TYPICAL
MERCURY
SWITCH

This Automotive Series
Control Devices
has been developed by

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CONTROLS

Control devices are used to "turn on" or "turn off" current flow in an electrical circuit. Control devices include a variety of switches, relays, and solenoids. **Electronic control devices include capacitors, diodes, and transistors, but those will be discussed in another training module**.

Control devices are needed to start, stop, or redirect current flow in an electrical circuit. Most switches require physical movement for operation while relays and solenoids are operated with electromagnetism.
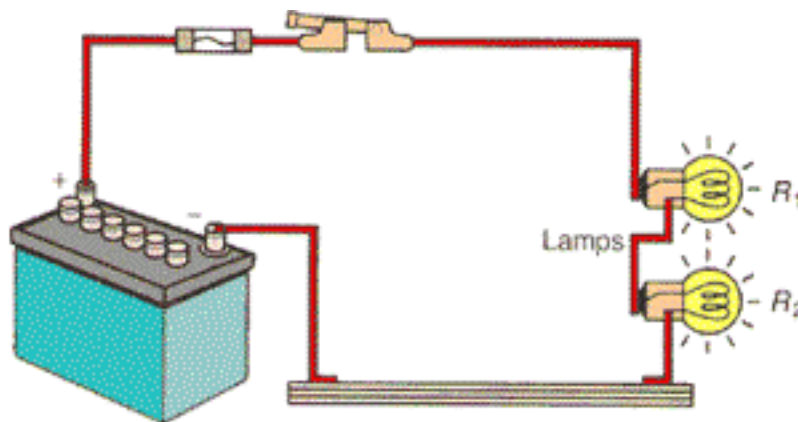
CONTROL DEVICES

SWITCHES

Single Pole Single Throw (SPST)
Single Pole Double Throw (SPST)
Momentary Contact
Multiple Pole Multiple Throw (MPMT or Gang Switch)
Mercury
Temperature (Bimetal)
Time Delay
Flasher

RELAYS

SOLENOIDS

SWITCHES

A switch is the most common circuit control device. Switches usually have two or more sets of contacts. Opening these contacts is called "break" or "open" the circuit, Closing the contacts is called "make" or "completing" the circuit.

Switches are described by the number of **Poles** and **Throws** they have. "Poles" refer to the number of input circuit terminals while "Throws" refer to the number of output circuit terminal. Switches are referred to as SPST (single-pole, single-throw), SPDT (single-pole, double-throw), or MPMT (multiple-pole, multiple-throw).

SINGLE POLE SINGLE THROW (SPST)

The simplest type of switch is a "hinged pawl" or "knife blade" switch. It either "completes" (turn on) or "breaks" (turn off) the circuit in a single circuit. This switch has a single input pole and a single output throw.

**SPST SWITCH
(SINGLE POLE SINGLE THROW)**
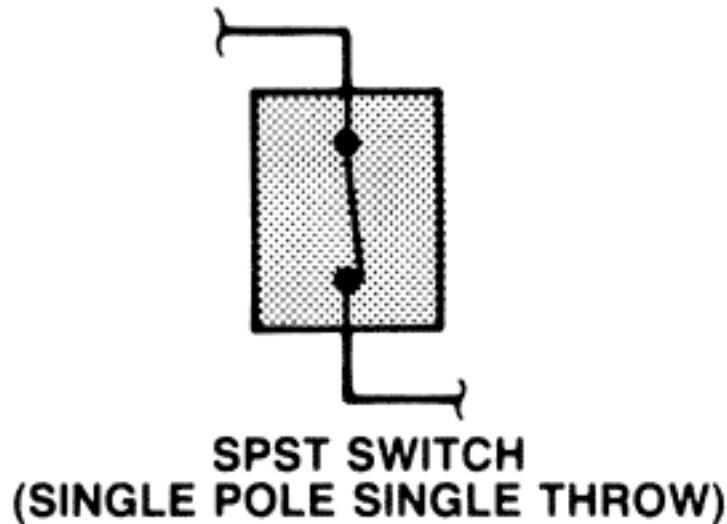
SINGLE POLE DOUBLE THROW (SPDT)

A single-pole input, double-throw output switch has one wire going it and two wires coming out. A Headlamp dimmer switch is a good example of a single-pole double-throw switch. The switch sends current to either the high-beams or low-beams of the headlight circuit.

