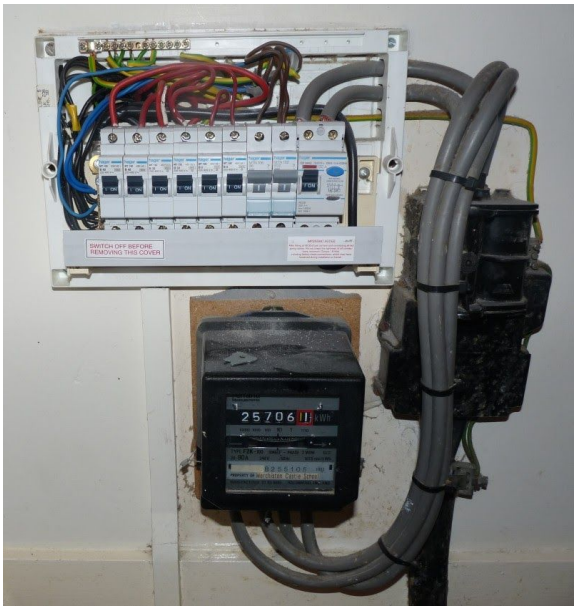
Domestic Electricity

Introduction

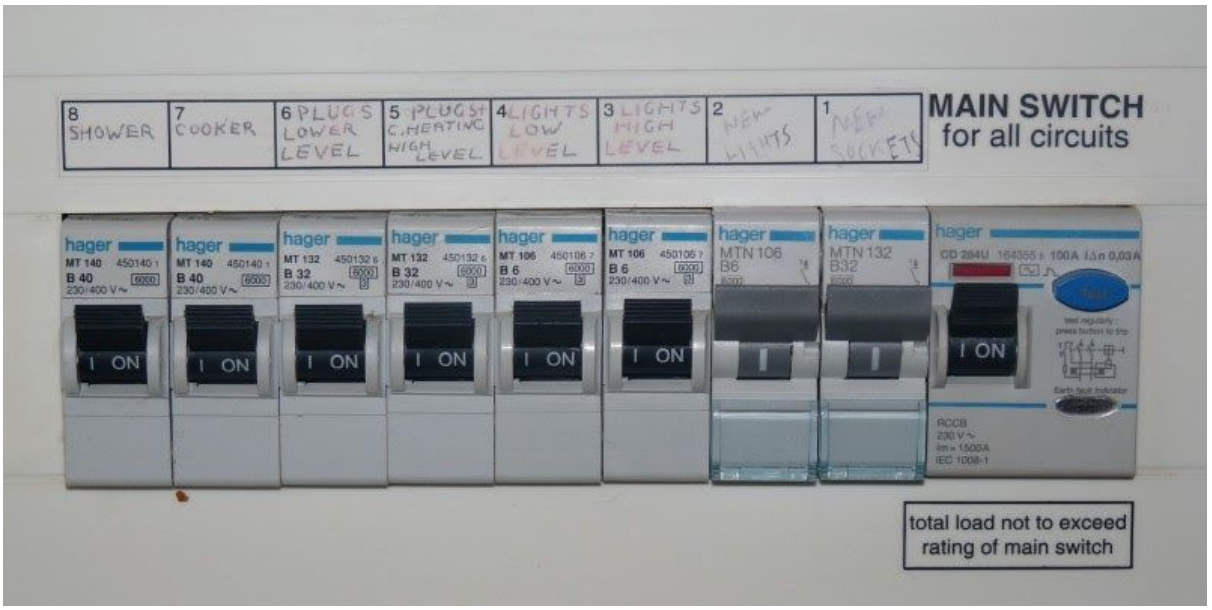
The electricity supplied to our homes is a.c. It is nominally 230 volts and has a frequency of 50Hz. The voltage and frequency can change slightly throughout the day as demand changes.

