

Technology and Environment 1

INTRODUCTION TO BUILDING SERVICES FOR DOMESTIC APPLICATIONS

Learning Outcomes

Aim

- Briefly introduce the concept of building services for low rise domestic buildings.
- Cold water services
- Hot water services
- Heating installations
- Electrical installations
- Soil and waste drainage

Learning objectives

- Enable students to recognise systems and equipment commonly used. Understand the design requirements for services.

BUILDING SERVICES

- Architecture has developed from the earliest times to meet the needs of local geography and climate.
- Manipulation of the building form and fabric cannot always provide all-year round comfort conditions and cannot provide other basic needs.
- It cannot supply water or remove waste.
- Hence the need for building services.

BUILDING SERVICES

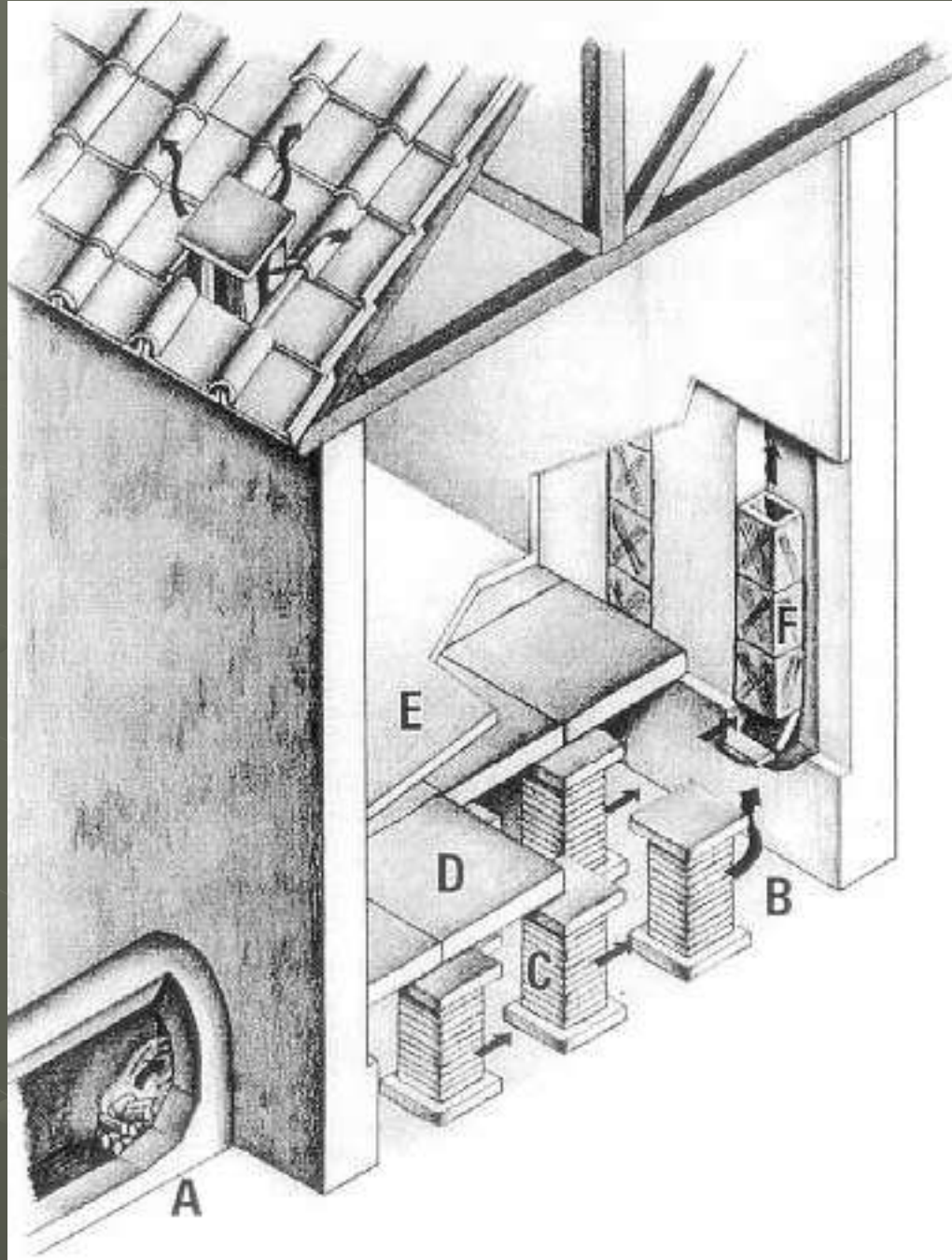
● *HISTORY*

- The first 'civilizations' succeeded in providing reliable means of water supply storage and distribution – not so successful with sanitation.
- Roman colonisation of Central and Western Europe brought a degree of sophistication to Heating and Ventilation.

