http://hauntspace.com/forum/posts/id_2869/title_electrical-basics/

Electrical Basics

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Part 1:

Well, I was sitting here thinking about what I could write about and realized that there were quite a few members here that did not feel comfortable working with electricity.

So, I have decided to try and put things into a little easier perspective for everyone. First and foremost, I will put my little disclaimer in here that electricity IS DANGEROUS STUFF!! It can definitely kill you...IF you are not paying attention and working safely.

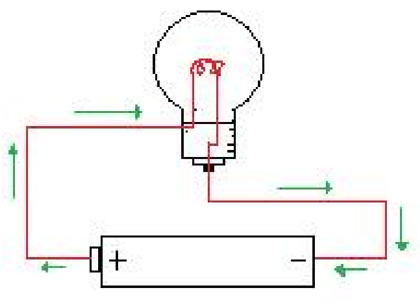
Now...to get one more thing out of the way. I AM NOT a licensed electrician, but do hold a degree in Electrical Engineering that I received many years ago and have not really used since...except on a rare occasion for my own benefit. But, I am not trying to teach you in-depth electrical knowledge here. We will not be learning how to add and divide voltages, resistors or capacitors. THIS IS BASIC STUFF!!! But stuff that will get you a little closer to being able to create your own mechanical wizardry.

PART 1: WIRE AND FLOW

The simplest explanation of electricity is the flow of energy through a conductor. Okay, raise your hand if you were picturing a man on a train wearing overalls and a big striped hat? Not that kind of conductor. A conductor in electrical terms is simply anything that will carry electricity from one point to another. MOST metals can be a conductor as well as water. Think about all those movies were someone is taking a bath and someone else tosses in a plugged in hair dryer or toaster...bad stuff. That is because water is an excellent conductor.

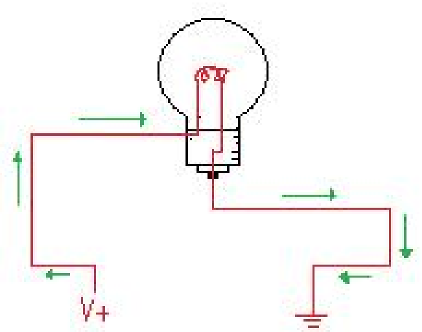
When looking at the power cord for most electronic devices, you will notice that there are two different wires in there (with the exception of a "grounded" plug which will have three)...think of these wires as the "IN" and the "OUT". The electricity flows from the outlet through one of the wires...into whatever the device is...and then out on the other wire back into the outlet and eventually to "GROUND"

GROUND!!!! What's a ground? Hmmm...how do I explain this easily. I am sure we have all looked at a battery before and have noticed a "+" and a "-" on either end of the battery...the "-" is the "ground" side of the battery...or, NEGATIVE VOLTAGE. (you guessed it...the "+" is POSITIVE VOLTAGE). Electricity flows from POSITIVE TO NEGATIVE...lets take a look at a simple light bulb circuit.



Notice that the power flows from the "+" (POSITIVE) side of the battery, through the light bulb and back into the "-" (NEGATIVE) side of the battery.

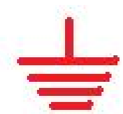
It will continue to do this until the battery has run out of power and can no longer light up the bulb.



This exact same circuit can be represented this way:

The electricity is flowing from the "V+", or positive voltage, through the bulb and back to ground.

That little upside down line triangle symbol is the symbol for ground (or at least close to it)



Now...once you start getting into household electric, you start hearing terms like "HOT", "NEUTRAL" and "GROUND". Here is how those equate to what we've already talked about:

HOT = "+" (carries the voltage IN)
NEUTRAL = "-" (carries the voltage OUT)
GROUND = "-" **sound of car crash is heard**

WHAT!?!?!? Why are there two "-" negative sides??? Well, basically...the GROUND in household wiring is only used if the NEUTRAL fails. If you take the inside cover off of your circuit breaker panel (or fuse box) at your house, you will probably notice that most times the WHITE and GREEN wires are all tied together. This is because they all go to the same place...GROUND.

White wires and Green wires?? Huh?

IN MOST CASES...electricians will run three wires to each light switch and electrical outlet in your house...BLACK, WHITE and GREEN. Let's put those into perspective....

BLACK - HOT - "+"
WHITE - NEUTRAL - "-"
GREEN - GROUND - "-"

Now, I use words like most times, and often because...despite the fact that there is a National Electric Code that tells people EXACTLY how everything should be ran...Home Depot does not verify that people know this prior to selling them cable. So...you can find all sorts of crazy wiring situations...but, what I have told you is the "standard".

