be recognized quicker as a warning than the word. Thus the  stands for, or is a \_\_\_\_\_ of, poison.

**3**

Other symbols which we often encounter are railroad crossing markers , stop signs , and yield the right of way signs . They are easily recognized and are nationally known to stand for the same thing every time. Railroad markers and stop signs are \_\_\_\_\_ used in driving.

**4**

In this short course, symbols will be used to represent parts (components) in wiring diagrams. At first it may seem that a knowledge of symbols is unnecessary to "get the job done," but as you progress you will realize that to "get the job done" quicker and better you should recognize most electrical \_\_\_\_\_.

**5**

*Pictorial* wiring diagrams show pictures of electrical components. Because they show "pictures" of the actual component that they are called pictorial wiring \_\_\_\_\_.



PICTURE OF PLUG



PICTURE OF LIGHT BULB



PICTURE OF LIGHT SWITCH

**6**

To interpret pictorial wiring diagrams you need little special training since the components are represented by \_\_\_\_\_.



PICTURE OF PLUG



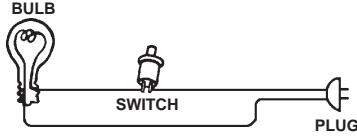
PICTURE OF LIGHT BULB



PICTURE OF LIGHT SWITCH

7

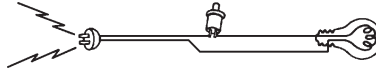
A simple wiring diagram is easy to follow when shown pictorially. An example of this type of wiring diagram could be like this:



The above is a \_\_\_\_\_ wiring diagram.

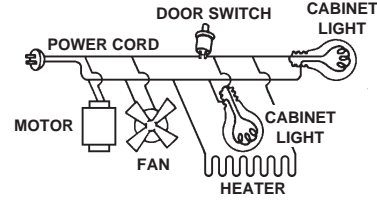
8

The bulb will light when the door is opened if wired as shown in this \_\_\_\_\_.



But the same power cord supplies other components, too.

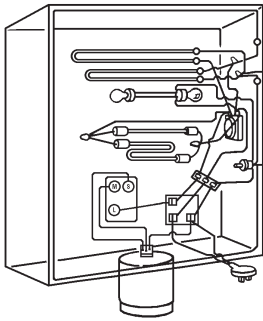
9



Pictorial wiring diagrams are easy to read when only a few components are involved. Add more components and the \_\_\_\_\_ wiring diagram is harder to read.

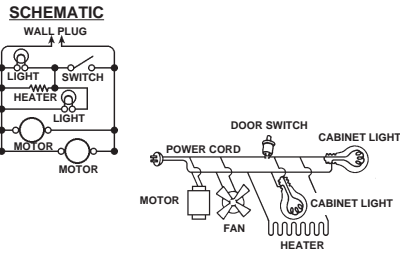
10

The bulb, switch, plug, and wire were easy to follow in the last diagram. However, a quick look at the pictorial at the right shows that more components make the diagram harder to read. CIRCLE THE BULBS, SWITCH, AND PLUG IN THIS PICTURE.



11

Many wiring labels show a pictorial and schematic wiring diagram. The \_\_\_\_\_ wiring diagram is more compact, and it is easy to trace its wiring circuits.



12

Learning to read a schematic wiring diagram is like learning a new language, but since most wiring diagrams are printed in the schematic language, we should learn to read \_\_\_\_\_ wiring symbols.

13

Let's start with something simple and learn how to read schematic wiring diagrams. The first step is to associate the electrical component with its appropriate symbol.

For example— This is an incandescent light bulb:



The schematic symbol for an incandescent light bulb is:



DRAW THE SCHEMATIC SYMBOL FOR LIGHT BULB IN THE ABOVE SQUARE.



14

We have shown the schematic symbol for a bulb is:



Here is the schematic symbol for a switch:





It looks like a drawbridge.

DRAW THE SCHEMATIC SYMBOL FOR A SWITCH IN THE ABOVE SQUARE.

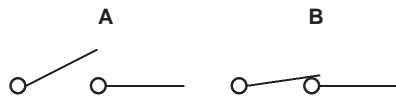


15



A switch controls the flow of electric current. When the switch is open like this:  current cannot flow. When the switch is \_\_\_\_\_ like this:  current can flow.

16

When a switch opens, we say that the circuit is broken; when a switch closes, we say that the circuit is made. Please circle the switch in which the circuit is broken.



17

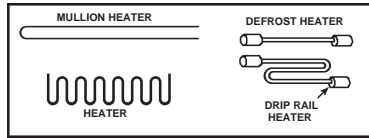
This is the symbol for a resistor . If a water pipe were shaped like that, water would have trouble getting through it, wouldn't it? So now when you see the symbol  you know it is a \_\_\_\_\_.

18

A resistor can be used to create heat or reduce current flow. Current reducing resistors will always be in series with some other component. One purpose of a resistor is to limit the amount of \_\_\_\_\_ going to a component.

**19**

Pictorial symbols for heaters are shown in many ways as indicated in the box below.

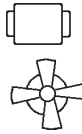


The schematic symbol for a heater is a sawtooth line.