ROMANS

● *Hypocaust*

- Method of underfloor heating that remained in use for about 500 years



1:2

Fragment of box-shaped tile from central Canterbury.
The pattern and initials of the tile maker have been applied with a roller.
The 'X' means a full stop.

- | | |
|--|---------------------------|
| A Furnace | D Bridging tiles |
| B Under floor chamber | E Floor of room |
| C Columns of tiles supporting floor | F Box-shaped tiles |



ROMANS

● AQUADUCT

- *"This bridge, over the river Gard, is 275 metres (900 feet) long and 49 metres (160 feet) high. It was part of an aqueduct nearly 50 kilometres (30 miles) long which supplied Nîmes with water. On its first level it carries a road and at the top of the third level, a water conduit, which is 1.8 metres (6 feet) high and 1.2 metres (4 feet) wide and has a gradient of 0.4 per cent. The three levels were built in dressed stone without mortar. The projecting blocks supported the scaffolding during construction."*
- *— John Julius Norwich. The World Atlas of Architecture. p154.*



OTHER DEVELOPMENTS

- The Romans used the *brazier*.
- Masonry *stoves* developed in the 9th Century.
- The Normans introduced the *simple fireplace* and the development of the chimney dates from about the 11th Century.
- Metal *stoves* date from the 15th Century.

OTHER DEVELOPMENTS

- 1745 *steam heating* proposed by Captain William Cook and used by James Watt in 1784.
- Successful hot water dates from the early 18th Century with a high pressure system introduced by Perkins in 1831.
- Early room heating used 4 inch cast or wrought iron pipe.
- Tasker in the USA devised a sectional radiator in 1858 while the more recognisable forerunner of today's type came some 20 years later.

The background is a dark gray gradient. Overlaid on this is a pattern of thin, light gray lines that form a grid of squares. At each intersection of these lines, there is a small, dark gray, three-dimensional-looking dot. The grid and dots extend across the entire frame, creating a sense of depth and perspective.

THE MODERN HOME

THE MODERN HOME

Its accommodation and services

- DESIGN - all homes must be provided with adequate accommodation and services
- All homes should be provided with the following accommodation and services, some of which may also be required by Building Regulations or other legislation

THE MODERN HOME –its accommodation and services

- Space for living, dining and sleeping
- A kitchen area.
- Space or provision for general storage.
- A room or rooms containing a wc, a wash hand basin and a bath or shower.
- Space or provision for the storage of clothes, linen and bedding.
- Hot and cold water services including the provision of water for drinking.
- A means of providing heating.
- Services outlets for:
 - Cooking
 - Lighting
 - Domestic appliances
 - Television equipment
- Sound insulation to reduce noise between rooms and wc's and soil pipes.
- Access to main roof space and water services within pitched roof spaces.
- Security and safety measures e.g. fire and intruder alarms.
- Provision for the reception of mail.
- Access from the highway to the home and garage or car parking.
- A space for the storage of household waste.



GROUND FLOOR



FIRST FLOOR

KEY

w : washing machine
d : tumble dryer
f : freezer space
dw : dishwasher

rf : refrigerator
ov : oven
h : hob

▲ single switched socket outlet
▲ double switched socket outlet
▲ telephone outlet

○ ceiling lighting
△ TV aerial outlet

ACCOMMODATION PROVIDED

Ground Floor

Living room	5.9m x 3.9m	(19'5" x 12'10")
Dining room	3.9m x 2.9m	(12'10" x 9'7")
Kitchen	3.5m x 2.8m	(11'6" x 9'3")
Utility room	3.5m x 2.0m	(11'6" x 6'7")
Cloakroom	2.1m x 1.0m	(6'11" x 3'4")

First Floor

Bedroom1 (exc. bay)	4.0m x 3.9m	(13'2" x 12'10")
Bedroom 2	3.9m x 3.7m	(12'10" x 12'2")
Bedroom 3	3.5m x 2.8m	(11'6" x 9'3")
Bathroom 1	2.7m x 1.7m	(8'11" x 5'7")
Bathroom 2	2.6m x 1.6m	(8'7" x 5'3")

These dimensions are accurate to within ± 50 mm. They are not intended to be used for carpet sizes, appliances spaces or items of furniture.