Distribution

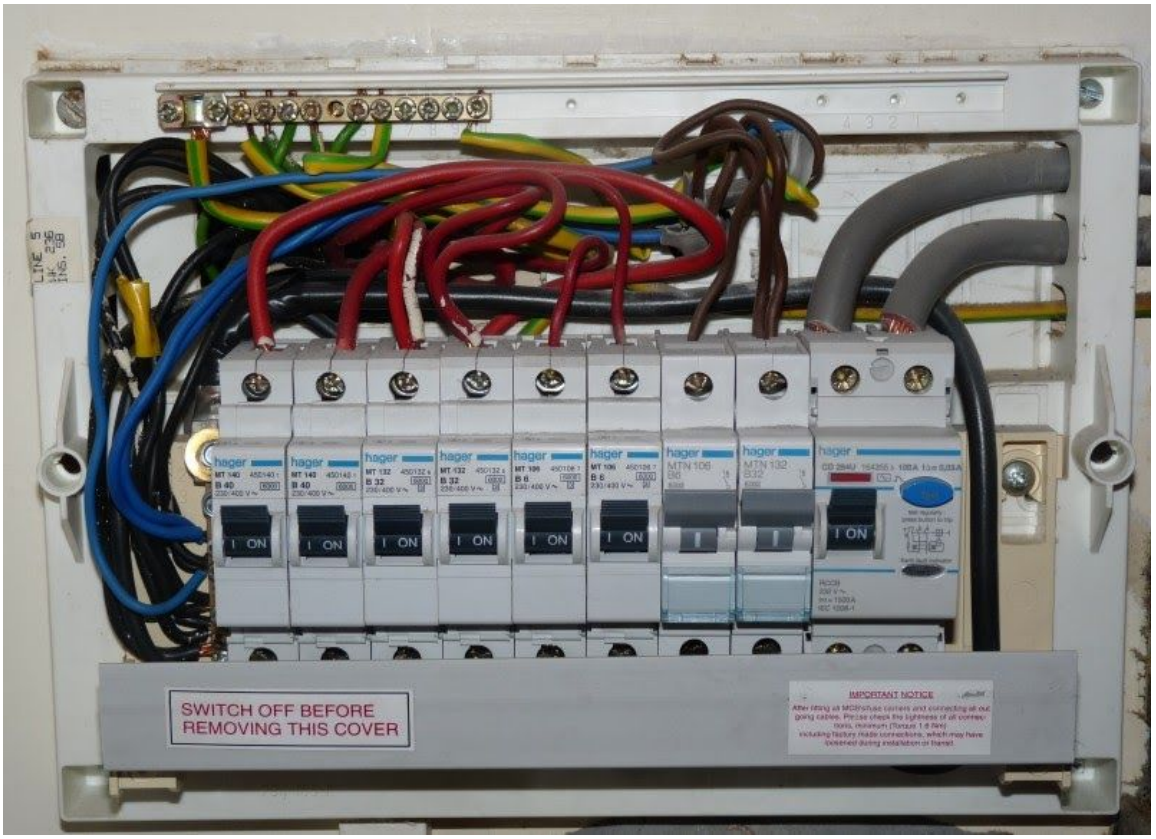


The Live and Neutral wires come into the house and are immediately connected to a main fuse (100A, shown as the black box) which the consumer can not access - this fuse for the whole house prevents the user damaging or short circuiting the mains supply. The mains supply then goes to the electricity meter via the thick grey wires shown in the picture. The electricity meter measures the amount of electricity (electrical energy) being used in units of kiloWatt hours (kWh). In this example the Live and Neutral come from underground in an armoured cable, the armouring around the main cables provides a good earth point (just visible). In many houses the Earth wire is attached to a large metal spike buried in the ground. From the electricity meter, more thick grey wires carry electrical current to the consumer unit.

From the consumer unit there are separate circuits for plug sockets, lights, electric immersion heaters, electric showers, electric cookers and out buildings etc. These circuits are arranged as ring mains - the cable runs around the house to each individual component on the ring main and then back to the consumer unit. Each different ring is protected by a fuse or circuit breaker. Different ring mains require different size fuses / circuit breakers. The ring main for the domestic plug sockets will usually have a 32 Amp fuse per ring and whereas the lighting circuit will only have a 5 or 6 Amp fuse per ring. Powerful appliances that require a lot of current have their own separate circuit - these might include electric cookers, electric showers and electric water heaters.

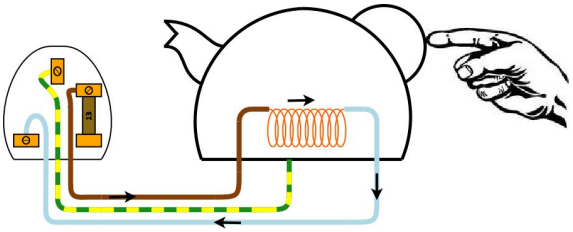


The main Live and Neutral supply coming from the electricity meter go directly to the Residual Current Circuit Breaker (shown on the right) before the Live supply is distributed via circuit breakers to each of the individual ring mains and other circuits. The Neutral wires are all connected together to a 'bus bar' on the left hand side of the unit and the Earth wires are all connected together at the top of the consumer unit. Notice how the live terminals are still covered when the consumer unit has the cover removed whereas the Neutral and Earth connections are both exposed - this is because the Neutral and Earth wires are both essentially at zero volts and so pose little risk of an electric shock.

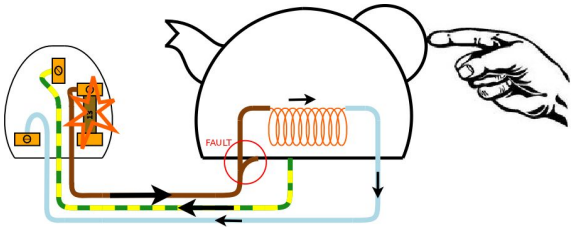


Earth Circuit

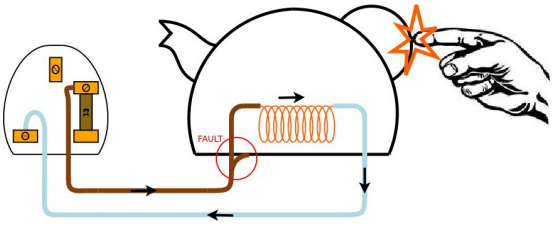
The Earth wire and the fuse together provide protection against the risk of an electric shock when a domestic appliance develops a fault. The fuse also protects against excess current causing a fire. The Earth circuit video shows the three situations in detail - follow Video link at the top of the page.



