A problem with many installations, particularly domestic, is that

Every man and his dog has had a hand in it

The domestic electrical installation

- likely to have been originally installed by competent electrical contractor
- additions/alterations possibly undertaken by unqualified persons
- periodic inspection and testing to ensure continued safety is unlikely

To what standards should an electrical installation conform?

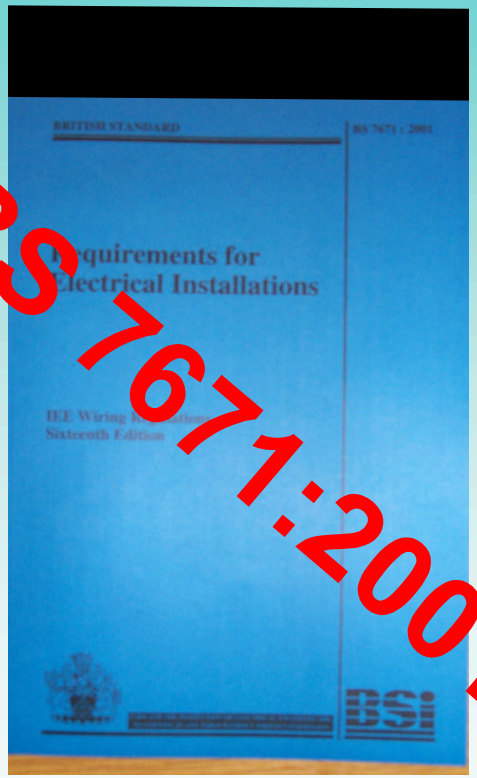
The Institution of Electrical Engineers Wiring Regulations

First Edition of the Regulations

Issued in 1882 and entitled ‘Rules and Regulations for the Prevention of Fire Risks Arising from Electric Lighting’

What about risk of electric shock and death by electrocution?

Jointly owned by the Institution of Electrical Engineers and B.S.I.



Latest edition

Came into effect

1st January 2002

Are these regulations statutory?

No, but they can be used as evidence of compliance with statutory regulations

limited value within the domestic installation in terms of enforcement

Very few enforceable regulations apply to domestic installations

The commercial or industrial electrical installation usually under the control of competent persons.

Statutory measures in place to ensure a safe working environment. This includes the electrical installation and electrical equipment

Failure to comply with statutory regulations within the workplace can lead to criminal prosecution

Other Interested Parties

Two organisations concerned with the quality and safety of all aspects of electrical installation work in including domestic

The Electrical Contractors Association

E.C.A.

National Inspection Council for Electrical Installation Contracting

N.I.C.E.I.C.

Organisations only concerned with the competence and quality of work for those electrical contractors who are members of their organisation

What happens if an electrical contractor carries out work in an unsatisfactory manner?

If the contractors are members of the ECA or NICEIC, then appropriate action can be taken

If not, the trading standards office, or local authority may be able to help

With many domestic installations there is little or no maintenance undertaken to ensure continued safety

In many cases, the integrity and safety of the installation is reduced by the D.I.Y. person!

The need for Inspection and Test

Installations should be inspected and tested

- before being put into service - *(initial verification)*
- at regular intervals thereafter - *(periodic)*
- on completion of any alterations or additions

The Initial Verification

For an initial verification

BS 7671:2001 states:

- installed equipment to an appropriate standard, i.e. BS, BS EN etc.
- correctly selected and erected
- not visibly damaged or defective as to impair safety

The periodic installation inspection

BS 7671:2001 states

Periodic inspection and testing of an electrical installation shall be carried out to determine,so far as is reasonably practicable, whether the installation is in a satisfactory condition for continued service

Generally, the main reason for undertaking an inspection and test is to ensure that the installation is safe to use

What are the likely reasons for an installation failing to be safe?

- Age
- Wear and tear - may be considerable in rented accommodation
- Botched work by incompetent persons, or unscrupulous contractors

Periodic Inspection Report

Where is it required?

- expiry of current certificate
- change of ownership or use
- as a result of damage - flood, fire, etc
- mortgage/insurance purposes

Factors affecting the safety

some common factors will include:-

- Damage to equipment or accessories
- Poorly installed equipment/accessories
- Loose connections giving rise to shock/fire
- Overloaded circuits
- Inadequate protection of circuits against overcurrent
- Circuit cables inadequate to safely carry load current
- Inadequate earthing arrangements

The visual Inspection

For reasons of safety the supply should preferably be switched off prior to conducting the inspection

Checking fixings of accessories and cabling

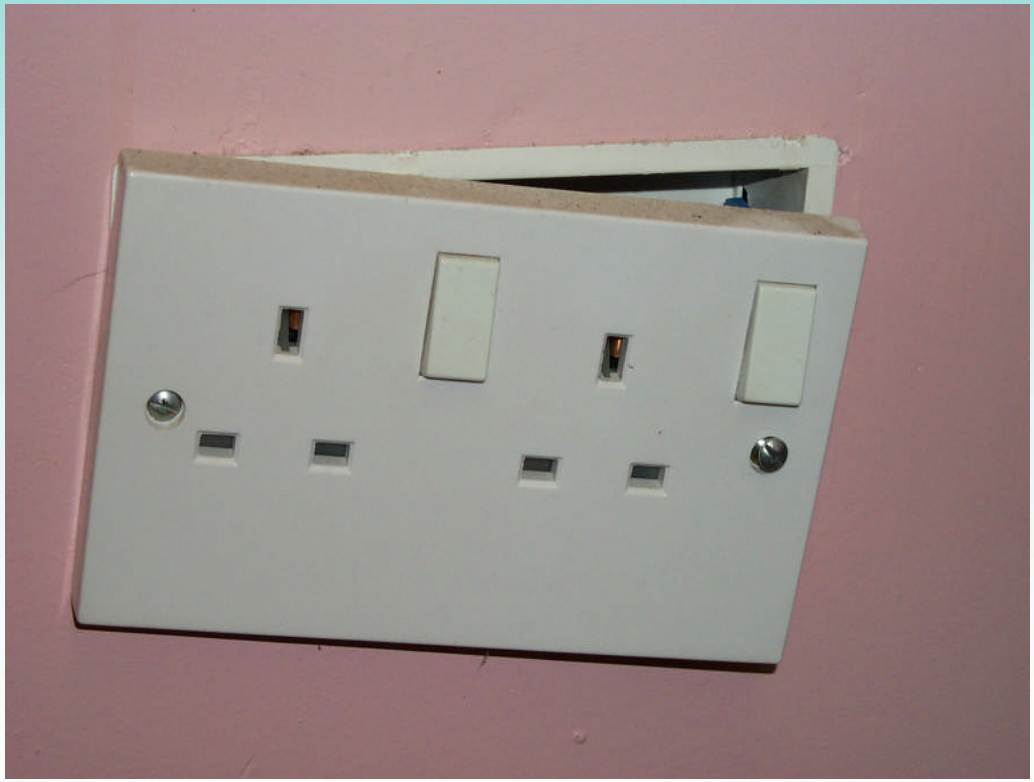
Loose connections may result in

electric shock

fire

circuit connections may be dislodged by movement of the socket outlet .

terminations should be checked before socket is secured



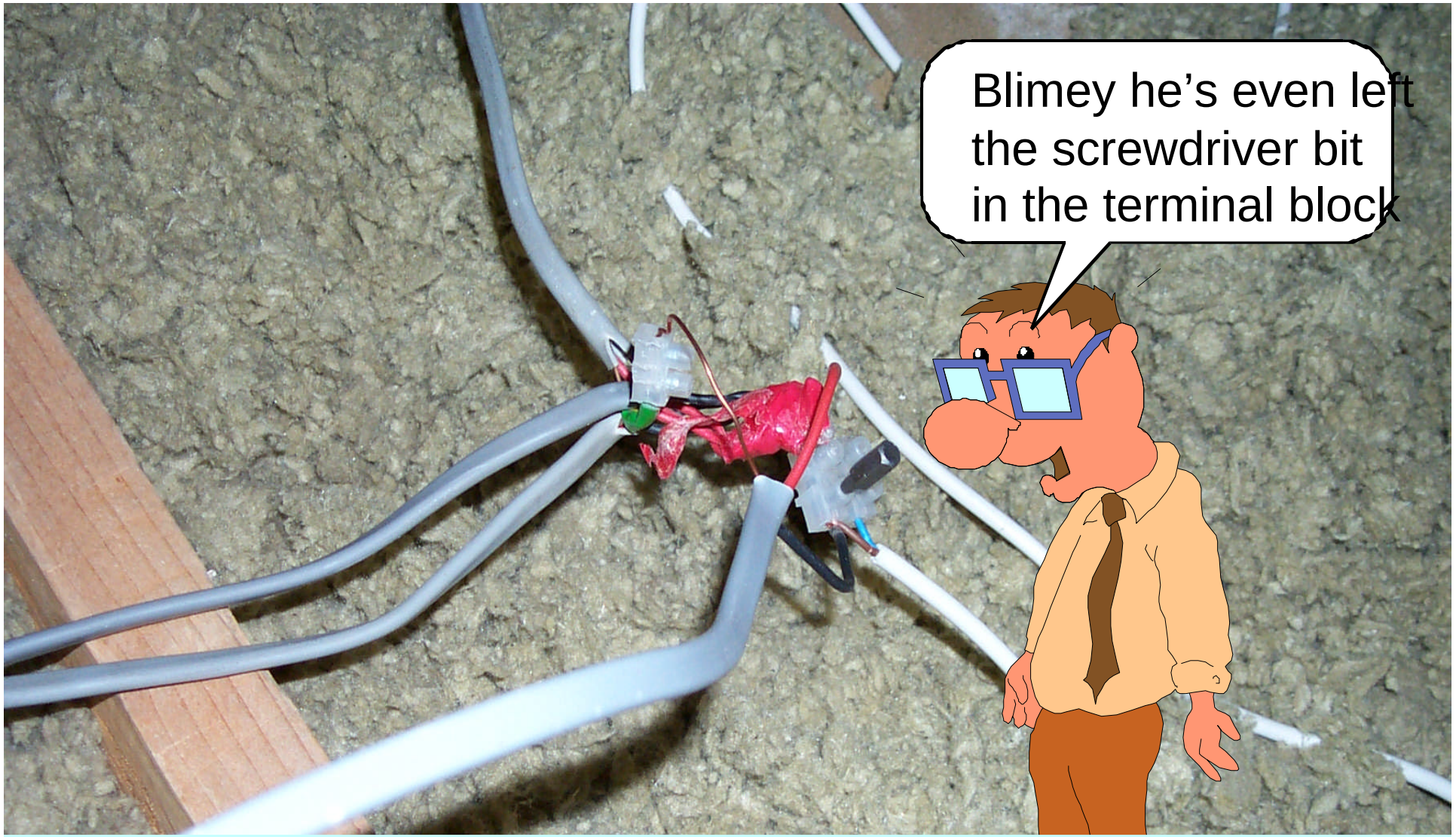
remember, loose connections may give rise to fire and shock

And
Before re-
securing
any accessory

The supply must be isolated

circuit connections may be dislodged by movement of the joint-box .

That’s assuming they bothered to use a joint box in the first place.

