Circuit Control Devices

An Online Continuing Education Course for Engineers

Course Number: E-3010

Credit: 3 Hours / 3 PDH / 3 CPD

INTRODUCTION

Electricity existed well before the beginning of recorded history. Lightning was a known and feared force to early man, but the practical uses of electricity were not recognized until the late 18th century. The early experimenters in electricity controlled power to their experiments by disconnecting a wire from a battery or by the use of a clutch between a generator and a steam engine. As practical uses were found for electricity, a convenient means for turning power on and off was needed.

Telegraph systems, tried as early as the late 1700s and perfected by Morse in the 1830s, used a mechanically operated contact lever for opening and closing the signal circuit. This was later replaced by the hand-operated contact lever or "key."

Early power switches were simple hinged beams, arranged to close or open a circuit. The blade-and-jaw knife switch with a wooden, slate, or porcelain base and an insulated handle, was developed a short time later. This was the beginning of circuit control devices.

Modern circuit control devices can change their resistance from a few milliohms (when closed) to well over 100,000 megaohms (when open) in a couple of milliseconds. In some circuit control devices, the movement necessary to cause the device to open or close is only .001 inch (.025 millimeters).

NEED FOR CIRCUIT CONTROL

Circuit control, in its simplest form, is the application and removal of power. This can also be expressed as turning a circuit on and off or opening and closing a circuit. Before you learn about the types of circuit control devices, you should know why circuit control is needed.

If a circuit develops problems that could damage the equipment or endanger personnel, it should be possible to remove the power from that circuit. Circuit protection devices will remove power automatically if current or temperature increase enough to cause the circuit protection device to act. Even with this protection, a manual means of control is needed to allow you to remove power from the circuit before the protection device acts.

Many electrical devices are used some of the time and not needed at other times. Circuit control devices allow you to turn the device on when it is needed and off when it is not needed.

Some devices, like multimeters or televisions, require the selection of a specific function or circuit. A circuit control device makes possible the selection of the particular circuit you wish to use.

TYPES OF CIRCUIT CONTROL DEVICES

Circuit control devices have many different shapes and sizes, but most circuit control devices are either SWITCHES, SOLENOIDS, or RELAYS.

Figure 1 shows an example of each of these types of circuit control devices and their schematic symbols.

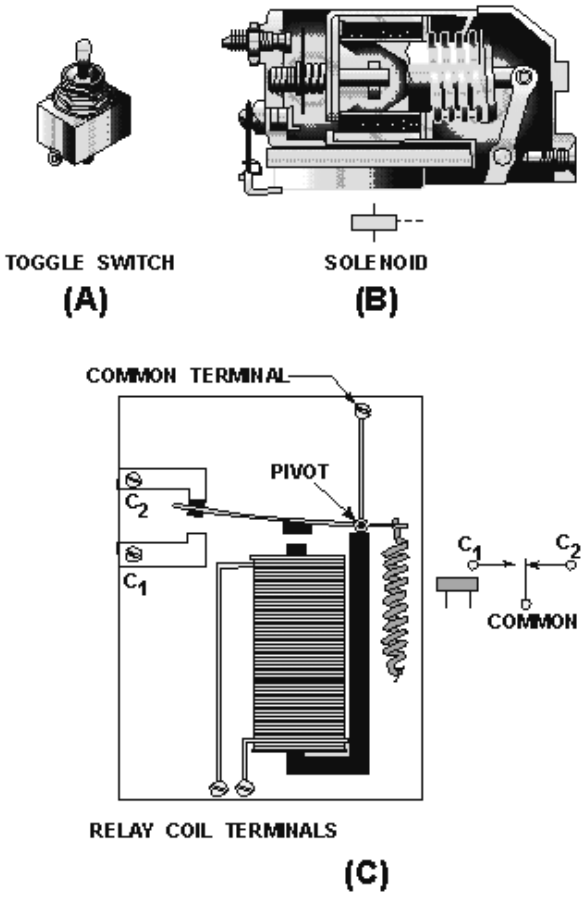

Figure 1.—Typical circuit control devices: RELAY COIL TERMINALS

Figure 1, view A, is a simple toggle switch and the schematic symbol for this switch is shown below it. Figure 1, view B, is a cutaway view of a solenoid. The schematic symbol below the solenoid

is one of the schematic symbols used for this solenoid. Figure 1, view C, shows a simple relay. One of the schematic symbols for this relay is shown next to the relay.

Q1. What are three reasons circuit control is needed?

Q2. What are the three types of circuit control devices?

Q3. Label the schematic symbols shown in figure 2.

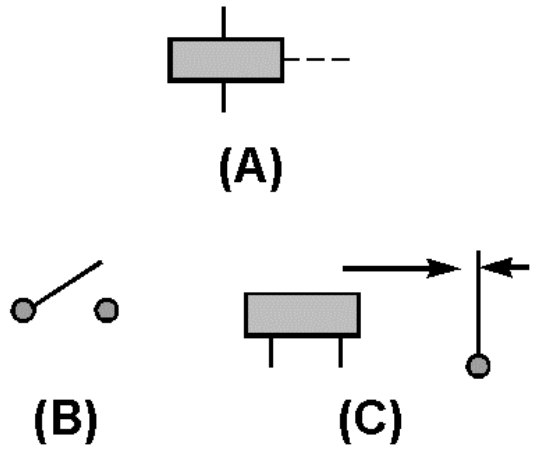

Figure 2.—Schematic symbol recognition.