The circuit is working properly, there is no fault. Current flows in the Live and Neutral wires - the element glows. No current flows in the Earth wire, the person is not electrocuted and the fuse doesn't blow.

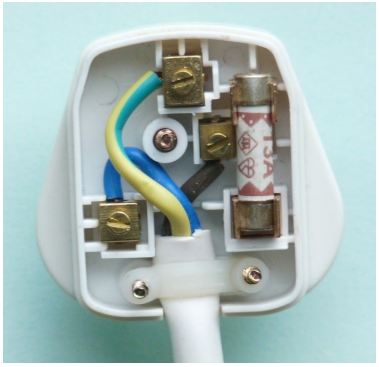


The circuit has a fault. The Live wire is touching the metal kettle and the person will receive an electric shock. However, a large current now flows along the Earth wire. This current is enough to blow the fuse and disconnect the electrical supply.



The circuit has a fault and no Earth wire. The Live wire is connected to the metal case of the kettle and the user will get an electric shock. The small extra current through the person is not enough to blow the fuse. The kettle remains connected to the electrical supply and is a danger to the user.

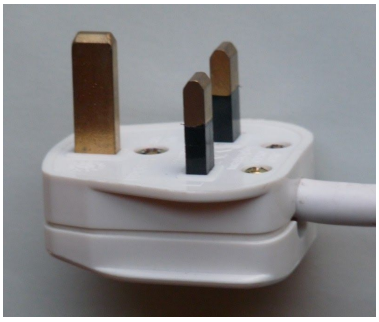
Plugs



The standard domestic plug is shown in the diagram.

The LIVE wire is BROWN
The NEUTRAL wire is BLUE
The EARTH wire is YELLOW & GREEN stripes
The FUSE is in the Live wire
Cord grip prevents the cable being pulled out of the plug
The plug can not be used with the top removed because all the pins fall out if you try to plug it in

There are a few extra safety features visible in this picture of a standard plug.



The Earth pin is the longest so that it goes in first and comes out last.

The Earth pin opens the shutters in the socket that protect the Live and Neutral connections.

The Live and Neutral pins have tape around them so that little fingers can't make contact when you pull the plug out – children tend to wrap their fingers behind the plug to pull.

Fuses

A fuse is a thin piece of wire included in a circuit. The material from which the fuse wire is made usually has a lower melting point and a slightly higher resistance than the other wires in the circuit. If too much current flows in the circuit, the fuse wire will get hot (due to its higher resistance) and melt (due to its lower melting point) before any of the other wires get hot. Once the fuse melts, the circuit is broken and no more current flows.

Domestic fuses are rated at 3A, 5A and 13A for use in plugs and 6A, 16A, 32A, 40A for use in consumer units. Many appliances, such as TVs etc, also contain internal fuses with an even lower current rating.

Left: 13A, 5A and 3A domestic fuses found in plugs
Right: fuses found inside appliances – the small ones are 500 mA
Bottom: Automobile fuses, sometimes called blade fuses. These come in multiples of 5A – the yellow ones are 20A

Circuit Breakers

A circuit breaker does the same job as a fuse, it breaks the circuit if too much current flows. A circuit breaker is an electro-mechanical device which means it uses an electromagnet to move a mechanical switch when the current is too high.

The advantages of a circuit breaker are:

- They disconnect the circuit quickly, faster than a fuse will blow
- They can be reset easily whereas a fuse has to be replaced
- They tend to be more accurate - a 5A circuit breaker will cut out at 5A whereas a 5A fuse may conduct 6A or more without blowing

Residual Current Circuit Breaker (RCCB)

If a fault occurs, or a person gets an electric shock, a small amount of current flows from Live to Earth – this is the residual current. The current in the Neutral wire is less than the current in the Live wire. A Residual Current Circuit Breaker (RCCB) detects the small difference in current in the Live and Neutral and disconnects the electrical supply. An RCCB is very fast, disconnecting the supply in just a few milliseconds.

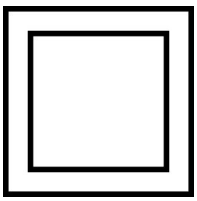
The device shown is also the main Circuit Breaker rated at 100A total for the whole house. The residual trip current is shown as 0.03A (30mA). The blue test button allows the device to be tested, it is a good idea to test the RCCB every few months or so.

Double Insulation

Not all appliances need an Earth wire. If there are no exposed metal parts then there is no risk of the appliance being live in the event of a fault.

Such appliances are called “Double Insulated” because there are two layers of insulation – one around the wire, the other around the case itself.

The picture shows an example of a double insulated power supply. Note the plastic Earth pin, it is still necessary to open the shutters in the socket.



Double Insulation Symbol which represents the two separate layers of insulation rendering the Earth wire unnecessary. Double insulated often still have a fuse to prevent excess current causing a fire.

Website

http://www.pfnicholls.com/Electronics/domestic.html

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