Resistance in the heater wire causes it to heat. That is why the symbols for a heater and a \_\_\_\_\_ are the same.

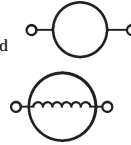
**20**

There are several pictorial symbols for single-speed motors. Two examples are shown here.



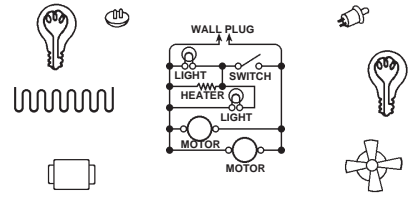
Actually the pictorial symbol for a single-speed motor can be any picture the artist thinks will look like a motor.

Here are the schematic symbols used to represent single-speed motors.



**NO RESPONSE REQUIRED**

**21**



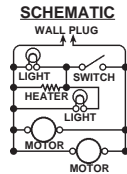
**DRAW A LINE BETWEEN MATCHING SYMBOLS AND PICTORIALS.**

**22**

Congratulations! You have identified seven schematic symbols on a \_\_\_\_\_ wiring diagram.

**23**

Notice the straight lines on the schematic wiring diagram. Symbols may be shown connected with \_\_\_\_\_ lines on a schematic diagram.

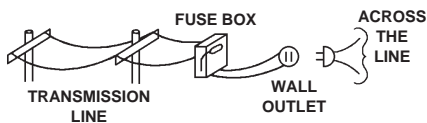


**24**

Lines indicate electric current conductors. They may be wires or they may be part of a component such as the base of a bulb. All straight lines connecting components on a wiring diagram may be considered conductors of electric \_\_\_\_\_.

**25**

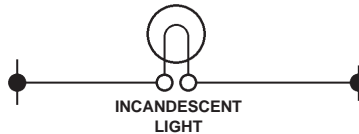
Electrical power comes from transmission lines. Eventually the transmission line will end at a wall outlet. When an electrical cord is plugged into a wall outlet, it puts the appliance "across the line."



**NO RESPONSE REQUIRED**

**26**

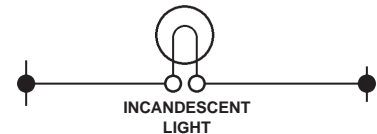
Take a look at the light bulb shown in the diagram below.



We can see that there is no switch, so the bulb will burn all the time. It is known as being "across the \_\_\_\_\_."

**27**

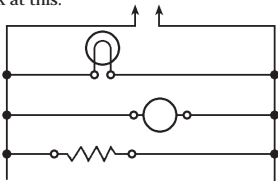
This bulb is wired into the circuit across the line.



Assuming there is the correct voltage on the line, will the bulb light?  Yes  No

**28**

You already know the schematic symbol for a wall plug. Now look at this:



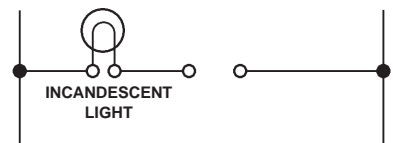
Note that the lines on each side are attached to the plug, therefore the components shown in this wiring diagram are "across the \_\_\_\_\_."

**29**

The wiring diagram which you have just seen showed three components "across the line." Each component followed its own circuit. When we see circuits running parallel to each other across the line we call them \_\_\_\_\_ circuits.

**30**

Let's see if you understand the first basic steps presented to you. Draw an open switch into this diagram so the current cannot flow and the bulb will not glow.



**31**

Now, let's go one step further. Draw a schematic wiring diagram showing a switch, then a light bulb on the same line and "across the line." SHOW THE SWITCH IN THE CLOSED POSITION.



**32**

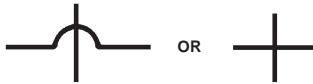
If you completed the previous frame correctly, you put the switch in series with the light. When two or more components are hooked together across the line, so that current must flow through one to get to the other, they are said to be hooked in \_\_\_\_\_.

**33**

When components are wired together so that the current must flow through one to get to the other we say it is a \_\_\_\_\_ circuit.

**34**

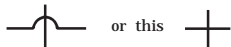
Lines sometimes cross each other in a schematic wiring diagram. This is called a crossover. The symbol for a crossover is





NO RESPONSE REQUIRED

**35**

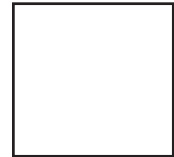
At a crossover the current does not change direction because the lines are insulated from each other. This \_\_\_\_\_ is the symbol for a \_\_\_\_\_.



**36**

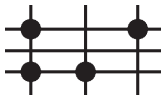
Don't become confused if you see this  or this  in a schematic wiring diagram. The black dot at the junction of the lines indicates that it is a junction (or splice) of conductors.

Now draw a junction of four conductors in the square.




**37**

You have just learned the symbols for a crossover and a junction. Circle all of the crossovers in the diagram below.



**38**

One of the symbols used for a single-speed motor is . Single-speed motors are used in timer motors, small fans, and for main drive motors in some appliances. DRAW THE SYMBOL FOR A SINGLE-SPEED MOTOR IN THE SQUARE.



**39**

Some appliances use multi-speed motors.