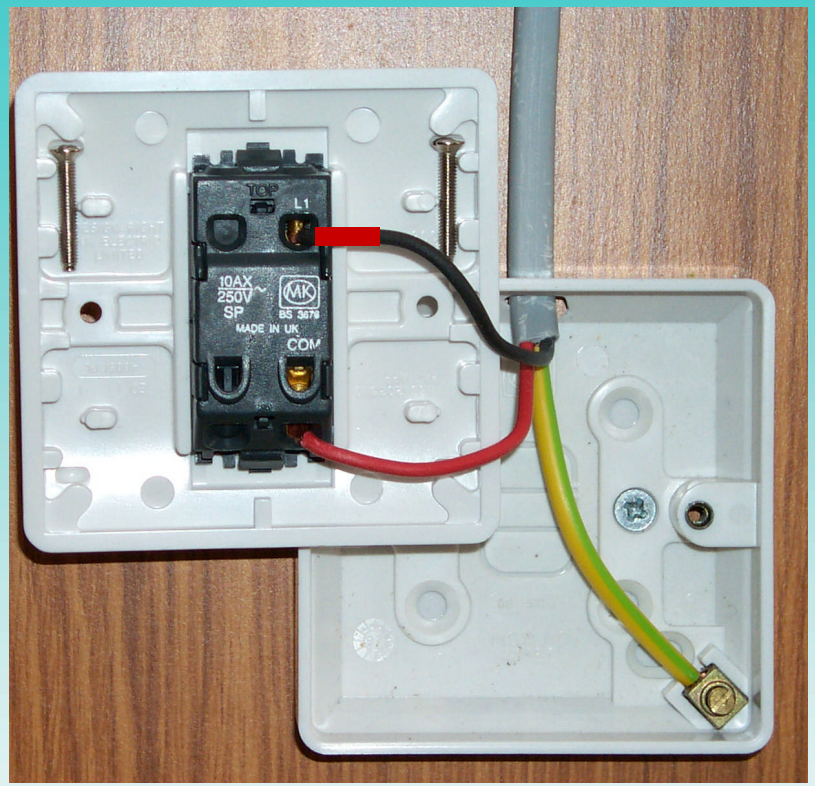


potential fire/shock risk due to mechanical damage or loose connections


Shock risk

Overheating due to loose connections

Correct connection of single-way switch

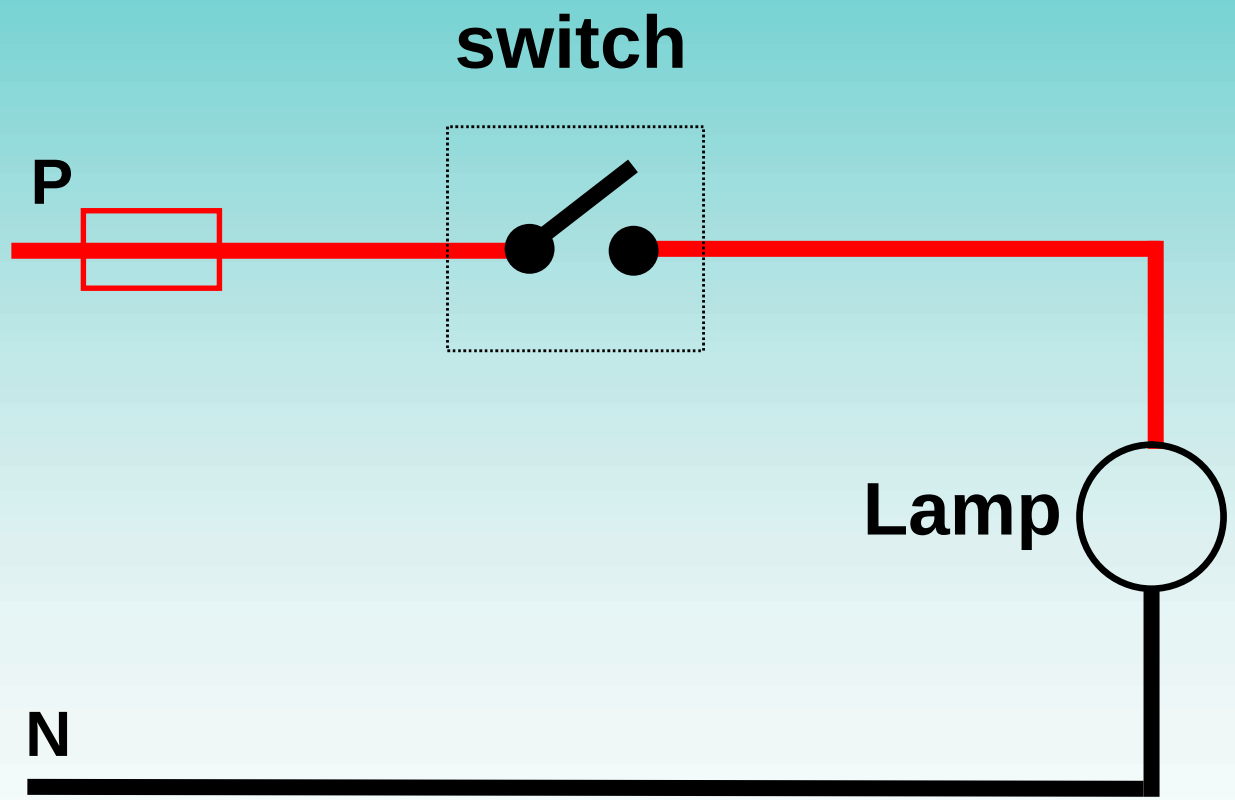


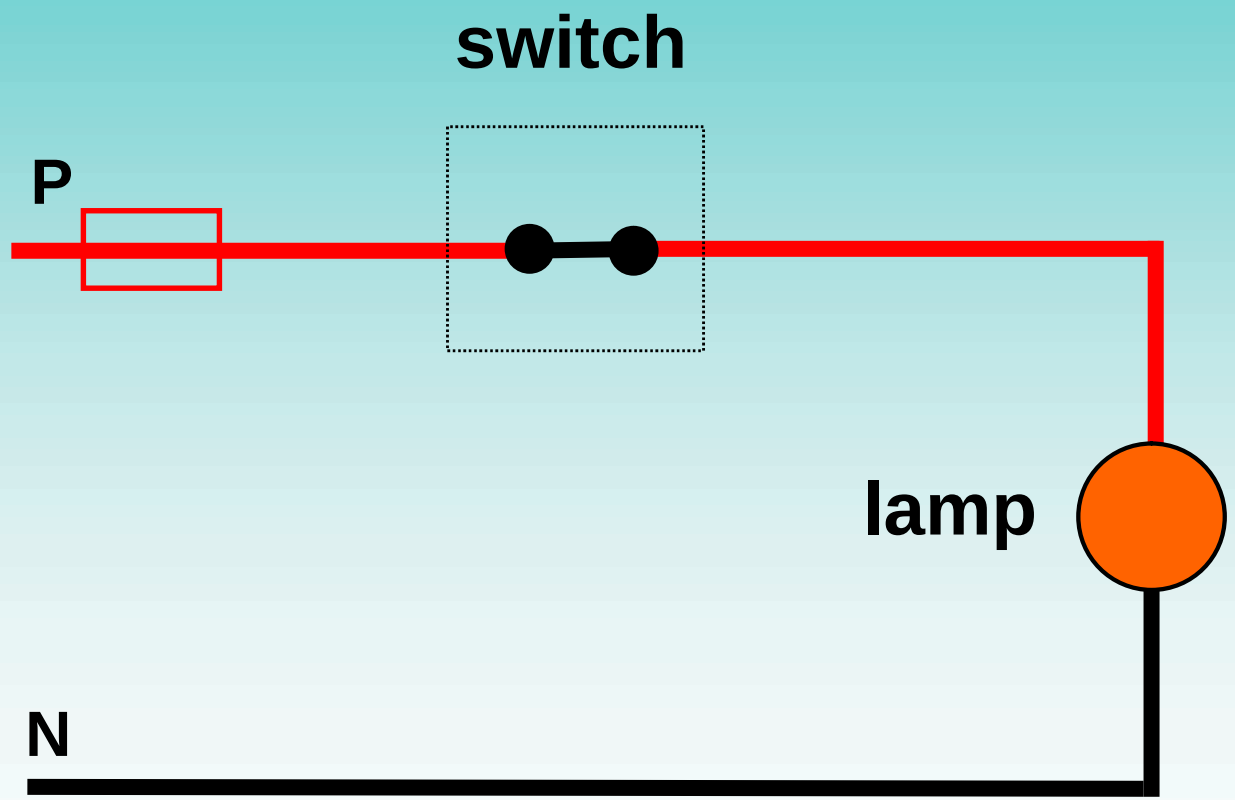
surface box secure

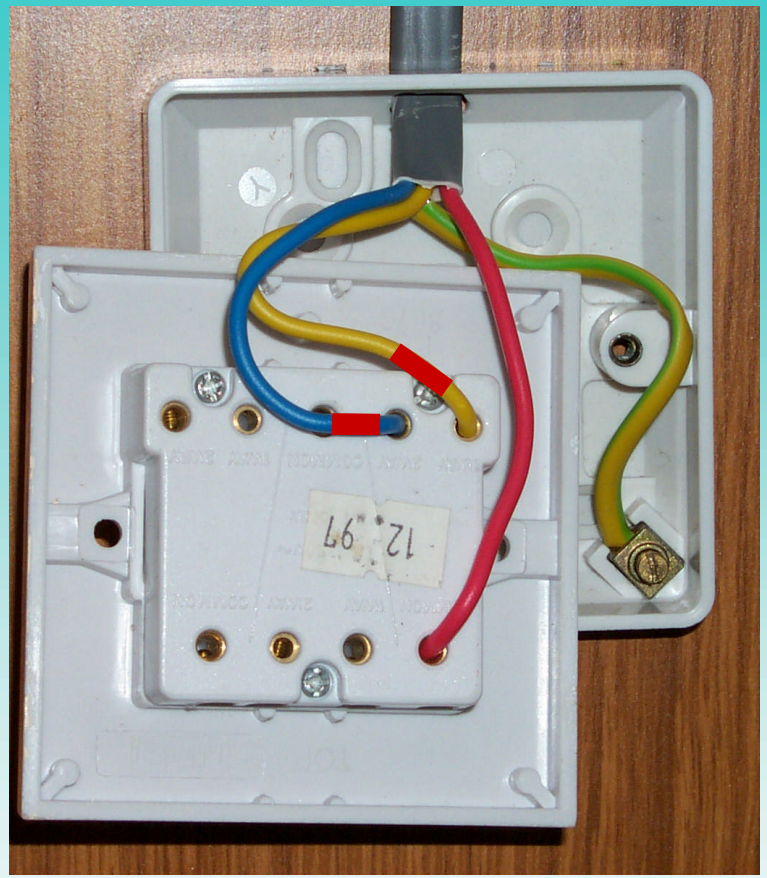
earth wire sleeved

terminations secure

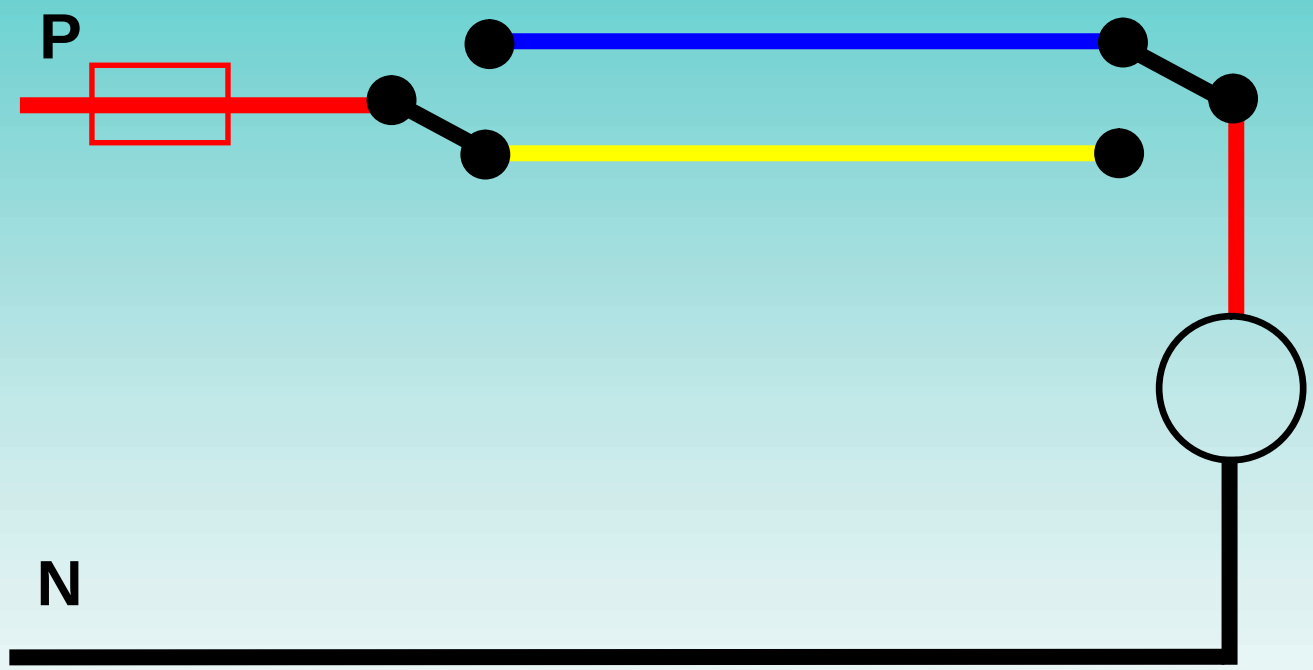
Basic one-way lighting circuit




switch
P
lamp
N



Switch connections for two-way lighting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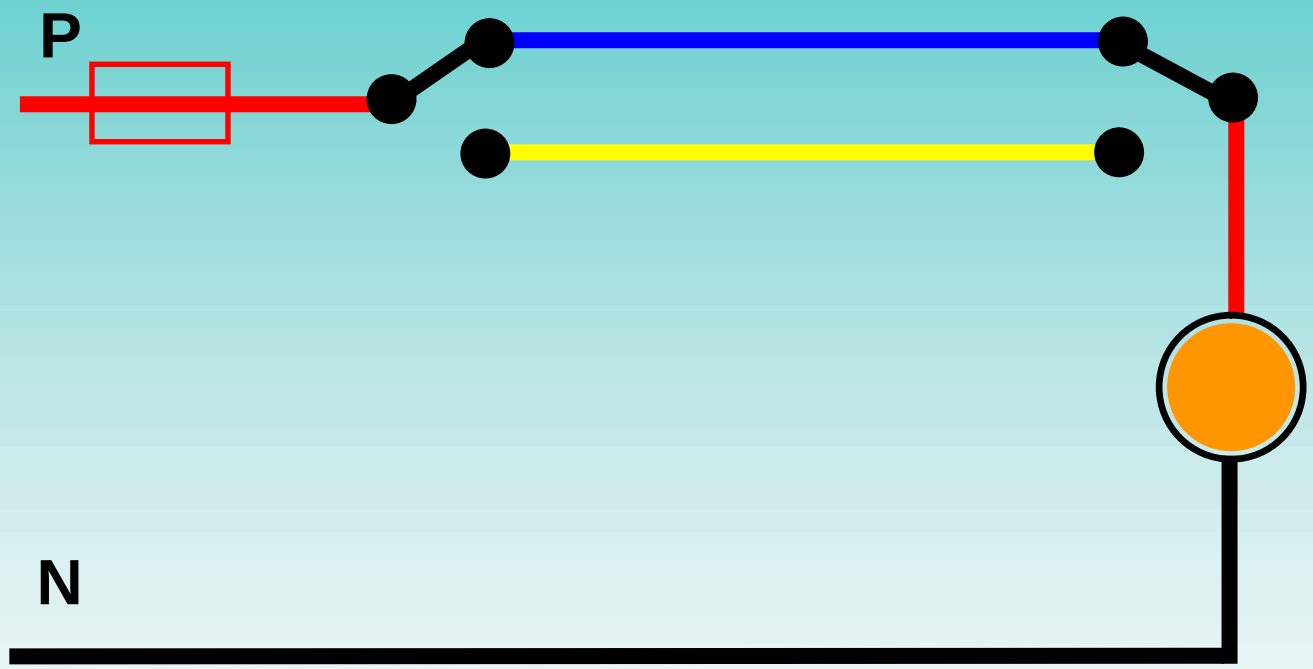
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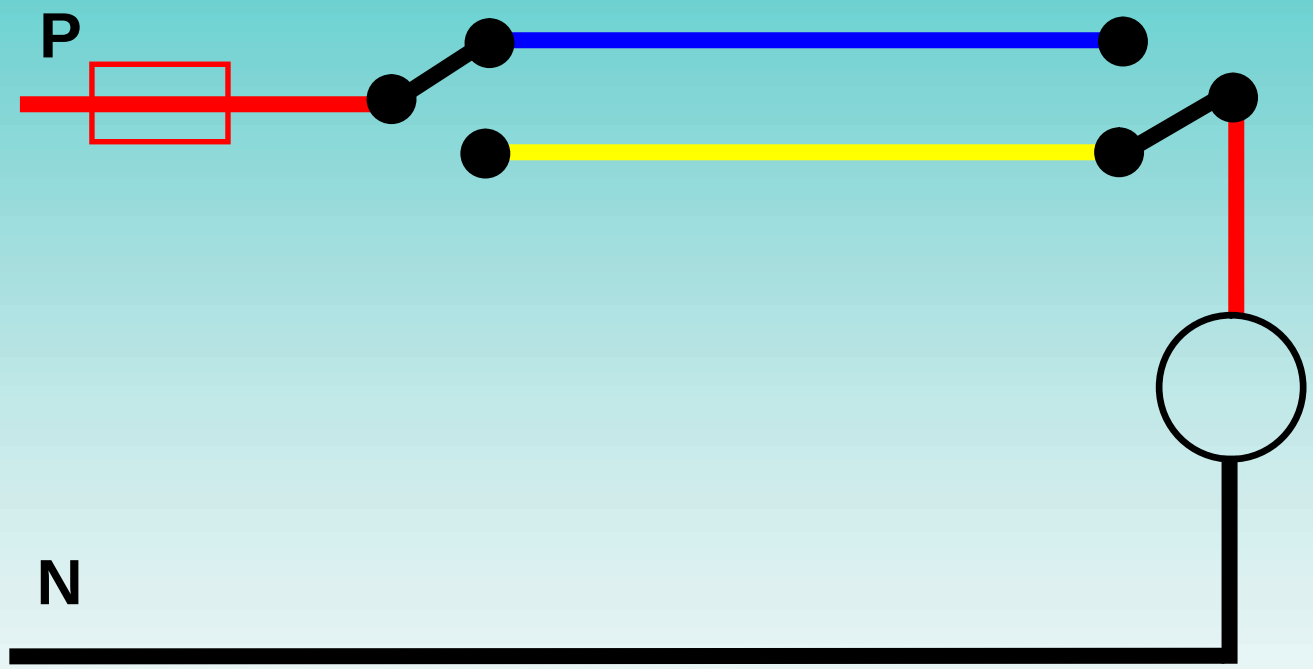
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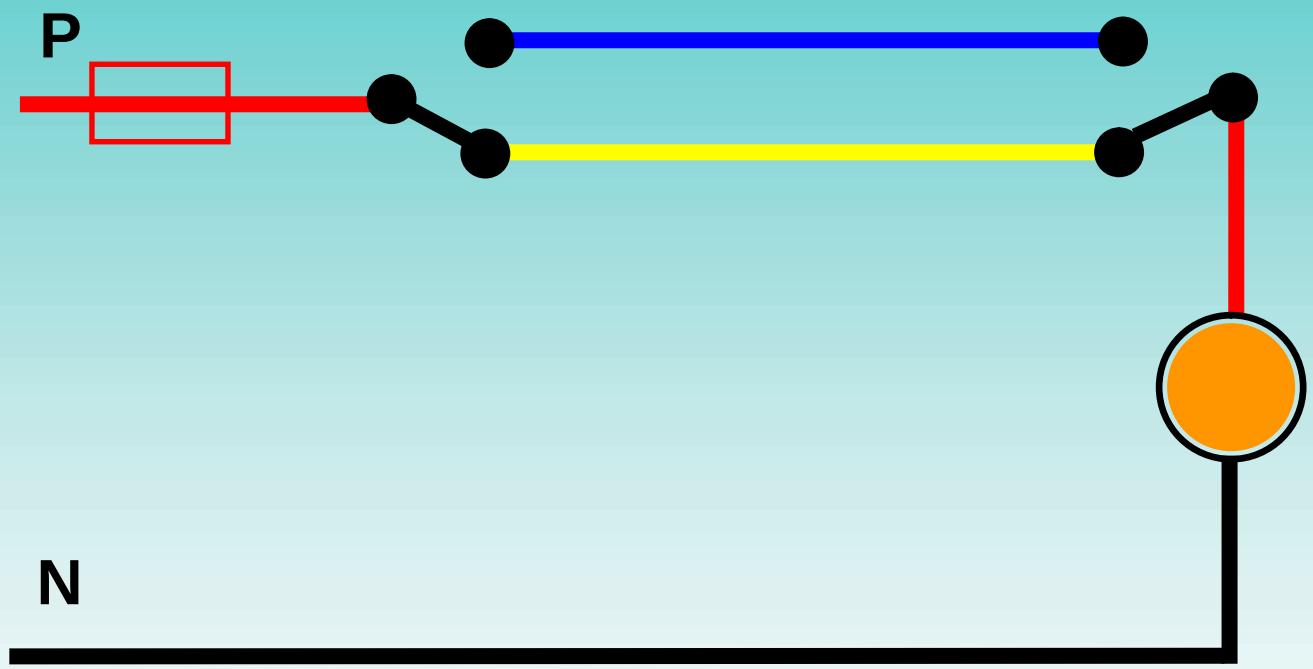
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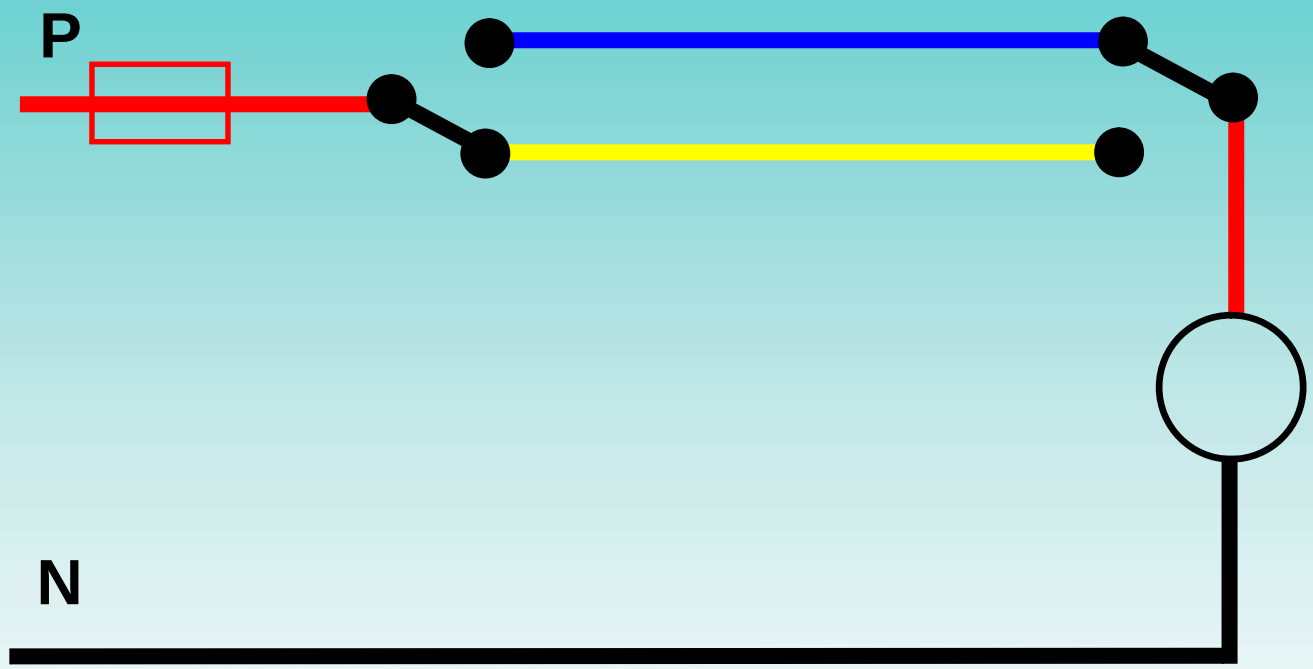