**SPDT SWITCH
(SINGLE POLE DOUBLE THROW)**
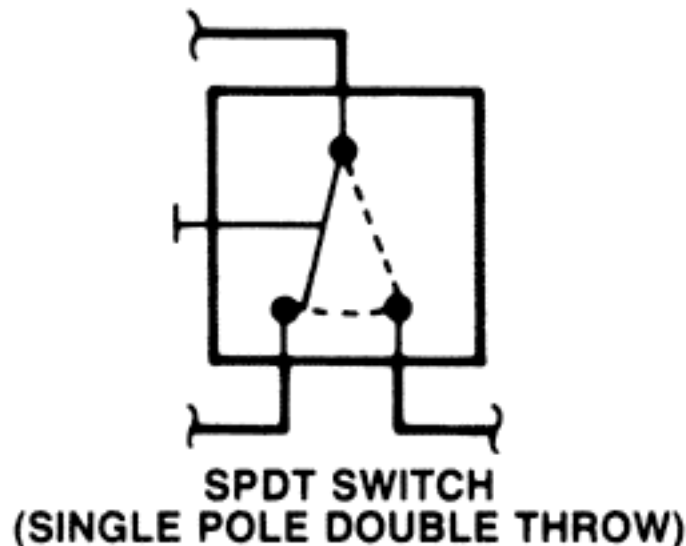
MULTIPLE POLE MULTIPLE THROW (MPMT)

Multiple-Pole input, Multiple-Throw output switches, which are also known as "gang" switches, have movable contacts in wired in parallel. These switches move together to supply different sets of output contacts with current. An ignition switch is a good example of a multiple-pole multiple-throw switch. Each switch sends current from different source to different output circuits at the same time depending on position. The dotted line between the switches indicates they move together; one will not move without the other moving as well.

MULTIPLE POLE MULTIPLE THROW SWITCH
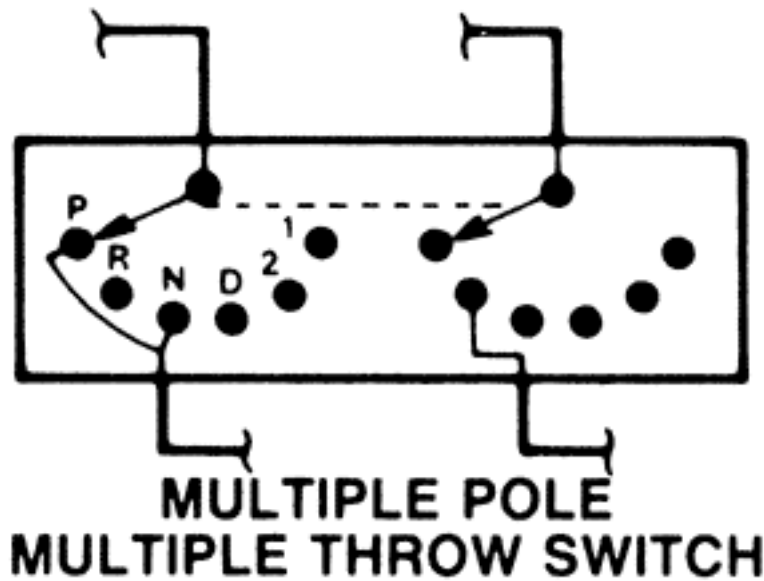
MOMENTARY CONTACT

The momentary contact switch has a spring-loaded contact that keeps it from making the circuit except when pressure is applied to the button. This is a "**normally open**" type (shown below). A horn switch is a good example of a momentary contact switch. Push the horn button and the hold sounds; release the button and the horn stops.

A variation of this type is the **normally closed** (not shown) which works the opposite as described above. The spring holds the contacts closed except when the button is pressed. In other words the circuit is "ON" until the button is pushed to break the circuit.

SPST
**MOMENTARY CONTACT SWITCH**
(NORMALLY OPEN)
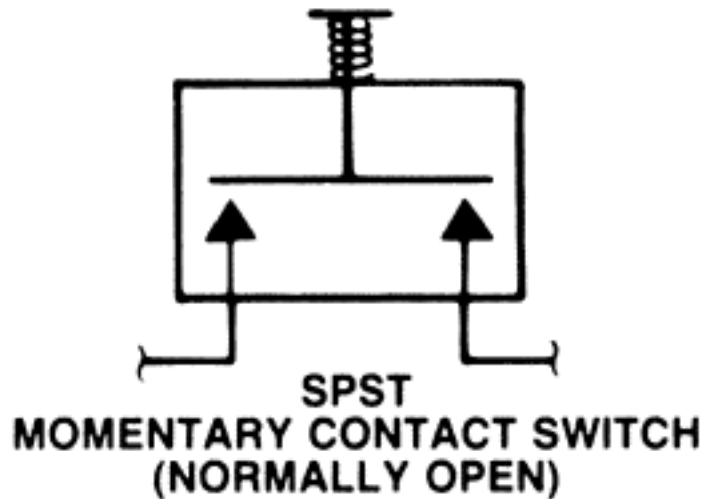
MERCURY

A mercury switch is made of a sealed capsule that is partially filled with mercury. In one end of the capsule are two electrical contacts. As the switch is rotated (moved from true vertical) the mercury flows to the opposite end of the capsule with the contacts, completing the circuit. Mercury switches are often be used to detect motion, such as the one used in the engine compartment on the light. Other uses include fuel cut off for roll-overs, and some air bag sensor applications. Mercury is a hazardous waste and should be handled with care.