Alright...I think I have covered the bare bones basics for now...and you should have a pretty good idea of how electricity works...and I bet that you could grab a bettery and a small light bulb and get it to glow..

I will continue this and go a little more in-depth later. I don't want to fry your minds too quick.

Just as a safety note...Doc Weitle pointed something out that I had missed...

As far as the light bulb example goes...the battery is actually backwards. The general rule of thumb is that the HOT wire would actually connect to the bottom of the bulb and the NEUTRAL is connected to the sides.

These reason for this is that it would be a lot easier for someone to accidentally touch the screw threads on a bulb...versus the bottom. If the HOT wire had power flowing through it...and you touched it, you could become the ground for the circuit sending around 110 volts through your body. NOT A GOOD FEELING!!!

I know that that sounds scary...but, I have been working with electricity in different capacities for many years now...commonly do not follow "safety practices"...and I am still alive and kicking. It CAN definitely kill you, there is no doubt about it...but as long as you use good old common sense...you will be fine...I promise.

I may try to get Doc to help me out with this...as I think he actually has a little more experience with it than I do.

Part 2:

I was planning on typing something up regarding different electronic components, but as I was searching around the internet today at work...I found a nice little tutorial. Compliments of www.1728.com . It touches on a few basic principles, but is mostly geared towards the various types of switches.

I decided to post this here, because as a home haunter/prop builder, there is a chance that you could use almost any of these different switch types.

I am going to write one up to start getting you acquainted with wiring diagrams (schematics) and the symbols that represent different aspects of an electrical circuit.

E L E M E N T A R Y   C I R C U I T S

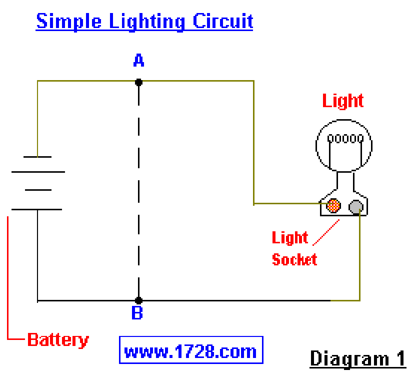
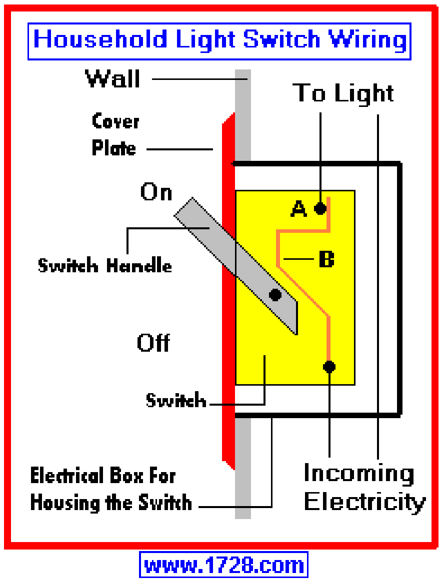


Diagram number 1 illustrates an extremely simple circuit. (For the moment, ignore the dotted line and the points A and B). The battery is represented by 4 lines (the longer line being positive and the shorter one negative). Starting from the negative end of the battery, electrons "circle" through one wire, pass through the light bulb, pass through the other wire and then return to the battery thereby completing the circuit. See? Quite simple.

This is all well and good but there are 2 drawbacks to this circuit 1) the light always stays on and 2) the power is constantly being used. How can we turn the light bulb 'off'? Well, we could unscrew the bulb from the socket but in the real world this is very inconvenient. (Light bulbs are inside fixtures, on ceilings and so on). Perhaps we could disconnect the power at the source. This too is very inconvenient. You would have to go down to your basement to shut the power off. Or - *much more dangerous* - you would have to disconnect the electrical supply wire before it reaches the light socket.

Is there a safe way to interrupt the electron flow without physically touching the wire? Sure. It is called a SWITCH !!!

The *inside* of a typical household wall switch has a strip of metal (B), making contact with point 'A', completing the circuit and thereby conducting electricity to the light. This would obviously be the 'ON' position. When the insulated lever is moved down to the 'OFF' position, it pushes the metal strip away from point 'A', breaking the circuit and turning the light 'OFF'.



This type of switch (having a lever which "flips" it on and off) is called a toggle switch.