For example, this is the symbol for a two-speed motor



and

this is the symbol for a three-speed motor.



DRAW THE SYMBOLS FOR A TWO-SPEED AND A THREE-SPEED MOTOR IN THE SQUARES MARKED BELOW.



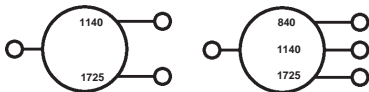
TWO-SPEED



THREE-SPEED

**40**

Symbols for multi-speed motors sometimes includes numbers to designate motor speeds.



The numbers in a multi-motor symbol indicate the motor \_\_\_\_\_.

**41**

Sometimes the internal circuitry, or windings, of a motor are shown for your convenience. The examples shown are typical.



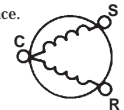
SINGLE-SPEED TWO-SPEED THREE-SPEED

NO RESPONSE REQUIRED

**42**

Many appliance motors have a winding for normal speed operation and a start winding that enables the motor to start against the load of the appliance.

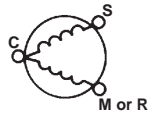
The symbol for this type of motor is:



DRAW THE SYMBOL FOR A MOTOR THAT HAS BOTH A START AND RUN WINDING IN THE SQUARE.

**43**

The letters by the terminals of a motor with a start winding designate their function. The "C" stands for COMMON, the "S" stands for the terminal connected to the start winding, and the "M" stands for the terminal connected to the main or run winding.



The "S" at the terminal on the motor in this frame means that it is connected to the \_\_\_\_\_ winding.

**44**

You have already learned the symbol for a light bulb. DRAW THE SYMBOL FOR A LIGHT BULB IN THE SQUARE BELOW.



That symbol is for the common *incandescent* light bulb.

**45**

Appliances use other types of light too. These are the A.N.S.I. (American National Standards Institute) schematic symbols for fluorescent, neon, and germicidal lamps.

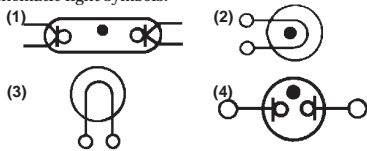


They are gas filled. A dot in the schematic symbol denotes that the bulb is filled with gas.

THE SYMBOLS ON THIS PAGE HAVE ONE THING IN COMMON. EACH HAS A \_\_\_\_\_ TO DENOTE A GAS.

**46**

Now prove to yourself that you can identify the different types of A.N.S.I. (American National Standards Institute) schematic light symbols.



1	2
3	4

NAME THE LIGHTS IN THE ABOVE BLOCKS.

**47**

Now you're really rolling. You know the A.N.S.I. (American National Standards Institute) schematic symbols for:

- Four kinds of lights.
- Resistors and heaters.
- Several kinds of motors.
- Current conductors and crossovers.

And you also know that this is the symbol for a \_\_\_\_\_.

**48**

Let's take a look at two new symbols. This is the symbol for an earth ground, and this is the symbol for a chassis ground.



EARTH GROUND



CHASSIS GROUND

DRAW THE SYMBOLS FOR THE TWO TYPES OF GROUNDS IN THE SQUARES.

**49**

When a product is properly grounded it protects the user from electrical shocks if the product malfunctions.

This is the symbol for a \_\_\_\_\_ ground.

**50**

The symbol for a ground can be combined with other symbols to indicate that the component is grounded. For example, this combined with this would be the symbol for a grounded \_\_\_\_\_.

**51**

Correct! Whenever you see this symbol for a grounded service cord you know that the product is \_\_\_\_\_ for safety.

**52**

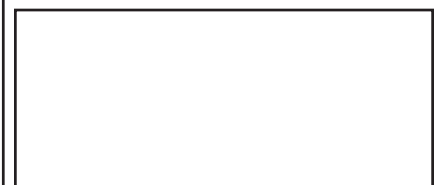
You know what a bulb and a switch are used for, but what is the purpose of a ? This is the symbol for a fuse. A fuse prevents overload of a circuit or component or power source when something goes wrong. A fuse is used to prevent \_\_\_\_\_.

**53**

In order for a fuse to protect a circuit or component from overload it must be wired in series with the item it is protecting. A fuse must be wired in \_\_\_\_\_ to protect a component from overload.

**54**

In the space below draw a fuse, switch, and a light bulb in series. Show a grounded service cord in the diagram.



55

Now, let's take a close look at switches. Up to this point you have been using a simple on-off (single-pole, single-throw) switch. Here is the symbol for a single-pole, double-throw switch:

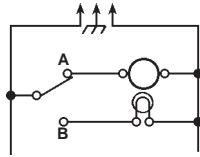


DRAW THE SYMBOL FOR A SINGLE-POLE, DOUBLE-THROW SWITCH IN THE SQUARE.



56

In the diagram the switch is closed through contact "W" completing a circuit through the motor.



If the switch were closed through contact "B," the circuit would be through the \_\_\_\_\_.

57

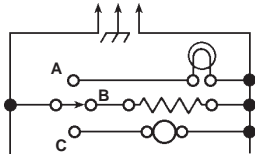
Some appliances use multi-position switches. Here is the symbol for a typical multi-position switch.