TYPICAL
MERCURY
SWITCH
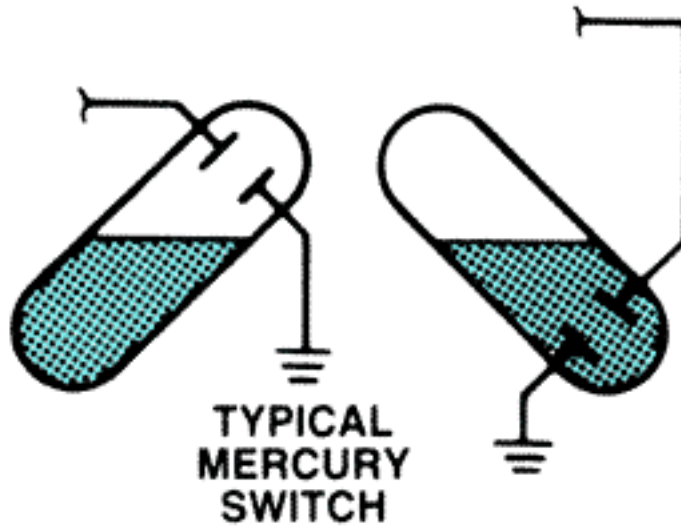
BI-METALLIC

A temperature-sensitive switch, also known as a "bi-metallic" switch, usually contains a bimetal element that bends when heated to make contact completing a circuit or to break contact opening a circuit. In an engine coolant temperature switch, when the coolant reaches the temperature limit, the bimetal element bends causing the contacts in the switch to close. This completes the circuit and lights the warning indicator on the instrument panel.
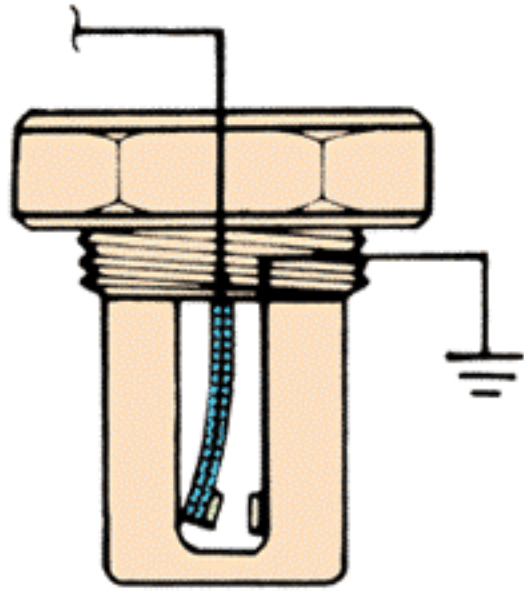

COOLANT
TEMPERATURE
SWITCH

TIME DELAY SWITCH

The time delay switch contains a bimetal strip, contacts, and a heating element. The time delay switch is normally closed. As current flows through the switch, current flows through the heating element causing it to heat, which causes the bimetal strip to bend and open the contacts. As current continues to flows through the heating element, the bimetal strip is kept hot, keeping the switch contacts open. The amount of time delay before the contacts open is determined by the characteristics of the bimetal strip and the amount of heat produced by the heating element. When power to the switch is turned off, the heating element cools and the bimetal strip returns to the rest position and the contacts are closed. A common application for a time delay switch is the rear window defroster.