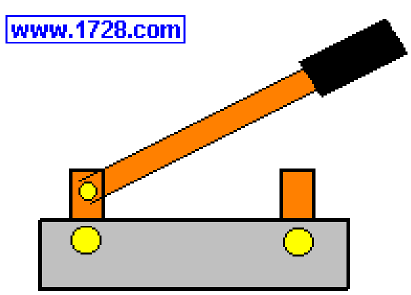
Because of being well-insulated and mounted in a box, household switches are a safe way for turning electrical devices on and off.

Finally, let's talk about that dotted line in Diagram 1. Now what would happen if point A and point B were to touch OR if they were connected with a wire or other conductor? Well, the light bulb would turn 'off', the wires and the battery would get very warm very fast and the electrons would simply travel from the battery to point A to point B and then back to the battery. Notice that in this new circuit , the electrons are travelling a path (or circuit) that is *shorter* than the original one. Hence you have just learned what a "short circuit" is and how its name is derived! Short circuits are dangerous. They cause wires to heat, circuit breakers to 'trip' and can even start fires.

S W I T C H E S

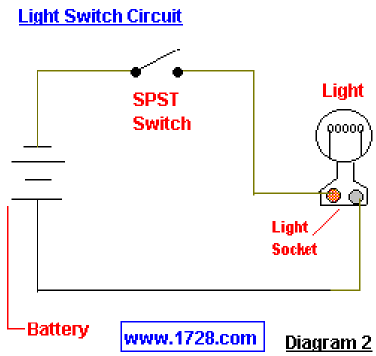
There are many different *types of switches:* toggle, rotary, pushbutton, "rocker", "pull-chain", slide, magnetic, mercury, timer, voice-activated, "touch-sensitive", and many others. Heck, even the Clapper™ is another type of switch !

The *"knife switch"* (rarely seen nowadays) is the type that most easily demonstrates the functioning of a switch. Old sci-fi movies ("Frankenstein (1931)" or "Young Frankenstein (1974)" , for example), made extensive use of these switches in the laboratory scenes.



Knife Switch

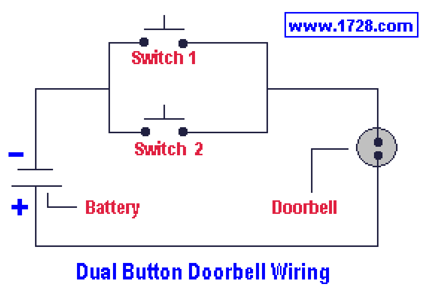
Today, use of knife switches has been confined to 1) heavy-duty industrial applications and 2) demonstration purposes - science projects for example. The knife switch has a metal lever, insulated at the 'free end' that comes into contact with a metal 'slot'. Since the electrical connections are exposed, knife switches are never seen in household wiring.



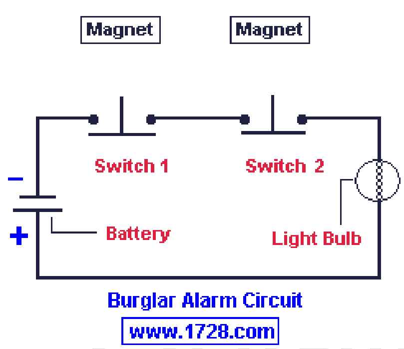
Referring to *Diagram 2*, the wiring is very similar to Diagram 1 except a switch has been added. Compare this to the Typical Household Light Switch diagram. Pretty much the same principle at work wouldn't you say? This type of switch is a Single Pole Single Throw (or SPST). This means that it controls one wire (pole) and it makes 1 connection (a throw). Yes, this is an on/off switch, but a 'throw' only counts when a connection is made. 'Off' is not considered a 'throw'. Also notice that only 1 wire has to be switched. (Following the circuit from one end of the battery to the other you can see why this is so).

As it is, this circuit alone could be your science project. A variation could be substituting a push-button switch and putting a 'buzzer' or 'doorbell' where the light is. Now you have a good demonstration of how a doorbell is wired. Pushbutton switches are *usually* "momentary on". That is to say the connection is made only when you press the button. There are "momentary off" pushbutton switches, but using one in a doorbell circuit would mean the bell would be constantly on *until* someone pressed the button. Impractical don't you think? (The comedian Tim Conway joked that his father wired a doorbell in just this way. When there was silence someone would say "Hey somebody's at the door").

A practical use of the *momentary off* switch is the "mute button" on your telephone. If a momentary on switch were used, it would be very annoying to press the button constantly as you talked and released it only for muting. This shows how each type of switch has its specific applications.