The symbol above is for a \_\_\_\_\_ switch.

58

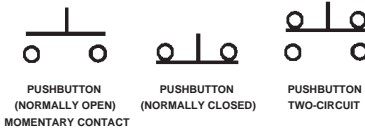
In the diagram the multi-position switch is closed through contact "B" and making a circuit through the heater.



If the switch were closed through contact "A," the circuit would be through the \_\_\_\_\_ and if the switch were closed through contact "C," the circuit would be through the \_\_\_\_\_.

59

Let's take a look at pushbutton switches. There are three basic types of pushbutton switches used in appliances:



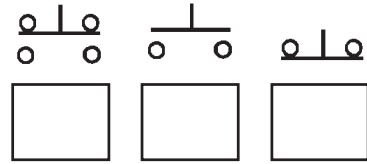
The pushbutton switch that is normally open is generally used on "push-to-start" switches. The pushbutton switch that is normally closed is used on refrigerator doors. The two-circuit pushbutton switch is sometimes used to start fluorescent lights.

NO RESPONSE REQUIRED

60

Identify the three types of pushbutton switches by placing the correct letter in the box below the switch symbol.

- A. Pushbutton: (N.O.) MOMENTARY CONTACT
- B. Pushbutton: NORMALLY CLOSED
- C. Pushbutton: TWO-CIRCUIT



61

The switches that you have learned the symbols for have all been manually operated switches. This means that you must do something to open or close the switch. This type of switch is called a \_\_\_\_\_ switch.

62

Appliances use switches that are operated (actuated) by temperature, pressure magnetism, or centrifugal force.

NO RESPONSE REQUIRED

63

This is part of the symbol for a thermostat. This plus this =Thermostat. A thermostat may look like this or like this

DRAW BOTH OF THESE THERMOSTATS BELOW.



64

Let's tear the word THERMOSTAT apart and see what it really means. THERMO is from the Greek word *therme* denoting heat.

STAT is also from a Greek word *states* meaning to render something stationary — *to balance*.

Combine the two words into one.

THERMOSTAT = A DEVICE TO \_\_\_\_\_ THE HEAT (OR COLD).

65

Bimetal switches such as motor overload protectors, defrost bimetals, and limit switches are thermostats in the strict sense of the word. Now because a bimetal switch is activated by temperature changes, it is a \_\_\_\_\_ in the strict sense of the word.

66

Thermostats, depending on how they are used, can either open or close on heat rise. This would be the symbol for a thermostat that opens on heat rise:

This would be the symbol for a thermostat that closes on heat rise:

NO RESPONSE REQUIRED

**67**

Now, before you forget, draw the symbols for a thermostat that closes on heat rise and a thermostat that opens on heat rise in the squares marked below.



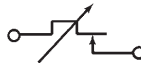
OPENS ON HEAT RISE



CLOSES ON HEAT RISE

**68**

Some thermostats are adjustable. If a thermostat is adjustable it will have an arrow drawn at a 45° angle through it like this:



An arrow drawn through a thermostat means that the thermostat is \_\_\_\_\_.

**69**

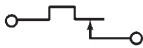
The refrigeration control thermostat closes on heat rise and causes the compressor to run to remove heat:



This maintains a temperature balance. A thermostat in the sense that we use it is an electrical switch that opens and closes to maintain a temperature \_\_\_\_\_.

**70**

Most laundry thermostats open on heat rise:



In other words, once a certain temperature is reached, the thermostat causes the heat source to turn off. When the temperature falls to a certain point, the thermostat will turn on the heat source by making a circuit to it. The thermostat maintains a temperature \_\_\_\_\_ by turning the heat on and off.

**71**

Now let's take a look at another type of switch.

This is the symbol for a pressure switch:



The symbol in this frame is the symbol for a \_\_\_\_\_ switch.



DRAW THE SYMBOL FOR A PRESSURE SWITCH.

**72**

Typically, pressure switches are used to control the amount of water entering automatic clothes washers and dishwashers:



Automatic washers and dishwashers use \_\_\_\_\_ switches to control the amount of water entering the machine.

**73**

This type of switch



is actuated by centrifugal

force and is called, very simply, a centrifugal switch.



DRAW THE SYMBOL FOR A CENTRIFUGAL SWITCH.

**74**

A typical use of the centrifugal switch is in an appliance that has a motor with a start winding. The centrifugal switch is wired in series with the start winding of the motor and is normally closed. When the motor starts, it uses both its start and run windings. As the motor picks up speed \_\_\_\_\_ force causes the switch to open and allows the motor to run on its run winding.

**75**

This is the symbol that Whirlpool uses for a humidistat:

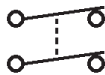


Humidistats are used on dehumidifiers and are generally adjustable. That is why the arrow is drawn through it. Humidistats are used to sense *moisture*, so they are \_\_\_\_\_ sensitive controls.

**76**

Now you are really rolling on switches. Sometimes two switches are linked together mechanically.

To show this, a dotted line is drawn between the switch blades:

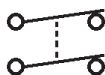


NOW, YOU CONNECT THE TWO SWITCHES BELOW WITH A MECHANICAL LINKAGE.