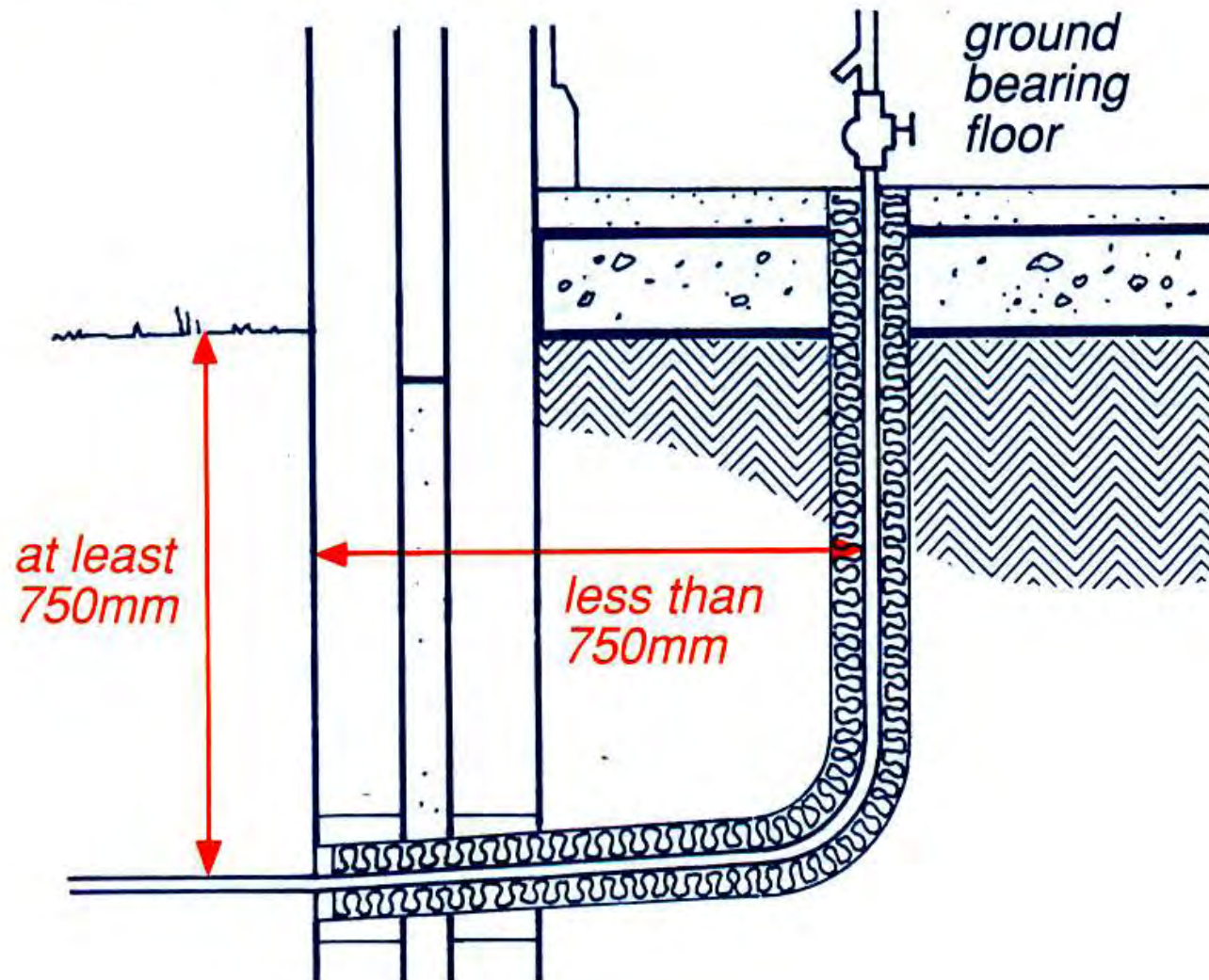
COLD WATER SUPPLY

- A plentiful supply of '**wholesome**' water is essential for the occupants of buildings.
- Most buildings supplied by water companies **utility** mains.
- In some rural areas it is sometimes necessary to obtain water from private sources such as streams, rivers, lakes, wells etc..
- In such instances consultation with private firms is advisable and suitability of the source checked with the local public health department.