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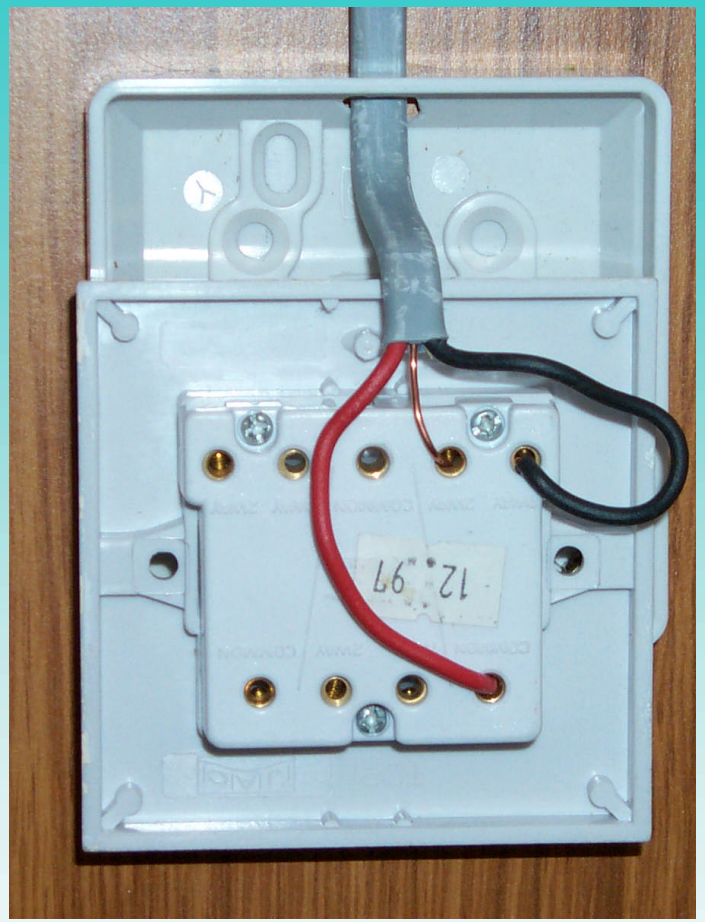


When converting one-way to two-way lighting the earth wire used as live conductor

Very dangerous practice

When installing socket outlets

- accessory secure
- correct amount of sheath
- terminations secure
- appropriate standard BS 1363
- correct cable size

Fuses and Circuit Breakers

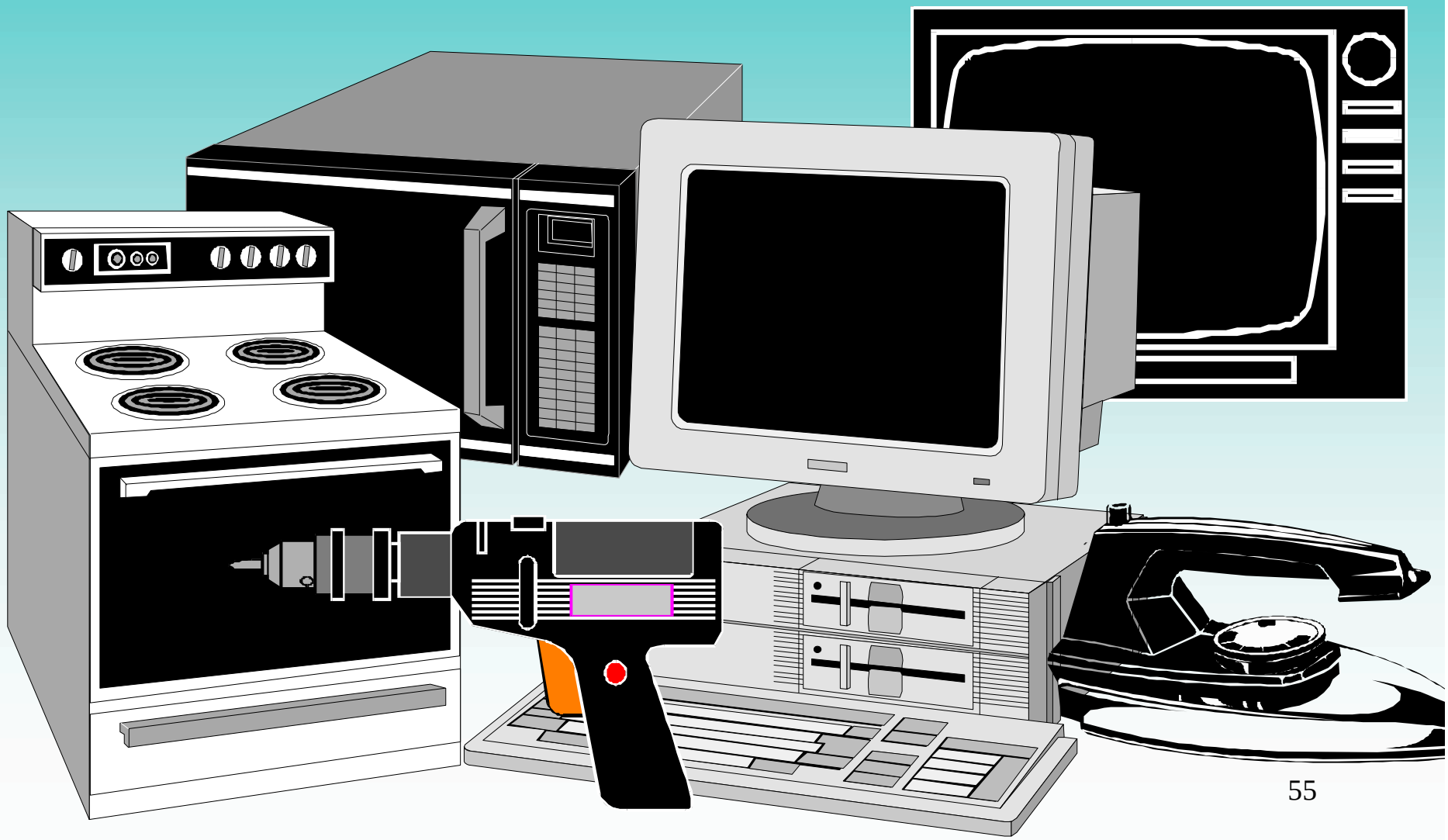
The purpose of a fuse or circuit breaker device is automatically to interrupt circuit current in the event of fault or overload conditions

Excessive current may flow as a result of:

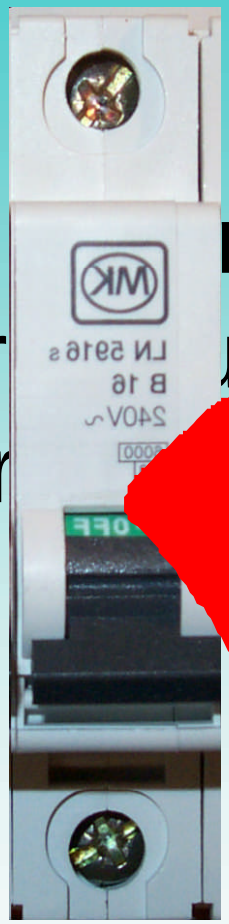
- overload (excessive connected load)
- short circuit between live and neutral
- earth fault (live or neutral to earth)

Overload

(excessive connected load)



Under normal circumstances the fuse or circuit breaker should operate before the circuit cables reach dangerously high temperature