**77**

Switches linked together mechanically are used in situations where we want to activate two different circuits by throwing only one switch lever. The dotted line between the two switches \_\_\_\_\_ indicates that they are \_\_\_\_\_ together.




**78**

Let's turn our attention to timers. A timer is actually a motor-driven switch. Inside the timer there are switch contacts that are opened and closed by cams that are turned by the motor. The opening and closing of different contacts in the timer at different times is what controls the function of the appliance.

A TIMER IS A MOTOR-DRIVEN \_\_\_\_\_.

**79**


In a wiring diagram the symbol for a single-speed motor is used to show the timer motor. 

The timer motor is always identified as the timer motor so you will not confuse it with other motors used in the appliance.



DRAW AND IDENTIFY THE SYMBOL FOR A TIMER MOTOR.

**80**

The timer switches (contacts) in the wiring diagram are represented by this symbol: 

The timer switches (contacts) are labeled in the wiring diagram just as they are labeled on the actual timer.

The symbol in this frame is for a \_\_\_\_\_ .

**81**

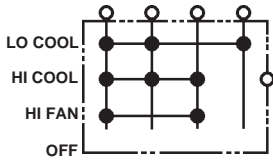
To help you identify the internal components of the timer, they are drawn with heavier (thicker) lines than the other components in the diagram.



The internal parts of a timer are easy to identify because they are drawn with \_\_\_\_\_ .

**82**

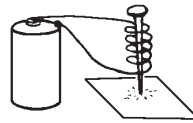
The master or control switch used on room air conditioners is represented by this symbol:



The symbol in this frame is for a \_\_\_\_\_ or \_\_\_\_\_ switch.

**83**

As a child, you probably wound insulated copper wire around a nail to make a battery powered electromagnet which would pick up iron filings.






It is this basic principle that makes possible what is called solenoid control. A solenoid is a type of electro-\_\_\_\_\_ .

**84**

Let's review our basics now.

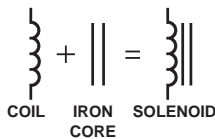
This  is a symbol for a single-speed motor.

This symbol  and sometimes this one  represent a coil. Whenever a coil is used you will see one of them.

For example, this symbol  can represent a solenoid \_\_\_\_\_ .

**85**


A solenoid has a coil of copper wire which pulls an iron core or bar into the center of the coil when energized. Now let's make the symbol for a solenoid.





A solenoid is like an electromagnet except that the iron core is movable and can do mechanical work.

**NO RESPONSE REQUIRED**

**86**


Iron cores are used with a coil in many electrical applications. The iron core is represented like this: 

Solenoids and transformers have iron cores. You might see solenoid symbols that look like this  or this  .



DRAW THE IRON CORE SYMBOL OVER THE SOLENOID COIL WHICH DOES NOT SHOW IT.

**87**

To convert this symbol  to a transformer symbol, we simply add a second winding like this:

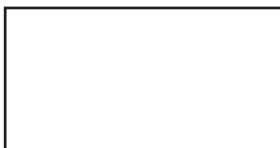


One winding with straight lines represents a solenoid. When there are two windings shown, it is always a \_\_\_\_\_ .

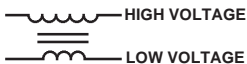
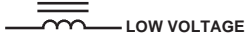
**88**


A transformer may be employed to increase voltage, decrease voltage, or isolate a circuit from ground without affecting its voltage.

DRAW THE SYMBOL FOR A TRANSFORMER.




**89**

The number of turns in each winding determines the primary and secondary of a transformer. The low voltage will have fewer turns.  **HIGH VOLTAGE**  
 **LOW VOLTAGE**

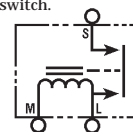
To actually determine the primary and secondary windings you must know whether you are working with a step-up or step-down transformer. Is this  the symbol for a transformer or solenoid?

**90**

Probably the most complicated symbol you will find on a schematic diagram is the relay.

One type of relay is a combination of two items, the solenoid  and a switch.

PUT THEM TOGETHER THEY LOOK LIKE THIS:



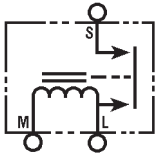
DRAW THE RELAY IN THE BOX.





91

Relays are of several types. One popular type used to start refrigerator motors is the magnetic relay:



In the magnetic type the circuit is closed to the start winding for a very brief period because the greater current required to start the motor compressor induces sufficient magnetism to hold the switch from "L" to "S" closed. When the motor reaches operating speed it draws less current, the \_\_\_\_\_ weakens and the switch drops open.

92

A magnetic relay relies on the heavier current draw of a motor during start to energize the solenoid and close the switch which will send current to the start winding. As soon as this motor is almost up to speed, the current draw is reduced and the solenoid can no longer hold the starting switch closed. What two basic symbols compose a magnetic relay?


\_\_\_\_\_ and \_\_\_\_\_.

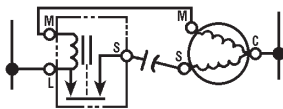
93

You have already been told this fact. Let us see if you remember. When components are wired together so that current must flow through the one to get to the other we say it is a \_\_\_\_\_ circuit.