COLD WATER SUPPLY

- Connection to the water mains – 7 days notice in writing.
- Mains are tapped under pressure by means of a special apparatus.
- Water company attaches a screw-down cock into the crown of the main and run a pipe to the boundary of the building where a stop vale is fitted.
- Pipework must enter the house 750mm below ground level and rise away from external walls.

If the incoming service pipe rises vertically within 750mm of the external wall and the floor is a ground bearing slab, the incoming water pipe should be insulated within the underfloor duct.



COLD WATER SUPPLY

- Water Hardness and Softness
- Generally surface waters are '**soft**' and subterranean waters '**hard**'.
- Hardness – when water is difficult to lather with soap due to passing through strata containing calcium and magnesium salts.
- Can cause scaling or furring in hot water pipes and boilers.

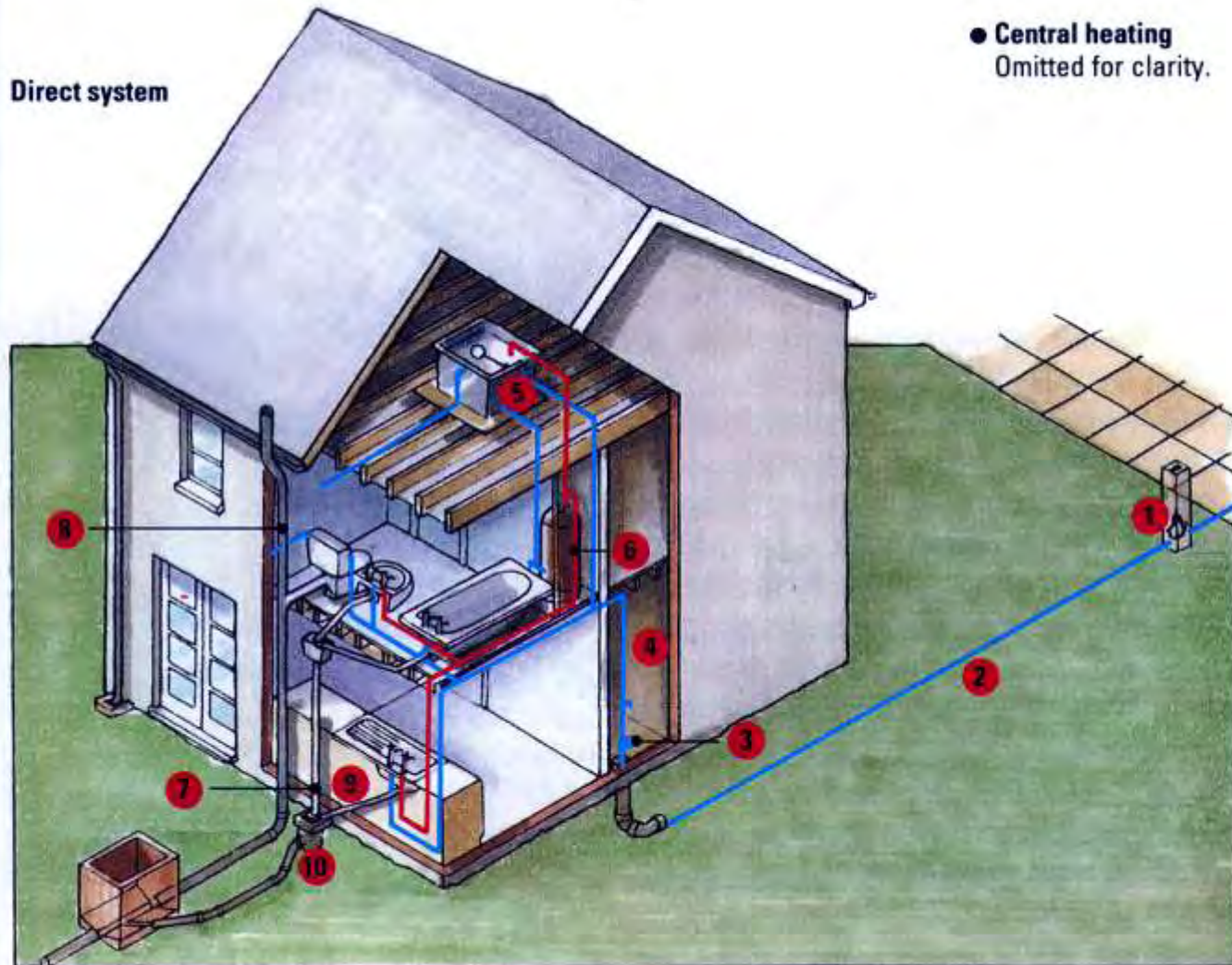
COLD WATER SYSTEMS

- There are two main types *direct* and *indirect*.
- ***Direct*** – Used extensively in Northern districts where high level reservoirs provide good mains supply and pressure.
- All sanitary fittings are fed directly from the mains and a cold water feed cistern is required to feed the hot water storage system.