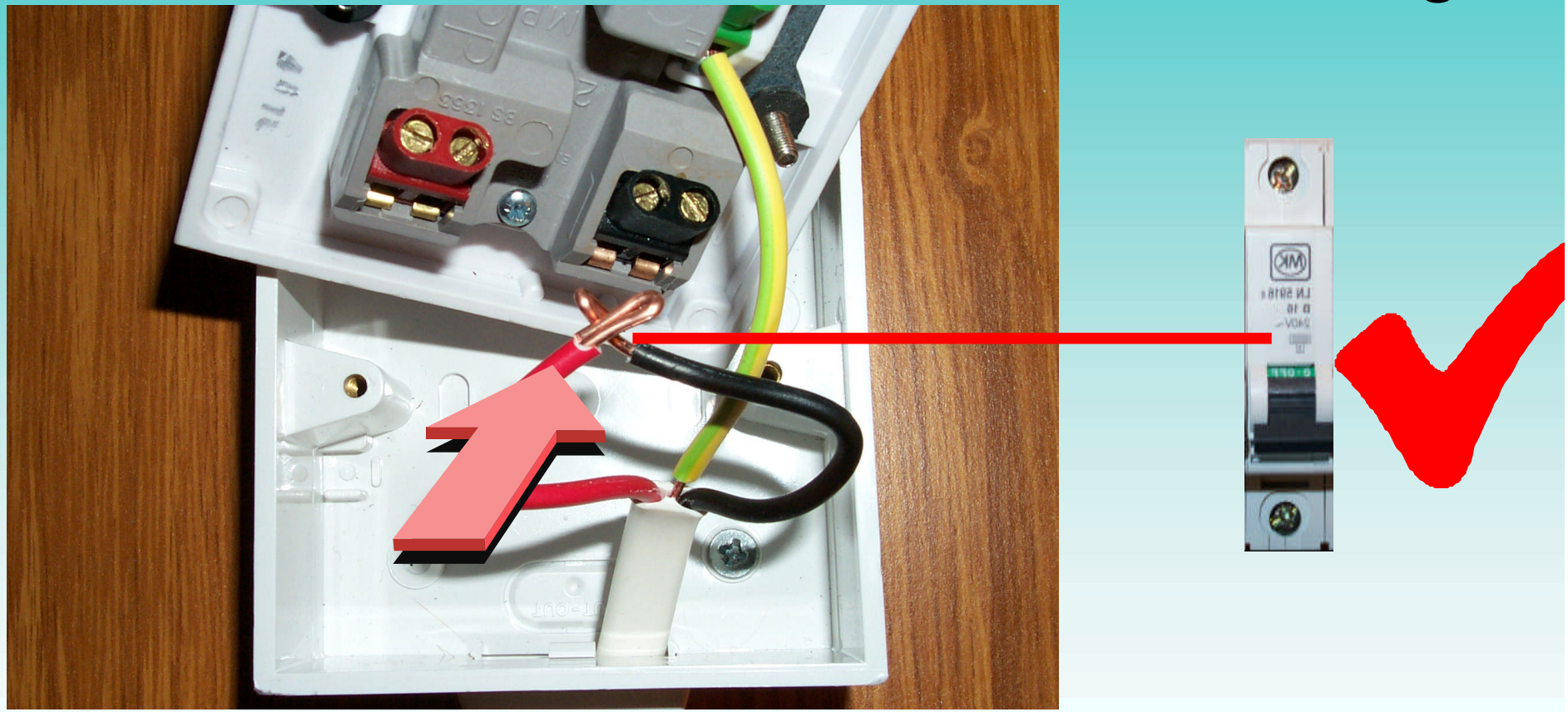


If the fuse or circuit breaker is to high for the circuit, the cables may reach a dangerously high temperature resulting in fire

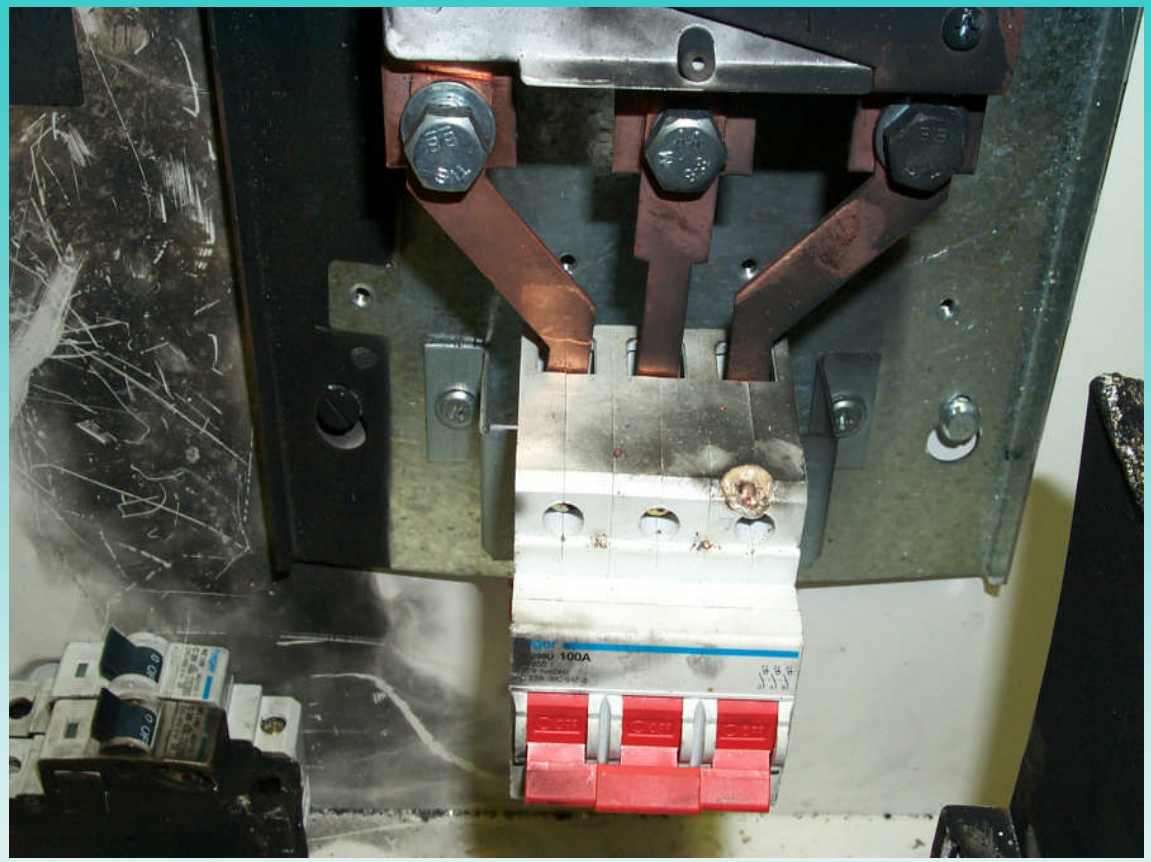
removing excessive load removes the problem

Short circuit

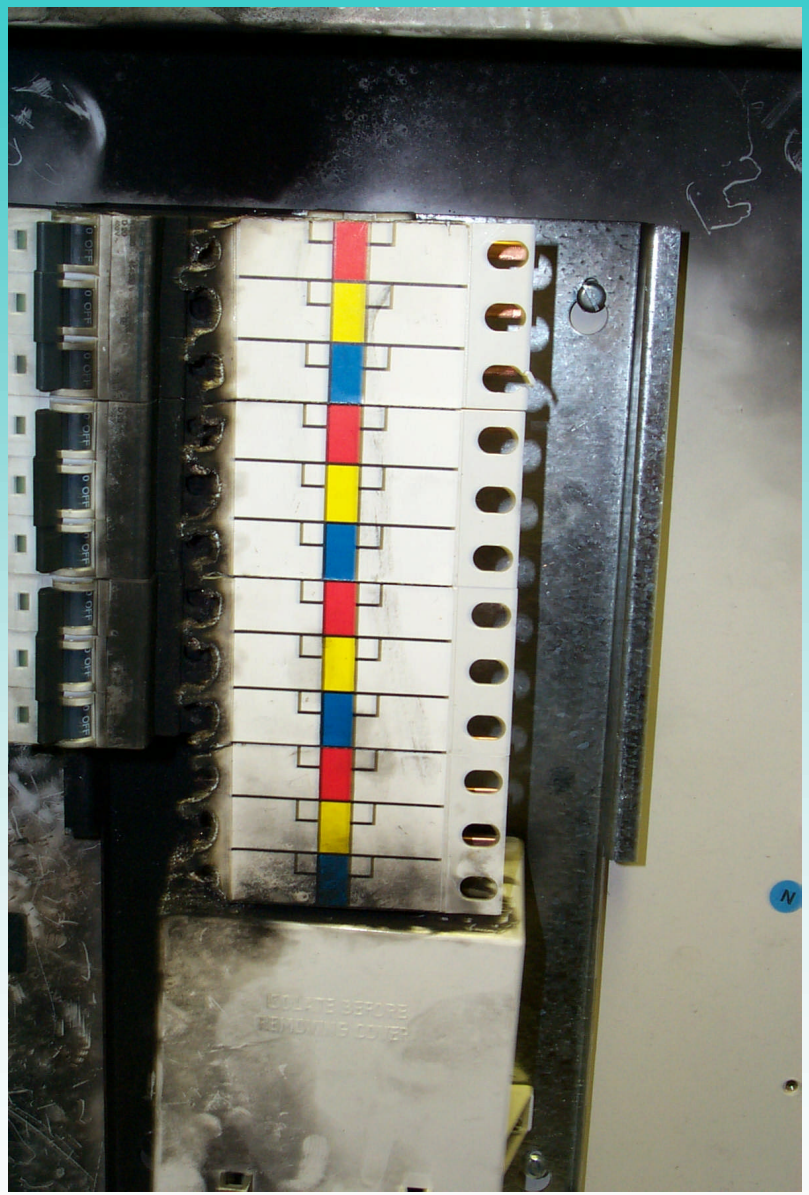
Phase and neutral conductors touching



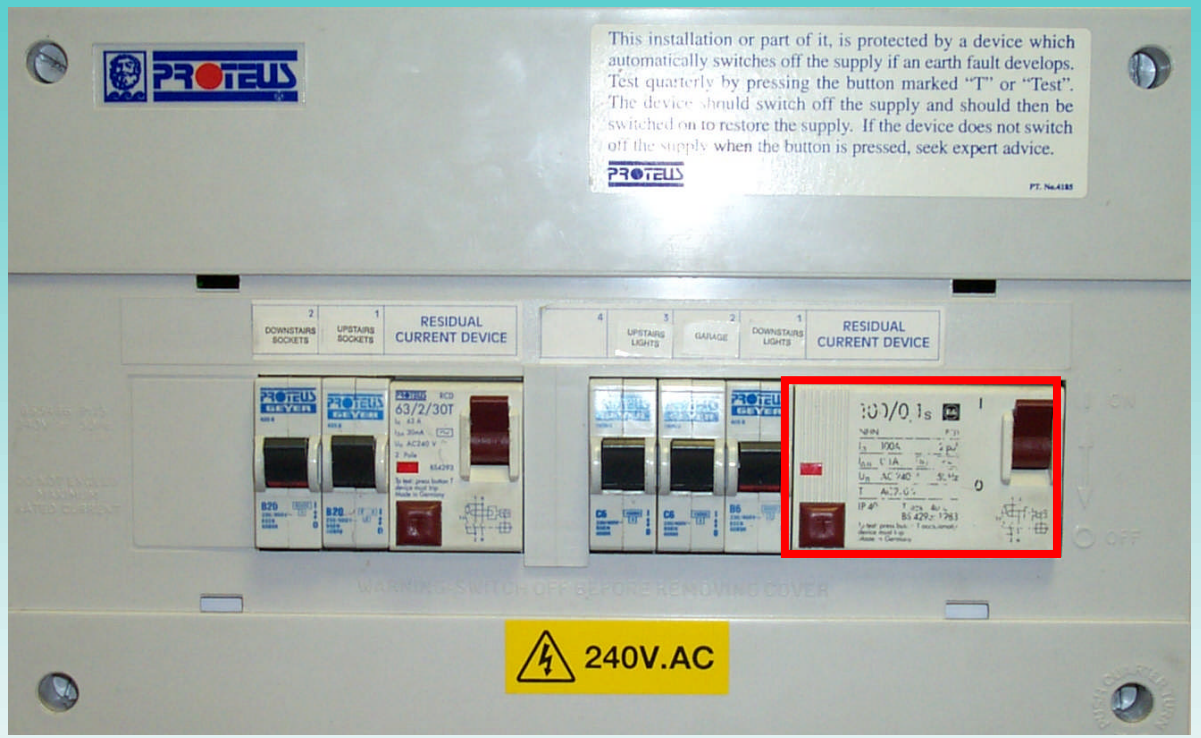
Large fault current flows - fuse or circuit breaker should operate



Result of electrician fitting circuit breaker to live board



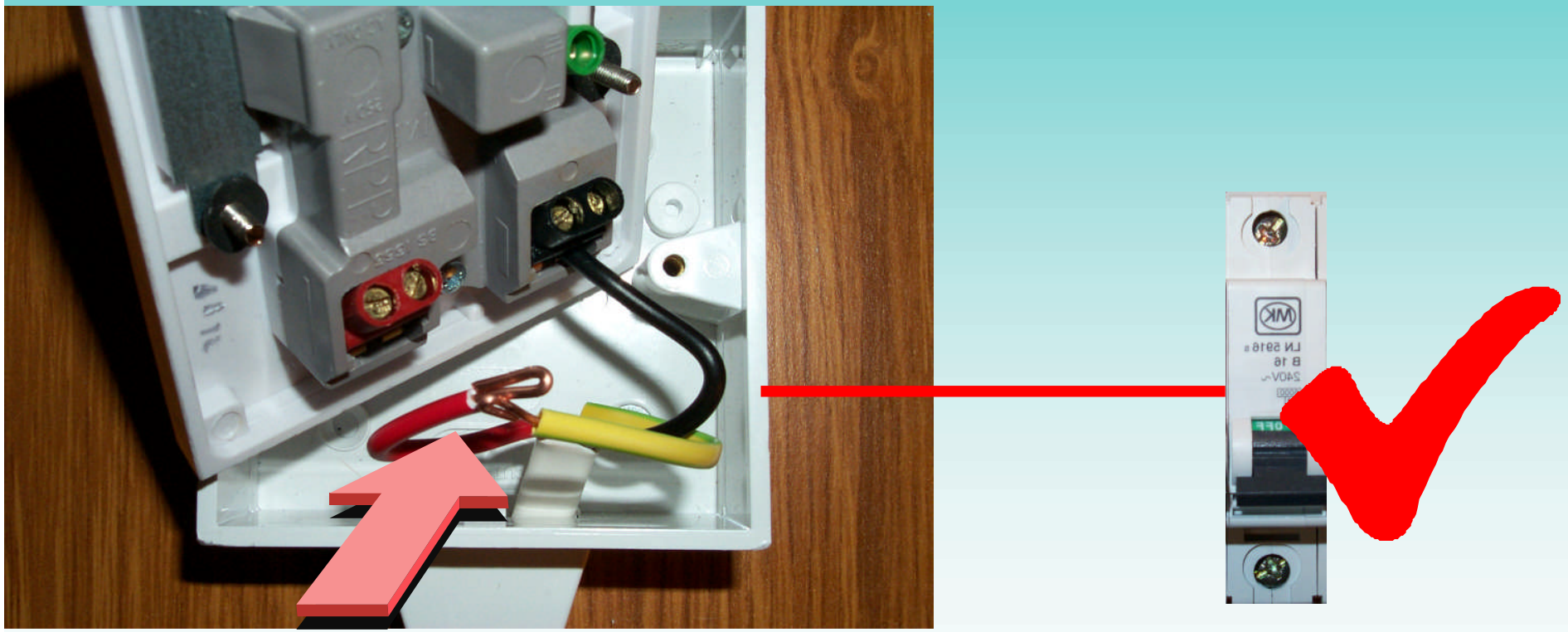
Combined main switch and r.c.d.