This diagram shows an interesting variation of doorbell wiring. The 2 doorbell buttons do not have to be right next to each other. One button could be at a front door and the other at a side door. If you follow the circuit, you can see that pressing *either* button will cause the doorbell to ring. The 2 switches are said to be wired in *parallel.*



The burglar alarm circuit at left employs magnetic switches. These switches and their associated magnets are generally mounted on doors and windows. Notice that Switch 1 and Switch 2 are wired in *series. Both* switches must be closed in order for the circuit to be complete and for the bulb to light. (This would indicate the 'armed' status of this burglar alarm.) Magnetic switches come in 2 varieties - "Normally Closed" and "Normally Open".

These 2 terms describe the state of the switch when it is NOT being controlled by the magnet. The switches in this diagram are the "Normally Open" type and because the magnets are far enough away, the switches are in the 'open' state. If the magnets were brought closer, the bulb would go on and the circuit would be "armed". At this point, moving *either* magnet would make the bulb go out and the alarm would be triggered. (For the sake of simplicity, the activated alarm circuit has not been drawn). An important point to note is that cutting the wires at *any* point would also make the bulb go out and trip the alarm.

The next type of switch (no diagram) is the Double Pole Single Throw (DPST). These switches are used when there are 2 'live' lines to switch but can only turn on or off (single throw). These switches are not used much and are usually found in 240 volt applications.

Single Pole Double Throw Switches

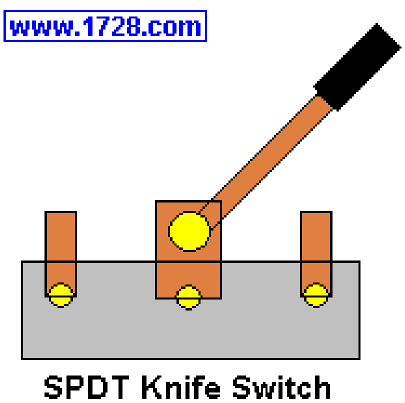
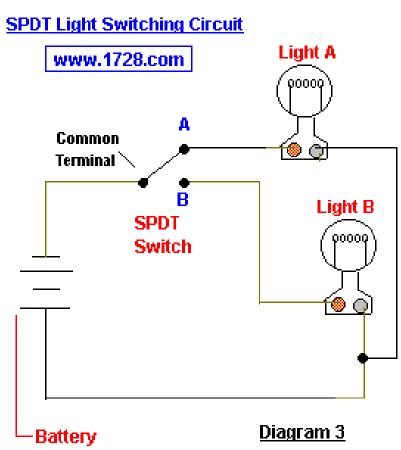
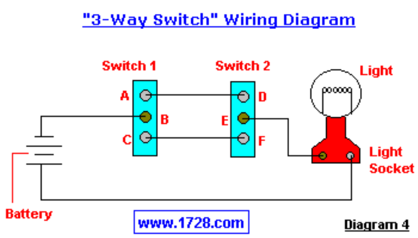


Diagram 3 makes use of the Single Pole Double Throw Switch. The common terminal is the middle terminal in the SPDT Knife Switch or if you are using a household switch, it would be the brass colored terminal. (the other 2 would be silver colored). This circuit clearly demonstrates what happens when the SPDT switch is moved back and forth. Light A goes on and B goes off, B goes on and A goes off and so forth. You can see that this popular switch would have *many* practical applications: the transmit/receive button on a "2-way" radio, the "high/low beam" switch for your car headlights, the pulse/tone dialing switch on your telephone, and so on.



If you are using the SPDT knife switch, you have a "center off" position, which an ordinary wall switch would NOT have in which case you will need to add an SPST switch for shutting this circuit off. (In electronics work, many SPDT switches have a middle position in which the electricity is turned off to BOTH circuits. It is an SPDT center off switch. Also, some electronic SPDT switches have a "center on" position. The best example of this type of switch is the "pickup" selector on an electric guitar which can choose the rhythm, treble or both pickups for 3 varieties of sounds).

Diagram 4 (below) depicts what is probably the most common use for the SPDT switch - the 3 way light switching circuit. Electricians incorrectly call the SPDT switch a "3 way switch". The proper terminology should be "three terminal switch". However the term 3-way switch has stuck and it's a misnomer we'll just have to live with.



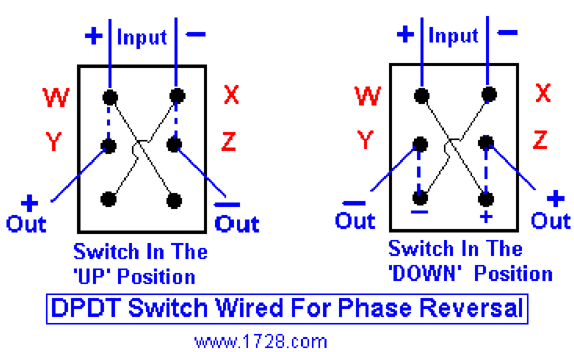
So, how does this work? Let's say that Switch 1 is at the bottom of a stairway and Switch 2 is at the top. Suppose Switch 1 is in a 'down' position (B & C connected) and Switch 2 is in an 'up' position (D & E connected). The light bulb is off. Now someone comes to the bottom of the stairs and flips Switch 1 up'.