94

Some electric motors used to drive refrigerator compressors require extra power at the instant of start. To provide this momentary voltage boost, a starting capacitor may be used.

The symbol for a capacitor is . The starting capacitor is always located in the line from the start terminal on the relay to the start winding of the motor. Put a starting capacitor in this circuit. The letter "S" identifies the start winding. The run winding is marked "R" or "M."



NO RESPONSE REQUIRED

95

A relay completes the circuit to the start winding at the instant of start. If a starting capacitor is used, it will be energized when the \_\_\_\_\_ closes the circuit to the start winding.

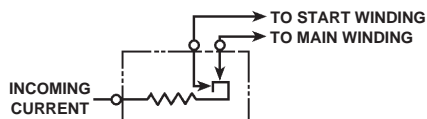
96

A start capacitor is in \_\_\_\_\_ with the start winding.

97

Another type of relay is the current or *hot wire* relay. The *hot wire* relay uses a short piece of iron wire to conduct current from the line to both the main and start windings. The resistance to the current flow afforded by the iron wire causes it to heat and stretch. As it stretches, it permits the start winding (which draws the most current) to open.

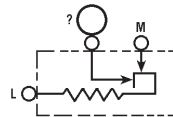
An excessive overload due to low line voltage or a defective motor will heat the wire more and the run winding contacts will also \_\_\_\_\_.



98

In identifying the markings on this *hot wire* relay, look for an "S" which means start winding and either "R" for running winding or "M" for main motor winding. The side of the line entering the relay will probably be marked "L" or "L1."

WHAT IS THE UNMARKED TERMINAL?



99

Bells and buzzers are used to notify the user that the appliance has completed a specific function. The symbols for a bell and a buzzer are below.



BELL



BUZZER

DRAW THE SYMBOLS FOR A BELL AND A BUZZER BELOW.



BELL



BUZZER

100

Buzzers are sometimes adjustable. Remember the 45° arrow that was drawn through the symbol for a thermostat to denote that it was adjustable? That 45° arrow drawn through the buzzer denotes that it is adjustable.

DRAW THE SYMBOL FOR AN ADJUSTABLE BUZZER BELOW.



101

Being able to read a schematic may be a great help in trouble diagnosis. From schematics we can determine where to expect to find voltage present and where to find continuity. What is continuity?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

YOUR OWN WORDS

102

Continuity might be one way of saying connected. Things which are *connected* across the line have \_\_\_\_\_.

On an ohmmeter, components which have continuity will give a reading on the scale. The extent of meter needle deflection will depend on the resistance of the circuit or component being checked. If more than one range of resistance scales is available, the high range scale will give the most needle deflection for checking components for continuity.

**103**

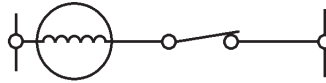
Another clue to the meaning of continuity is the similar word "continuous." Things or circuits which have continuity have no breaks or open spots. They are continuous. In electrical "talk" things which have continuity will conduct \_\_\_\_\_.

**104**

Continuity does not mean that there will be no resistance to the circuit. It simply means that there will be no open drawbridges (switches) or bridges out (broken wires, etc.) in the road the current is traveling. There may be detours (resistors, motor, lights) but the journey may be completed from one side to the other. Wire "N" below has continuity, wire "B" does not.

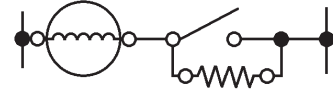


The circuit shown below has \_\_\_\_\_.



**105**

If something electrical is to operate (that is run, heat, vibrate, etc.), current must flow. In order for current to flow, a circuit must be complete. We say a complete circuit has continuity because it is continuous from one side of the line to the other with no breaks. Does this circuit have continuity from one side of the line to the other?

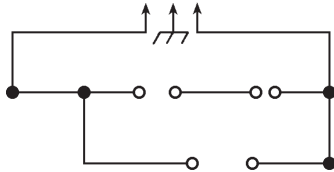


Yes  No

**106**

Here is a wiring diagram in which we show the names of the components, but we did not draw in the symbols.

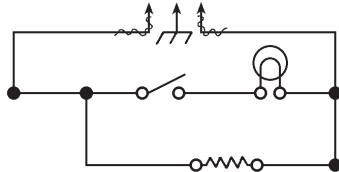
WE WANT YOU TO DRAW IN THE SYMBOLS BELOW.



**107**

You might have shown the light switch open or closed in the last frame, and in either case you were right.

Now we want you to draw a wavy line through the current carrying (energized) circuits in this diagram. We will help you get started, but want you to continue the wavy lines through energized circuits.

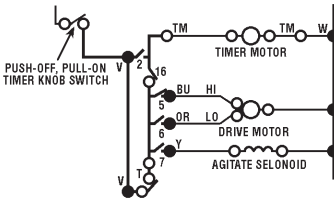


**108**

Even if you do not recognize all A.N.S.I. (American National Standards Institute) symbols, you can learn to read a wiring diagram. Most wiring diagrams show the name of the component along with its Basic Symbol. Some slight deviation in symbols will not be a problem to you, once you know the B\_\_\_\_\_ S\_\_\_\_\_.