Least sensitive of the two devices and protects circuits feeding fixed equipment.

Earth fault

a fault condition that exists between live conductors and earth

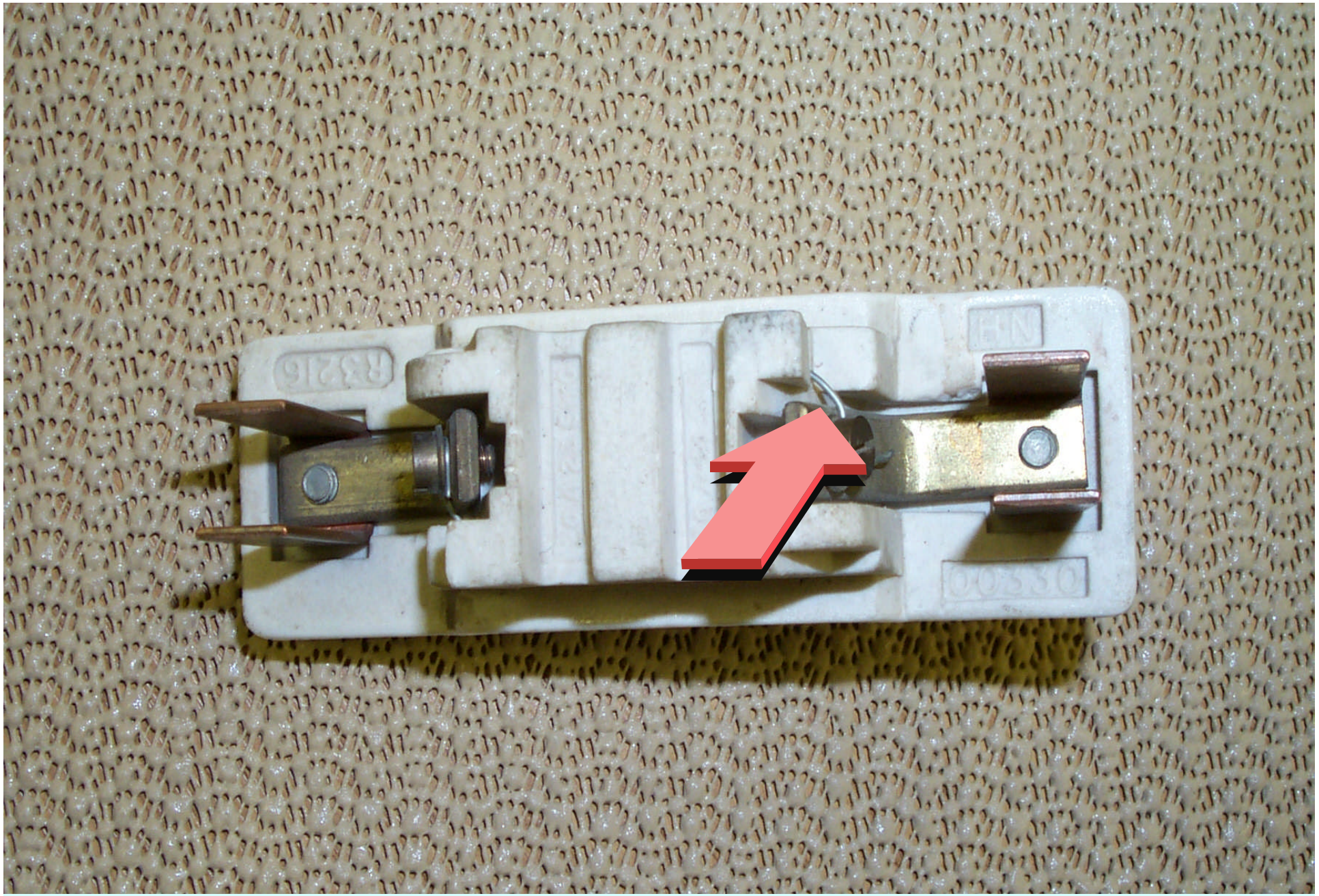


Excess current should cause fuse or circuit breaker to operate

rewirable fuse -
most widely abused

Most likely reason for device failing to operate

Incorrect size of element



fuse element too large

a fuse failing to operate under fault conditions may well result in fire

The Rewirable fuse is an antiquated device. even with the correct rating of fuse element it may not safely interrupt high levels of fault current

Cartridge fuses to BS 1361

- scattering of hot metal particles contained within cartridge thus reducing fire risk during operation
- operates much closer to its current rating when compared to the rewirable fuse

- has the ability to interrupt high levels of fault current
- less likelihood of premature failure due to oxidisation when compared to the rewirable


1
MAIN SW
2
SHOWER
3
DOWNSTAIRS SOCKETS
4
HEATER
5
DOWNSTAIRS LIGHTS
PROTEUS
GEYER
240/415 V
ON
B40
NFC05
5A
BS1361 FUSE CARRIER
NFC15
15A
NFC30
30A

Selection of fuses used in consumer units


PROTEUS
DOWNSTAIRS SOCKETS
UPSTAIRS SOCKETS
DOWNSTAIRS LIGHTS
RESIDUAL CURRENT DEVICE
or part of it, is protected by a device which
ches off the supply if an earth fault develops.
pressing the button marked "T" or "Test".
switch off the supply and should then be
ore the supply. If the device does not switch
n the button is pressed, seek expert advice.
MK
B 16
240V
6000
O-OFF

Circuit-breakers to BS EN 60898

- most widely used type of overcurrent protective device, particularly for domestic applications

Thermal-magnetic operation

- thermal - overload
- magnetic - short circuit conditions

Older ‘miniature’ circuit breakers to BS 3871

Circuit-breakers to BS EN 60898

rating (A)	application
3	bell transformers
6	lighting circuits
16	immersion heaters
20	13A socket radial
32	13A socket rings
32	13A socket radial
45	cooker/shower circuits

The Residual Current Device (r.c.d.)

Provides protection against earth faults in terms of:

- electric shock, and
- fire of an electric origin

Why bother with an r.c.d. when a fuse or circuit breaker can provide protection against earth fault conditions?

an r.c.d can operate in the region of milli-amps

in fact a r.c.d. rated at 30mA can provide protection against electrocution

fuses and circuit breakers require relatively high currents in order to operate

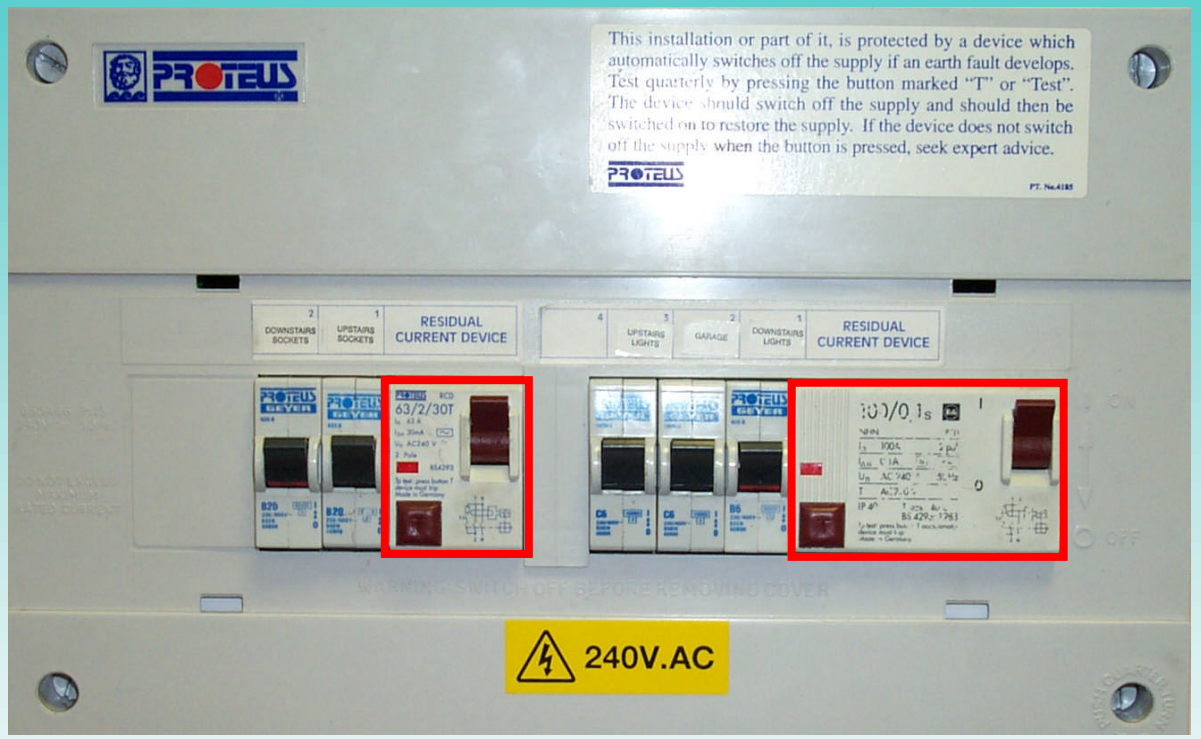
for example, for a 30A rewirable fuse requires approximately 200A to operate within a safe time period

Types of r.c.d.

Socket outlet incorporating r.c.d. protection

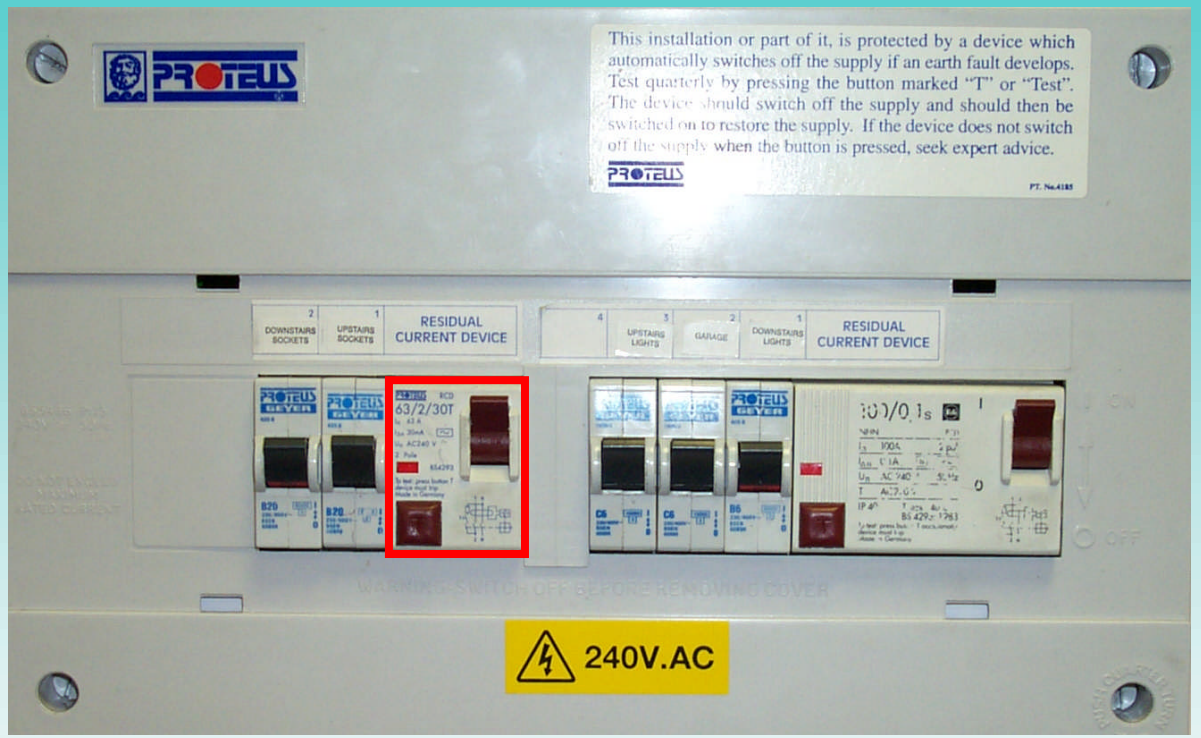
High level of personal protection against shock, particularly when using portable electrical equipment outdoors

Domestic consumer unit with two r.c.d.’s



Extensively used in conjunction with an earth electrode earthing system

Providing personal protection



Second r.c.d. has greater sensitivity and is used to protect socket outlet circuits

Combined r.c.d. circuit breaker (RCBO)

single device provides protection against both overload, short circuit and earth fault currents

Combined r.c.d. circuit breaker (RCBO)

An r.c.d. is a device which can provide protection against:

- fire resulting from earth faults
- earth faults where circuit resistance is too high for protection by conventional devices, i.e. circuit breakers or fuses
- where greater protection against electric shock, for example socket outlet circuits likely to supply portable equipment outdoors

fuses and circuit breakers are totally unable to provide this level of shock protection

The best thing since sliced bread

What rating of r.c.d. are generally available and where would they be used?

as a guide

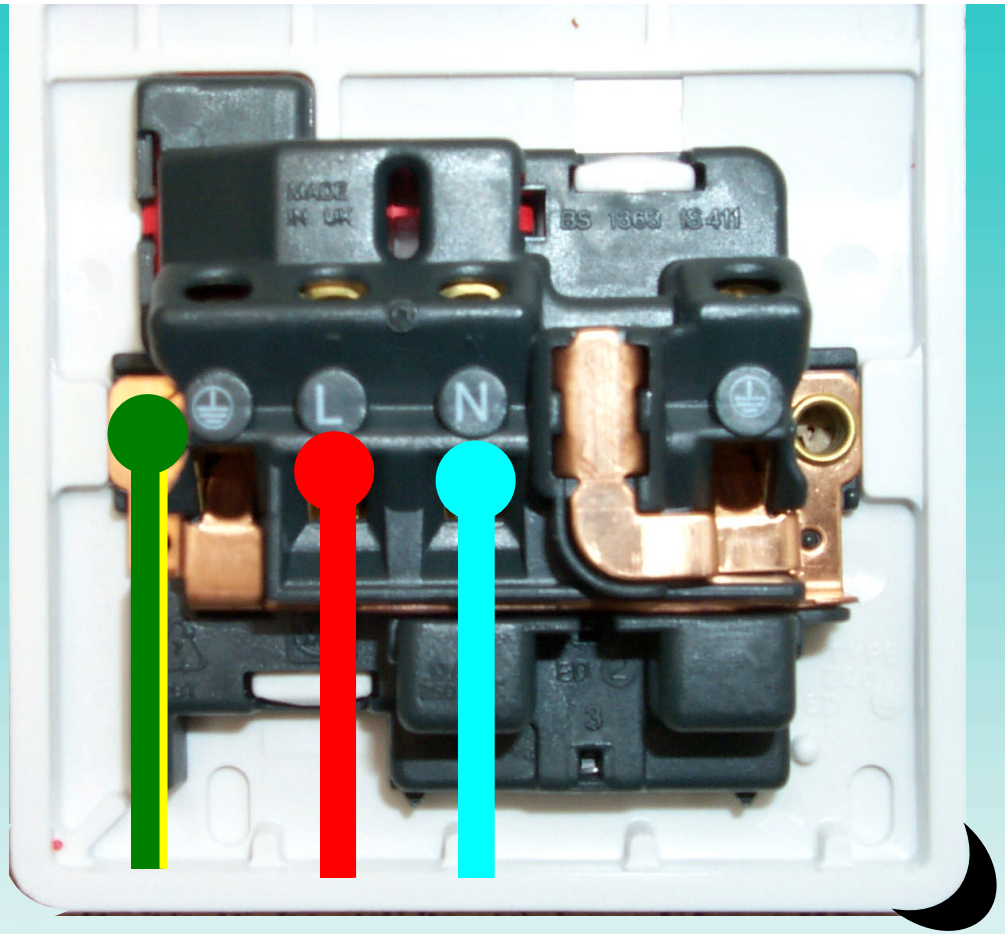
30mA for personal protection socket outlet circuits