SWITCH TYPES

There are thousands and thousands of switch applications found in the home and industry. Hundreds of electrical switches work for you everyday to perform functions you take for granted. Some switches operate by the touch of a finger and many others are operated automatically.

Switches are used in the home to turn off the alarm clock, to control the stove, to turn on the refrigerator light, to turn on and control radios and televisions, hair dryers, dishwashers, garbage disposals, washers and dryers, as well as to control heating and air conditioning. A typical luxury automobile with power seats and windows might have as many as 45 switches.

Industry uses switches in a wide variety of ways. They are found in the business office on computers, copy machines, electric typewriters, and other equipment. A factory or shop may use thousands of switches and they are found on almost every piece of machinery. Switches are used on woodworking machinery, metal working machinery, conveyors, automation devices, elevators, hoists, and lift trucks.

Switches are designed to work in many different environments from extreme high pressure, as in a submarine, to extreme low pressure, as in a spacecraft. Other environmental conditions to consider are high or low temperature, rapid temperature changes, humidity, liquid splashing or immersion, ice, corrosion, sand or dust, fungus, shock or vibration, and an explosive atmosphere.

It would not be possible to describe all the different switches used. This course will describe the most common types of switches.

MANUAL SWITCHES

A manual switch is a switch that is controlled by a person. In other words, a manual switch is a switch that you turn on or off. Examples of common manual switches are a light switch, the ignition switch on a motor vehicle, or the channel selector on a television. You may not think of the channel selector as a switch that you use to turn something on or off, but that is what it does. The channel selector is used to turn on the proper circuit and allows the television to receive the channel you have selected.

AUTOMATIC SWITCH

An automatic switch is a switch that is controlled by a mechanical or electrical device. You do not have to turn an automatic switch on or off. Two examples of automatic switches are a thermostat and the distributor in a motor vehicle. The thermostat will turn a furnace or air conditioner on or off by responding to the temperature in a room. The distributor electrically turns on the spark plug circuit at the proper time by responding to the mechanical rotation of a shaft. Even the switch that turns on the light in a refrigerator when the door is opened is an automatic switch.

Automatic switches are not always as simple as the examples given above. Limit switches, which sense some limit such as fluid level, mechanical movement, pressure (altitude or depth under water), or an electrical quantity, are automatic switches. Computers use and control automatic switches that are sometimes quite complicated.

Basically, any switch that will turn a circuit on or off without human action is an automatic switch.

MULTICONTACT SWITCHES

Switches are sometimes used to control more than one circuit or to select one of several possible circuits. An example of a switch controlling more than one circuit is the AM/FM selector on a radio. This switch enables you to control either the AM or FM portion of the radio with a single switch. An example of a switch that selects one of several circuits is the channel selector of a television set. These switches are called MULTICONTACT switches because they have more than one contact or MULTI(ple) CONTACTS.

Number of Poles and Number of Throws

Multicontact switches (other than rotary switches, which will be covered later) are usually classified by the number of POLES and number of THROWS. Poles are shown in schematics as those contacts through which current enters the switch; they are connected to the movable contacts. Each pole may be connected to another part of the circuit through the switch by "throwing" the switch (movable contacts) to another position. This action provides an individual conduction path through the switch for each pole connection. The number of THROWS indicates the number of different circuits that can be controlled by each pole. By counting the number of points where current enters the switch (from the schematic symbol or the switch itself), you can determine the number of poles. By counting the number of different points each pole can connect with, you can determine the number of throws.

Figure 3 will help you understand this concept by showing illustrations of various multicontact switches and their schematic symbols.

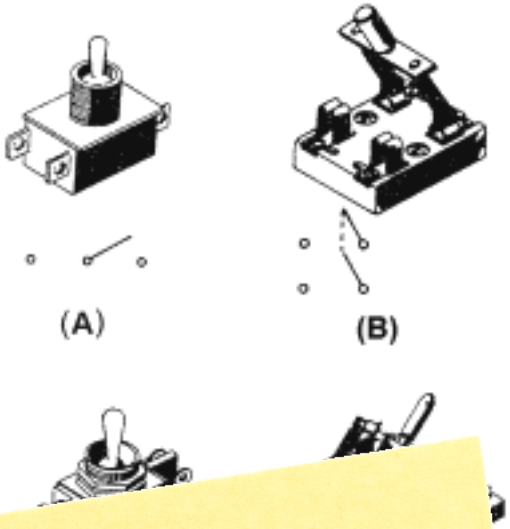

Figure 3(A) show ows three terminals (connections) on this s n.

The center connec ch current enters the switch. The left and rigl h this current can be switched. From the sche -pole, double-throw switch.

Now look at figure . he schematic symbol has two points at which c uble-pole switch. Each of the poles is mechanically connected ( ) to one point, so this is a single-throw switch. Only one throw is required to route t separate circuit paths through the switch.

Figure 3(C) shows a double-pole, double-throw switch and its schematic symbol. Figure 3(D) shows a four-pole, double-throw switch and its schematic symbol.

It might help you to think of switches with more than one pole as several switches connected together mechanically. For example, the knife switch shown in figure 3(D) could be thought of as four single-pole, double-throw switches mechanically connected together.

Q4. What is the difference between a manual and an automatic switch?

Q5. What is one example of a manual switch?

Q6. What is one example of an automatic switch?

Q7. Why are multicontact switches used?