## TEMPERATURE SENSITIVE
TIME DELAY SWITCH
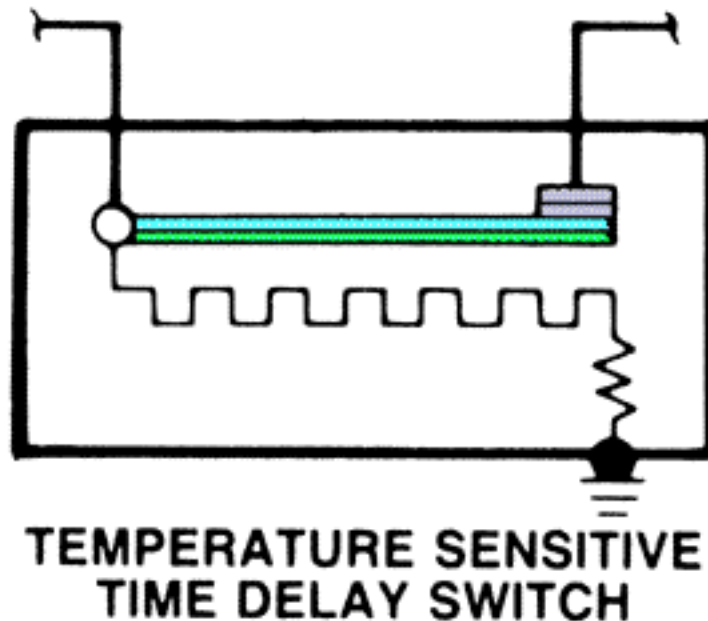
FLASHER

The flasher operates basically the same as the time delay switch; except when the contacts open, current stops flowing through the heating element. This causes the heating element and bimetal strip to cool. The bimetal strip returns to the rest position which closes the contacts, allowing current to flow through the contacts and heating element again. This cycle repeats over and over until power to the flasher is eliminated. Common uses for this type of switch are the turn signals or the four-way flasher (hazard lamps).
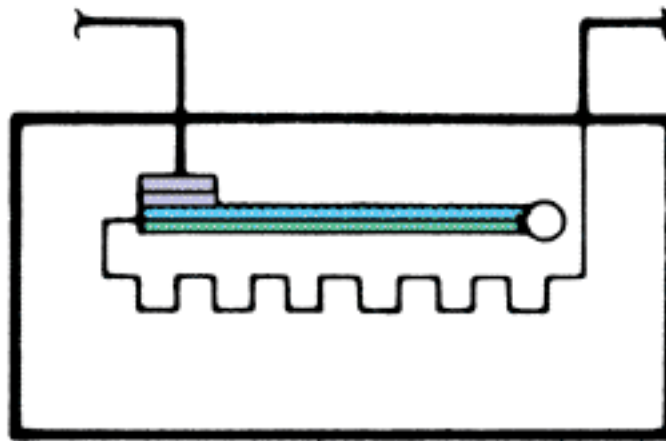
FLASHER

RELAYS

A relay is simply a remote-control switch, which uses a small amount of current to control a large amount of current. A typical relay has both a **control circuit** and a **power circuit**. Relay construction contains an iron core, electromagnetic coil, and an armature (moveable contact set). There are two types of relays: **normally open** (shown below) and **normally closed** (NOT shown). A Normally open (N.O.) relay has contacts that are "open" until the relay is energized while a normally closed (N.C.) relay has contacts that are "closed" until the relay is energized.

Construction
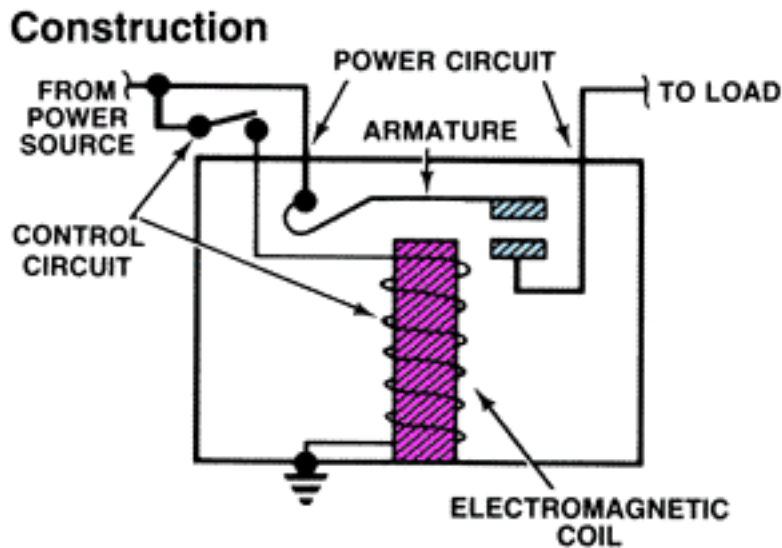
RELAY OPERATION

Current flows through the control coil, which is wrapped around an iron core. The iron core intensifies the magnetic field. The magnetic field attracts the upper contact arm and pulls it down, closing the contacts and allowing power from the power source to go to the load. When the coil is not energized, the contacts are open, and no power goes to the load. When the control circuit switch is closed, however, current flows to the relay and energizes the coil. The resulting magnetic field pulls the armature down, closing the contacts and allowing power to the load. Many relays are used for controlling high current in one circuit with low current in another circuit. An example would be a computer, which controls a relay, and the relay controls a higher current circuit.