100mA or above for protection against fire

verification of polarity

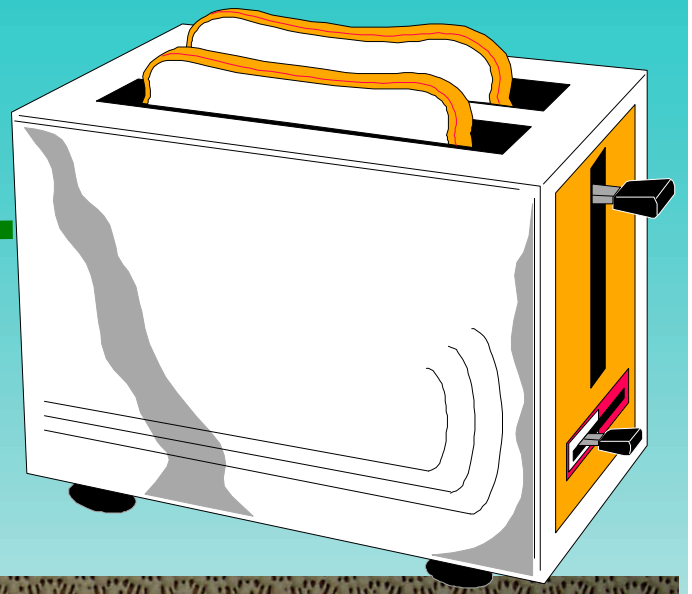
most importantly, at socket outlets

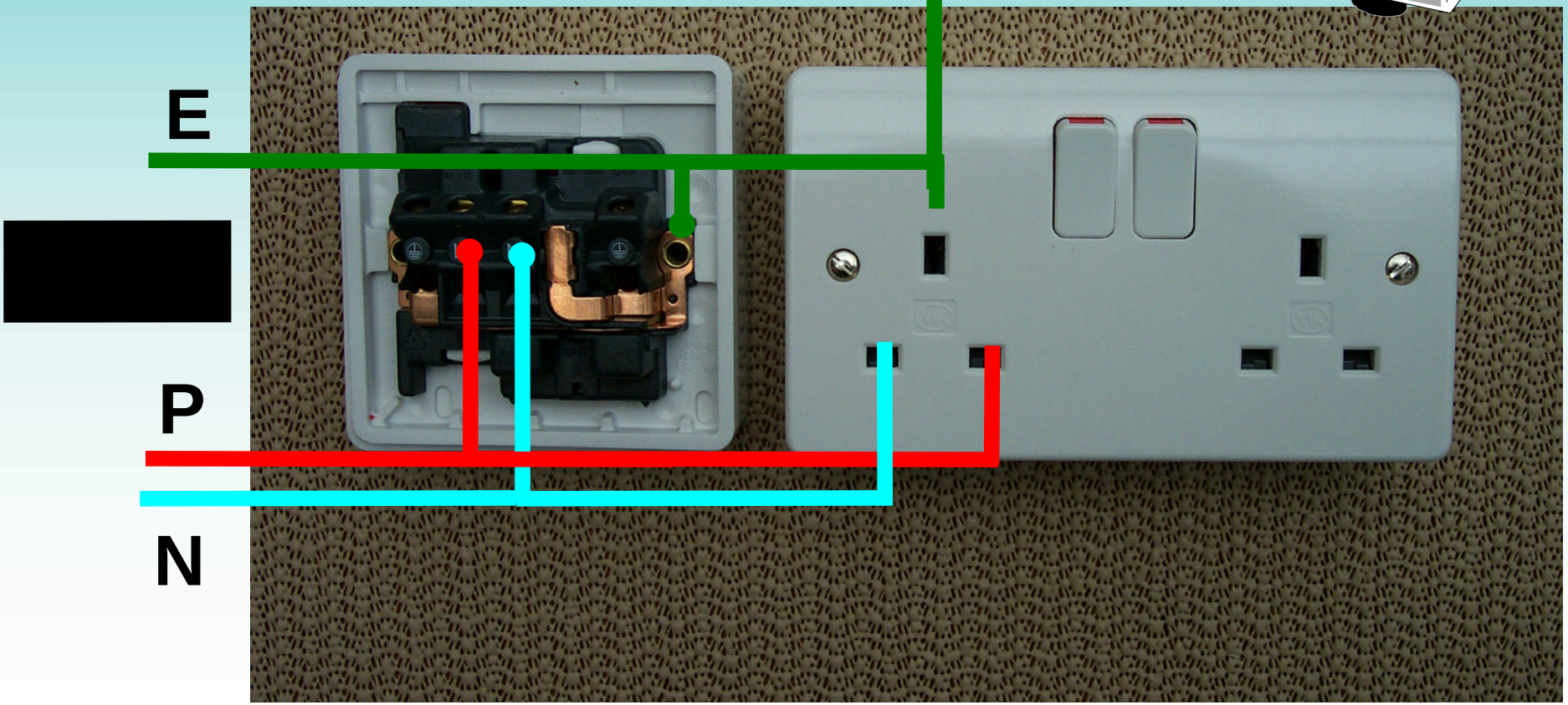
correct polarity is essential



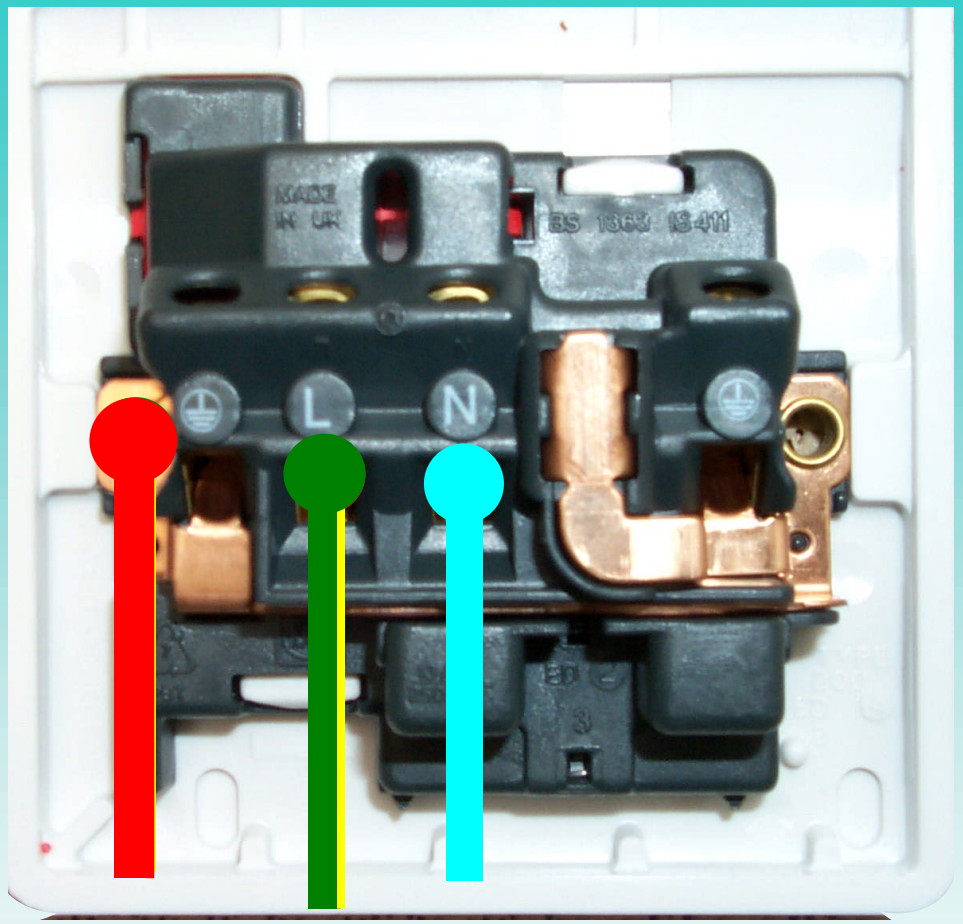
socket outlet correctly wired

the earth pin of the socket connects directly to the exposed metalwork of the appliance





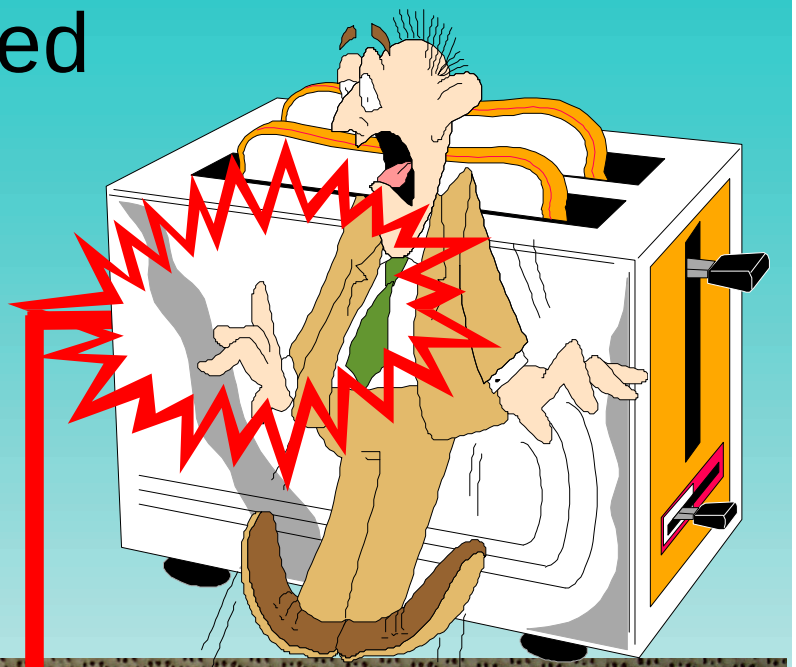
What happens when the phase and earth connections are reversed?

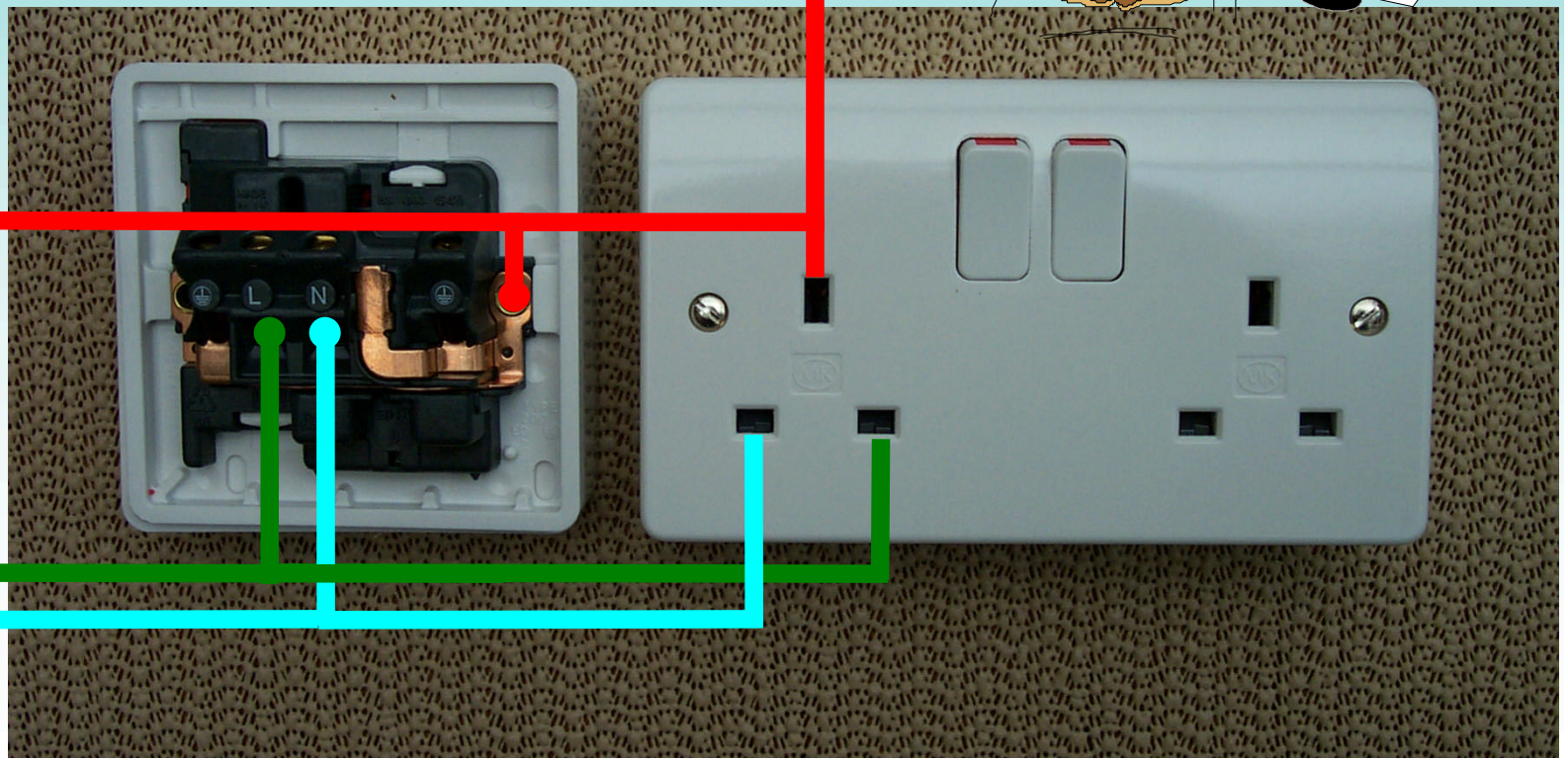


incorrect polarity can lead to death by electrocution

The phase and c.p.c. reversed

the phase conductor is directly connected to the exposed metalwork of the appliance