**109**

Let's suppose that the appliance is plugged into a wall receptacle. TRACE OUT THE ENERGIZED CIRCUITS SHOWN ON THIS PARTIAL DIAGRAM. (Use a wavy line.)



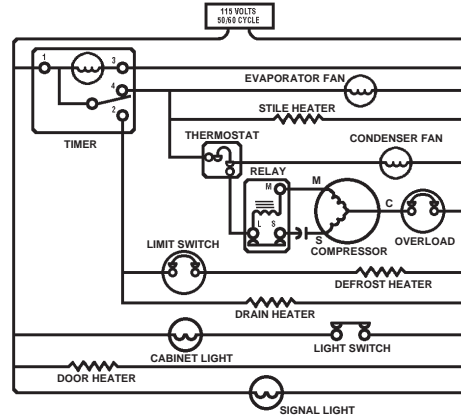
**110**

Many symbols in this wiring diagram do not conform to A.N.S.I. standards, but we want to prove to you that you can read any wiring diagram, if you know the basic principles.

NAME TWO HEATERS WHICH ARE NOT SHOWN ENERGIZED IN THIS SCHEMATIC.

1. \_\_\_\_\_
2. \_\_\_\_\_

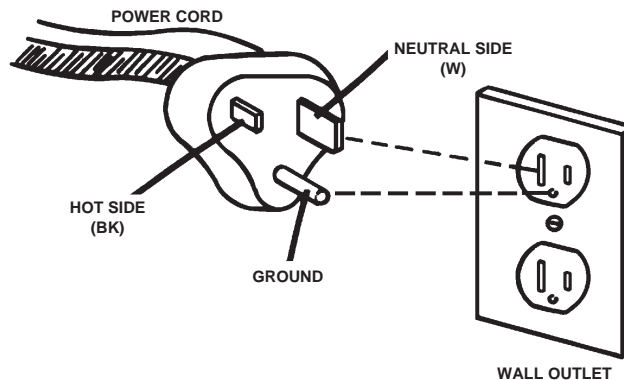
**WIRING DIAGRAM**



**111**

The one thing to remember about the schematic of a grounded plug on a wiring diagram, you are looking into the plug end.

NO RESPONSE REQUIRED



# ANSWERS TO QUESTIONS FROM PAGES 7-16

1. Wiring

2. Symbol

3. Symbols

4. Symbols

5. Diagrams

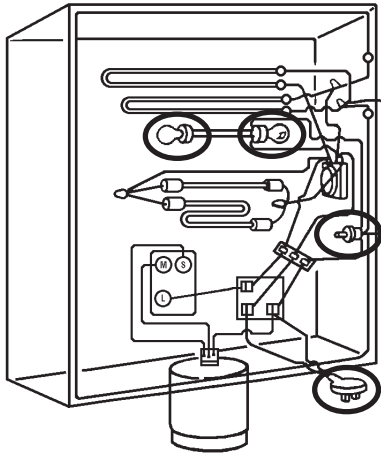
6. Pictures

7. Pictorial

8. Pictorial Wiring Diagram

9. Pictorial

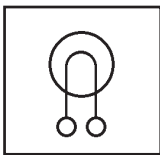
10.



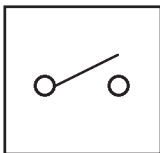
11. Schematic

12. Schematic

13.

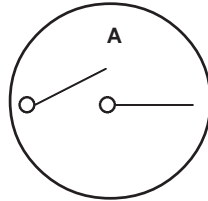


14.



15. Closed

16.



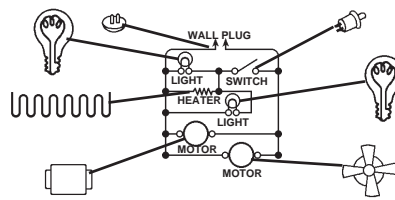
17. Resistor

18. Current

19. Resistor

20. No Response Required

21.



22. Schematic

23. Straight

24. Current

25. No Response Required

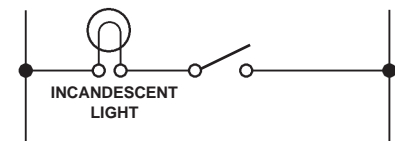
26. Line

27. Yes

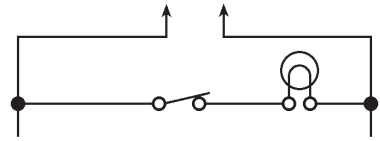
28. Line

29. Parallel

30.



31.



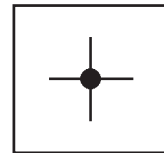
32. Series

33. Series

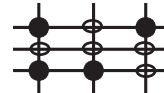
34. No Response Required

35. Crossover

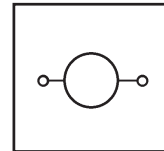
36.



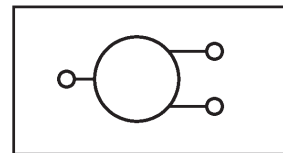
37.



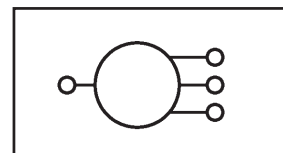
38.