If you follow the circuit you can see why the light bulb would now turn on because A & B and D & E are connected. When the person reaches the top of the stairs, Switch 2 is flipped 'down', E & F are now connected and so the light bulb goes off. Another person shows up at the bottom of the stairs and flips Switch 1 'down', connecting B & C thereby turning the light on again. The person reaches the top of the stairs, flips Switch 2 'up' connecting D & E and the light bulb goes off. Notice that in the case of the second person, a down stroke turns the bulb on and an upstroke turns the bulb off. If you have such switches in your house OR if you have purchased household wall switches for this circuit, you now see the reason why they do NOT have the words on and off printed on them.

Don't you think this switching arrangement would make a great science project?

The Double Pole Double Throw Switch

A simple way to think of this switch is imagining 2 SPDT switches side by side with the 'handles' attached to each other. Perhaps the most popular use for this switch is 'phase or polarity reversal'. So, how does the DPDT switch accomplish this? First, *you* have to wire the 2 'top' and 2 'bottom' terminals in a 'criss-cross' fashion. The top 2 terminals become the input and the middle two terminals become the output. Now, referring to the bottom left diagram, the switch is in the 'up' position, W & Y are connected, as are X & Z. The polarity is maintained because the input and output are directly connected. No problem seeing that right?



Now let's see what happens when the switch is in the 'down' position (right diagram). The + input goes from the 'W' terminal, down to the lower right and then up to the 'Z' terminal. The negative input goes from the 'X' terminal and out through the 'Y' terminal. See what has happened? With one flip of a switch, polarity has been reversed. What applications does this have? For one thing, electric guitar players use this type of switch to put one pickup out of phase with the other, producing a thin, 'squawcky', 'inside-out' kind of sound. In the 'old days' before 3 prong plugs, power switches on some electrical devices used this switching arrangement to switch polarity in case the plug was in the outlet the "wrong way".

Another important (though not very common) use is to put this switch between 3-way switches so that the same light may be switched from *many* different locations. Referring to Diagram 4, if A & B and E & F were connected, the bulb would be off. But now think of the wires going from A to D and C to F. If their connections were reversed, (A to F, C to D), the light bulb would turn on again. So, how would we be able to reverse the polarity of these 2 wires? By using the polarity reversing switch ! (See Diagram 5 below).

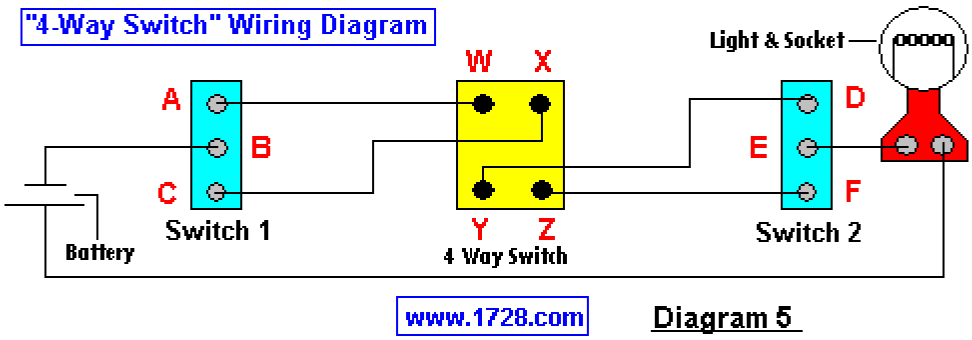


Diagram 5

Incidentally, electricians have once again stuck us with another misnomer by calling this a "4-way" switch. Can you see what the 4-way switch is? It is a DPDT switch, wired for phase reversal without the bottom 2 terminals exposed (they don't have to be). If you can buy a 4-way switch, great. If not, you know how to make one right? Also, you don't have to limit yourself to using just one 4-way switch. If you were to attach another 4-way switch from the 'Y' 'Z' terminals to the 'W' 'X' terminals of the next switch, you could have the same light switched from a 4th location. Or you could add a 5th or 6th, etc. Now wouldn't that make an impressive science project?

Good luck with the project !!!