Operation
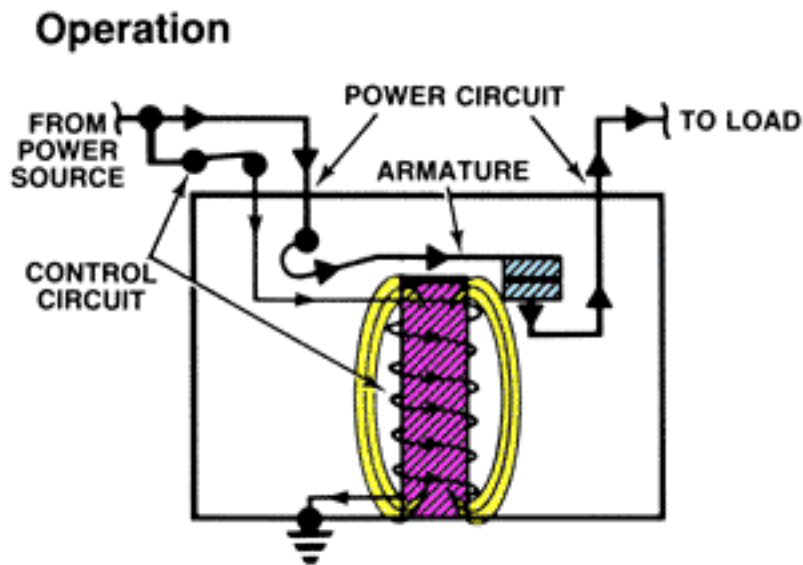
SOLENOIDS - PULLING TYPE

A solenoid is an electromagnetic switch that converts current flow into mechanical movement. As current flows through the winding a magnetic field is created. The magnetic field will pull the moveable iron core into the center of the winding. This type of solenoid is called a "pulling" type solenoid, as the magnetic field pulls the moveable iron core into the coil. A common use for pulling solenoids are in the starting system. The starter solenoid engages the starter with the flywheel.

Principle

MOVEABLE IRON CORE

+   −
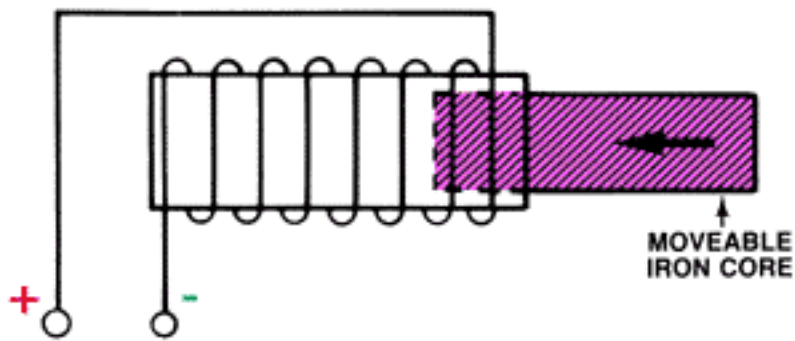
SOLENOIDS - PULLING TYPE OPERATION

As current flows through the winding a magnetic field is created. These magnetic lines of force want to be as small as possible. If an iron core is placed near the coil that has current flowing through it, the magnetic field will stretch out like a rubber band, reaching out and pulling the iron bar into the center of the coil.
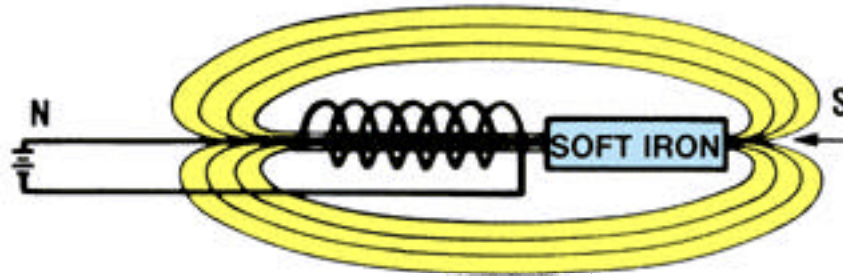
SOLENOIDS - PUSH/PULL TYPE

In a "push-pull" type solenoid, a permanent magnet is used for the core. Since "like" magnetic charges repel and "unlike" magnetic charges attract, by changing the direction of current flow through the coil, the core is either "pulled in" or "pushed out." A common use for this type of solenoid is on electric door locks.