39.



TWO-SPEED

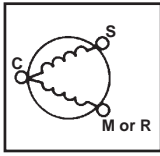


THREE-SPEED

40. Speeds

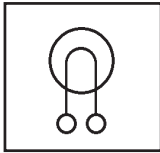
41. No Response Required

42.



43. Start

44.



45. Dot

46.



1 FLUORESCENT



2 GERMICIDAL



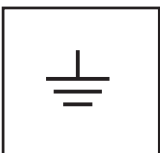
3 INCANDESCENT



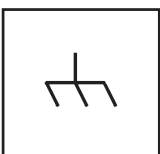
4 NEON

47. Service (power) Cord or Wall Plug

48.



EARTH GROUND



CHASSIS GROUND

49. Chassis

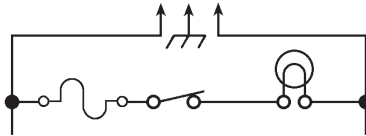
50. Service (power) Cord.

51. Grounded

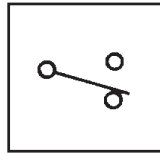
52. Overload

53. Series

54.



55.



56. Light Bulb

57. Multi-Position

58. A — Light Bulb  
C — Motor

59. No Response Required

60.



C.

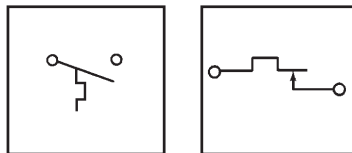
A.

B.

61. Manual

62. No Response Required

63.

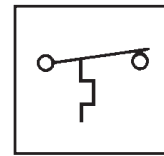


64. Balance

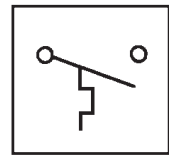
65. Thermostat

66. No Response Required

67.



OPENS ON  
HEAT RISE



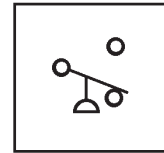
CLOSES ON  
HEAT RISE

68. Adjustable

69. Balance

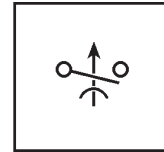
70. Balance

71. Pressure



72. Pressure

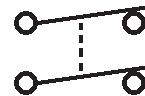
73.



74. Centrifugal

75. Moisture

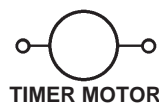
76.



77. Mechanically Linked

78. Switch

79.



TIMER MOTOR

80. Timer Switch

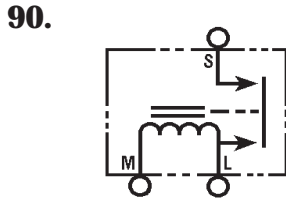
- 81. Heavy Lines
- 82. Master, Control
- 83. Magnet
- 84. Coil
- 85. No Response Required
- 86.



- 87. Transformer



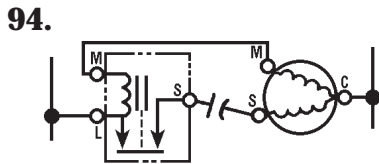
- 89. Solenoid



- 91. Magnet, Solenoid Coil, or Current

- 92. Solenoid and Switch

- 93. Series



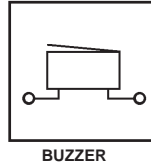
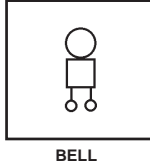
- 95. Relay

- 96. Series

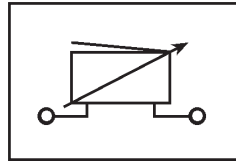
- 97. Open

- 98. "S" for Start

- 99.



- 100.



- 101. Briefly, continuity is a completed path through wires or components which will permit the flow of electricity.

- 102. Continuity

- 103. Current or Electricity

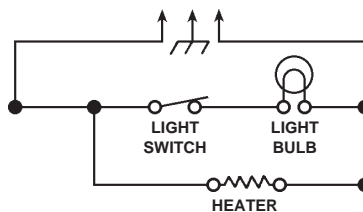
- 104. Continuity

- 105. YES

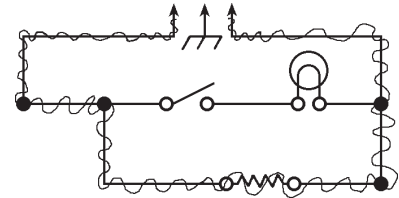
The resistor completes the circuit even though the switch is open.

This could be the circuit for a two-speed fan. Fast when the switch is closed and slower when the current must pass through the voltage dropping resistor.

- 106.

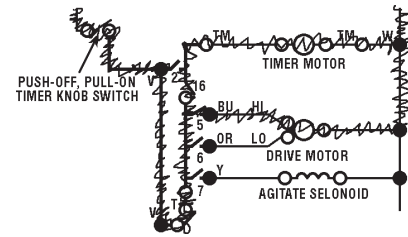


- 107.



- 108. Basic Symbol

- 109.



- 110. 1. Drain Heater  
2. Defrost Heater

- 111. No Response Required

# NOTES

**BLANK**

**BLANK**