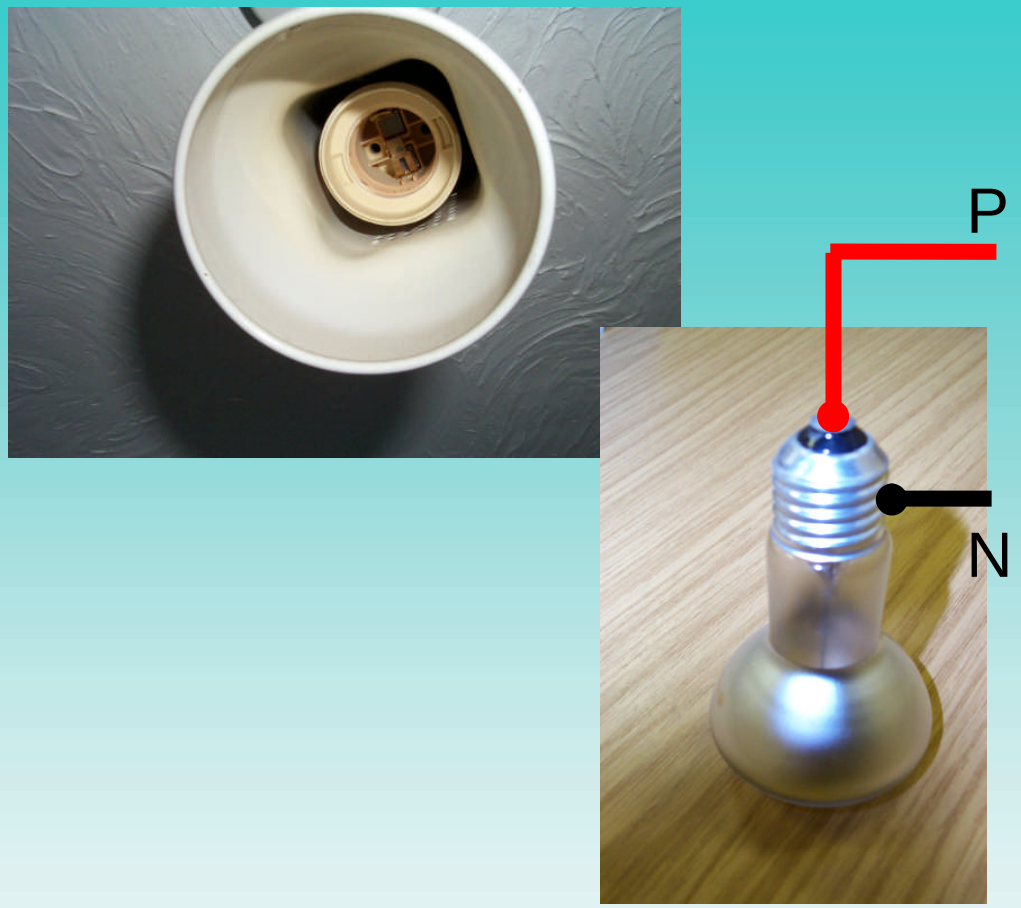


From supply

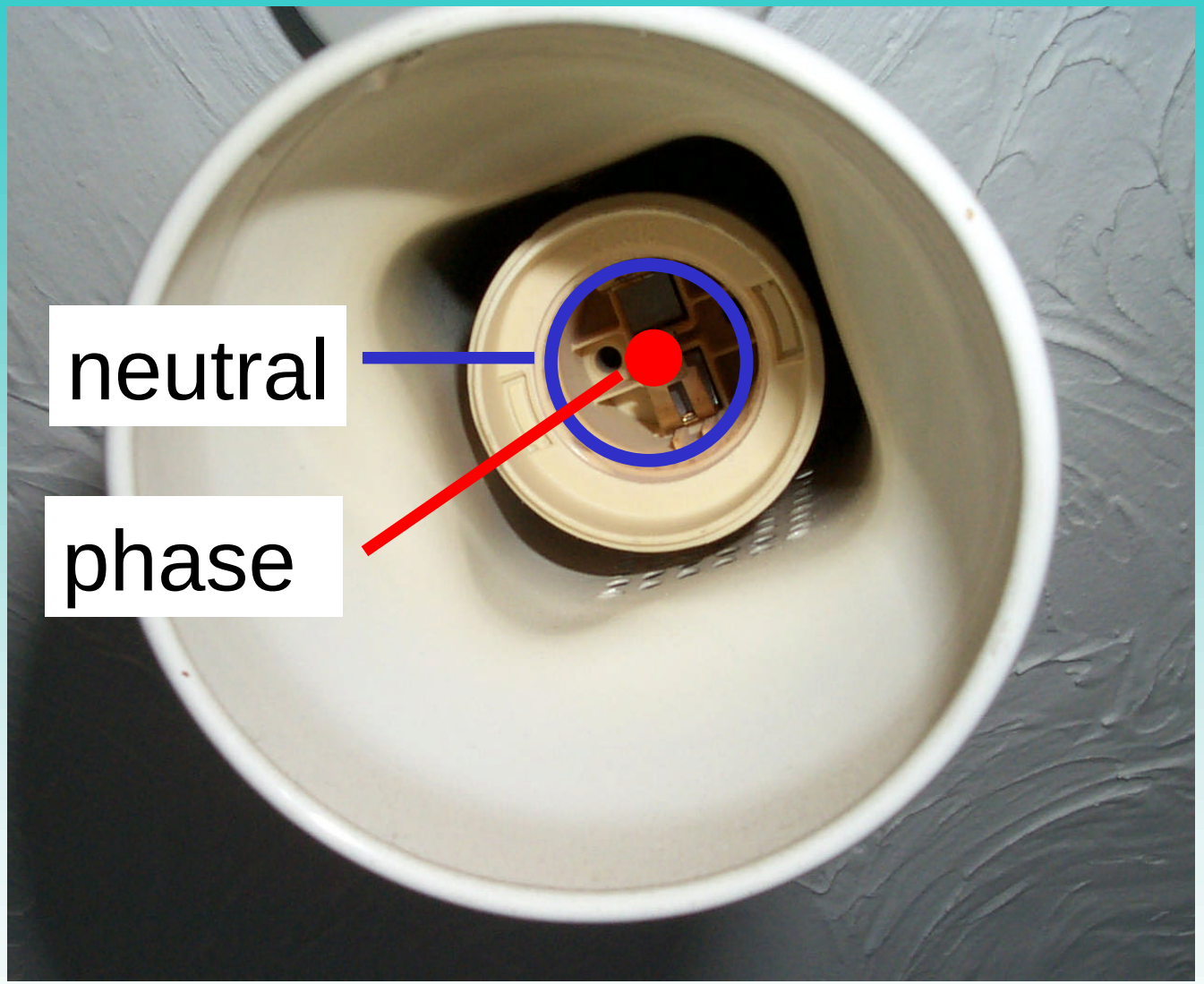
Correct polarity

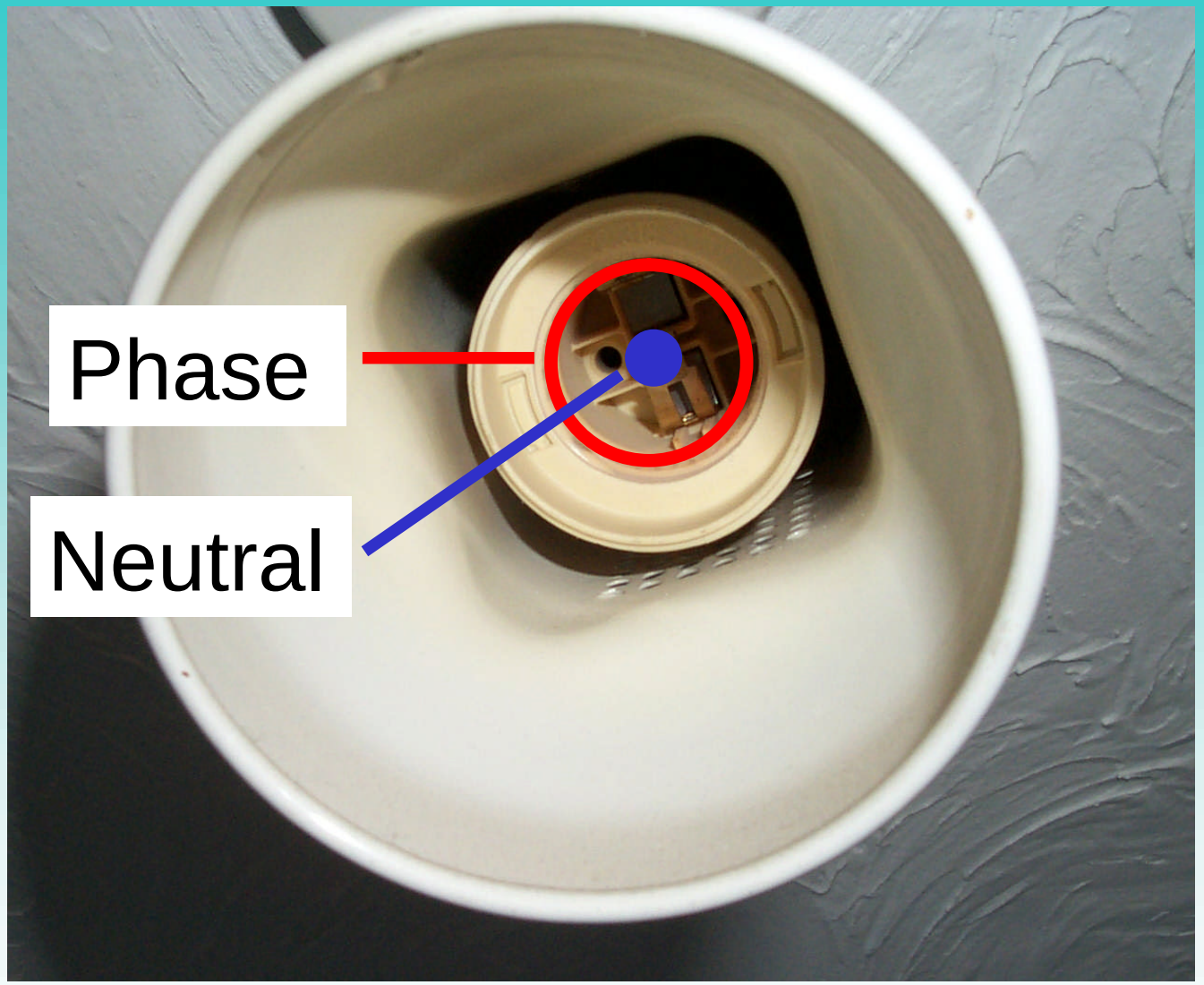
Edison-screw

Correct polarity of Edison-type screw fittings essential if shock is to be avoided



Centre contact must always be connected to the phase conductor of the supply


neutral
phase



Phase and neutral connections reversed

Reversed polarity

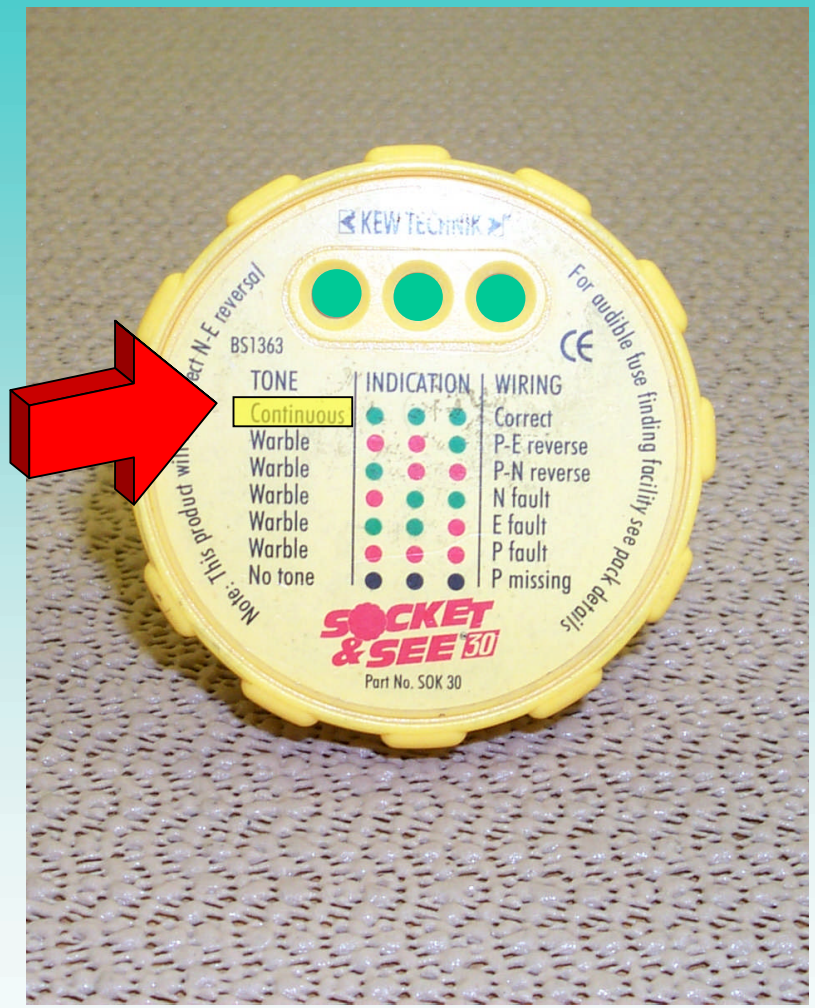
A person removing an Edison-screw lamp could receive a serious electric shock if they touched the lamp thread before it had completely been removed from the fitting

Verification of polarity can be quite a complex affair and generally only undertaken by competent persons

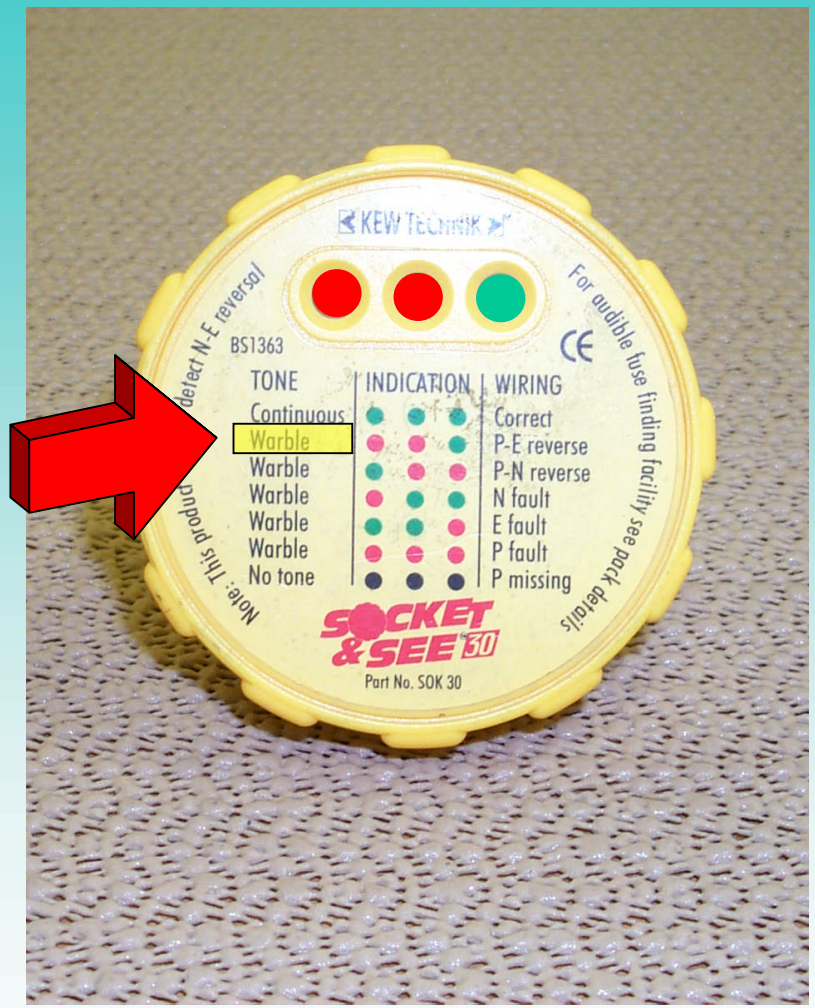
However! If common sense is applied rudimentary testing may be undertaken at socket outlets by using a socket tester

The socket tester

useful but limited in its application



All lights green indicates correct polarity



red - red -green indicates P-E reversed

worst possible condition

The socket tester will INDICATE

THE PRESENCE OF SUPPLY

IDNETIFY THE CORRECT POLARITY OF THE PHASE CONDUCTOR

THAT SOME FORM OF EARTH CONNECTION IS PRESENT AT THE SOCKET OUTLET

The socket tester will NOT INDICATE

A HIGH RESISTANCE EARTH PATH

A REVERSED NEUTRAL EARTH CONNECTION

AND ABOVE ALL

NEVER USE A SOCKET TESTER TO PROVE THAT A CIRCUIT IS ISOLATED, (dead).

Earthing

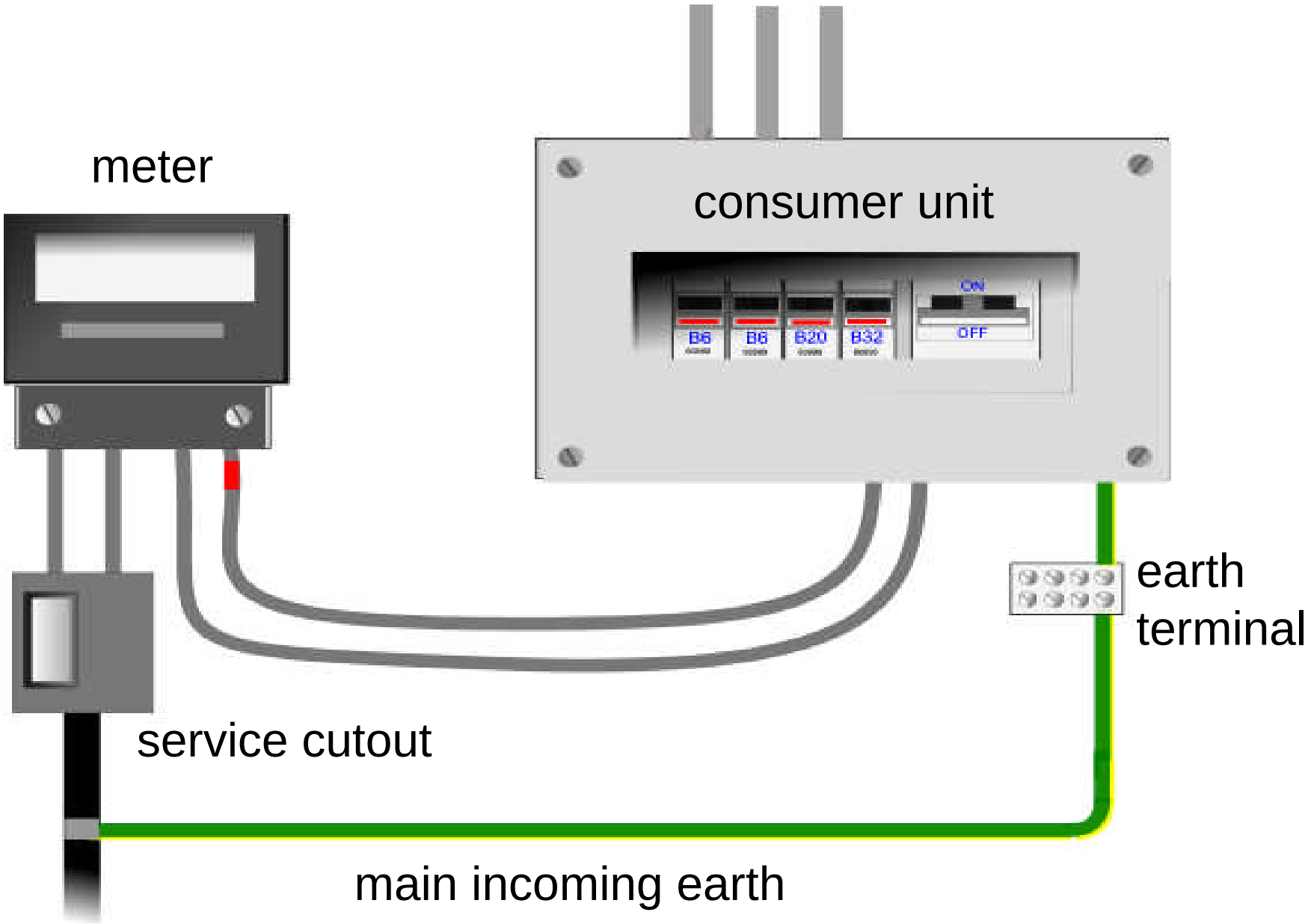
In order to prevent electric shock the exposed metalwork of electrical appliances, metal conduit etc should be earthed.

In the majority of cases the earthing facility is provided by the local electricity supplier.

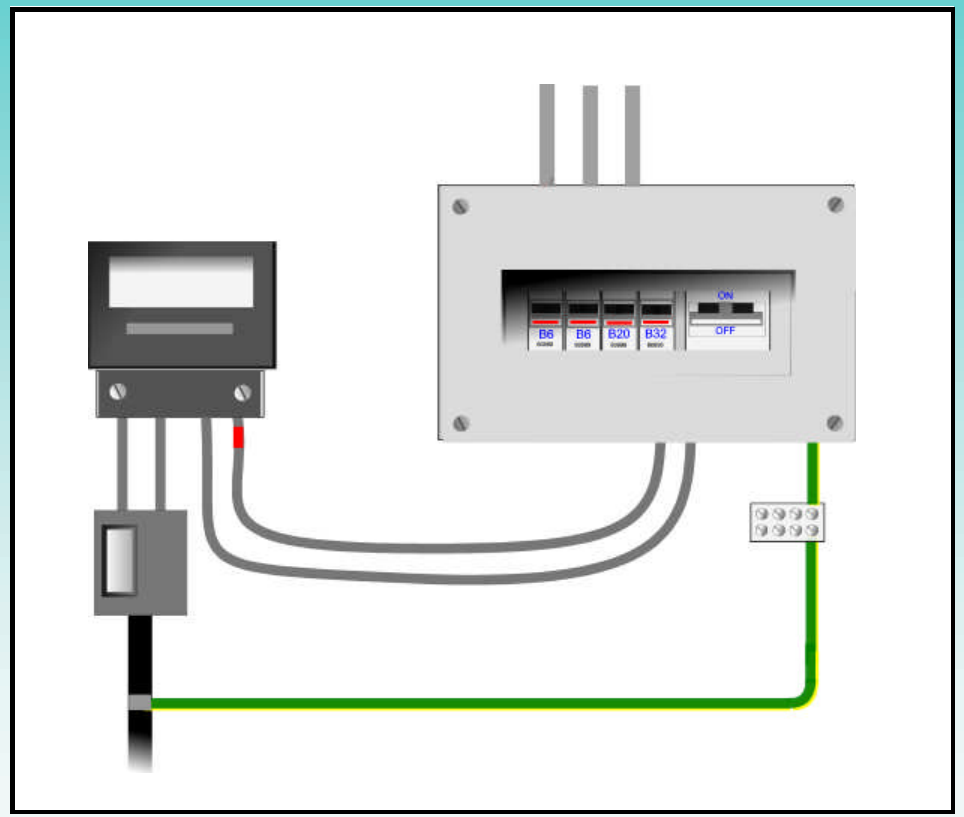
Inadequate earthing arrangements may lead to electric shock or death through electrocution

Earthing arrangements

Typical domestic intake

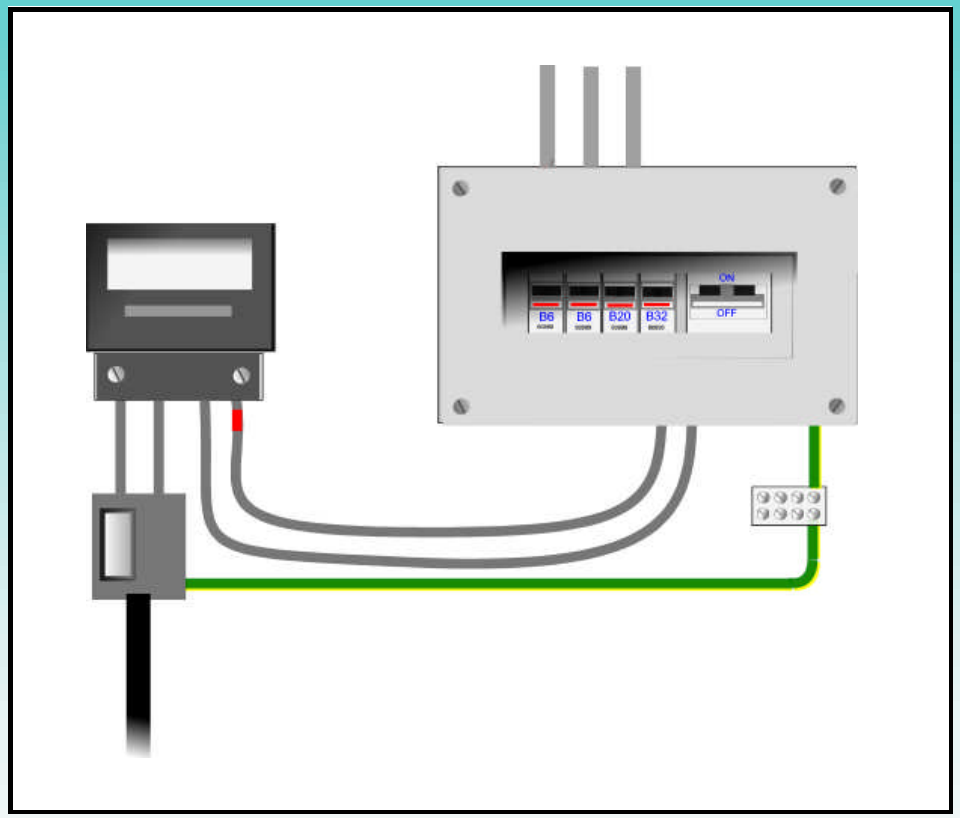


Earth connection is obtained from suppliers sheath (main incoming cable)



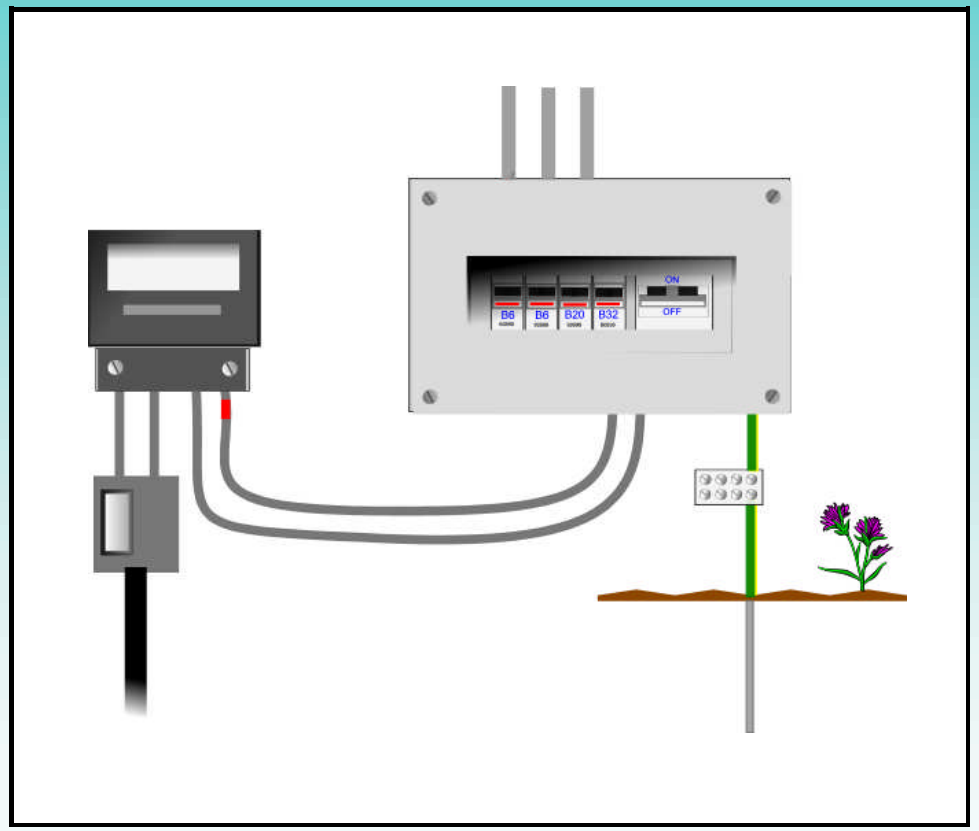
This method of earthing is still widely used and is reliable

Modern earthing arrangement where the earth is connected to the incoming neutral at the service head



Rapidly becoming the most widely used supply arrangement

Widely used in agricultural/rural areas.
Earthing relies on earth electrode (rod/spike)



Gradually being phased out wherever possible

Earth rod and typical enclosure

Problems with earth electrodes

- generally does not provide a very good earth return path

- liable to corrosion and mechanical damage