THE DIRECT SYSTEM

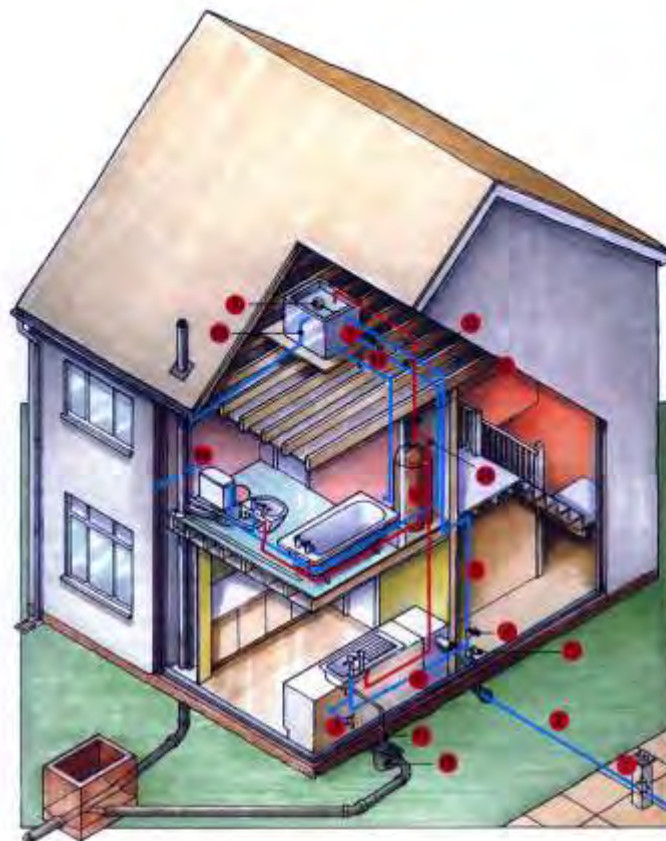
- 1 **Water supplier's stopcock**
- 2 **Service pipe**
- 3 **Main stopcock**
- 4 **Rising main**
Supplies water directly to cold-water taps and WCs as well as the storage cistern.
- 5 **Cold-water storage cistern**
- 6 **Hot-water cylinder**
- 7 **Wastepipe**
Surmounted by hopper head, it collects water from basin and bath.
- 8 **Soil pipe**
Separate pipe takes toilet waste to main drains.
- 9 **Kitchen wastepipe**
Kitchen sink drains into same gully as wastepipe from upstairs.
- 10 **Trapped gully**

Direct system



COLD WATER SYSTEMS

- ***Indirect*** – In this system all the sanitary fittings, except the drinking water drain off at sinks and fountains are supplied indirectly from a cold water storage cistern.
- All sanitary fittings are fed directly from the mains and a cold water feed cistern is required to feed the hot water storage system.
- Since the cistern supplies cold to baths, basins and showers, etc and also the hot water cylinder it must be approx double that of a direct system.
- 227 litres min.
- Accommodated in the roof space and insulated (lagged).



THE INDIRECT SYSTEM

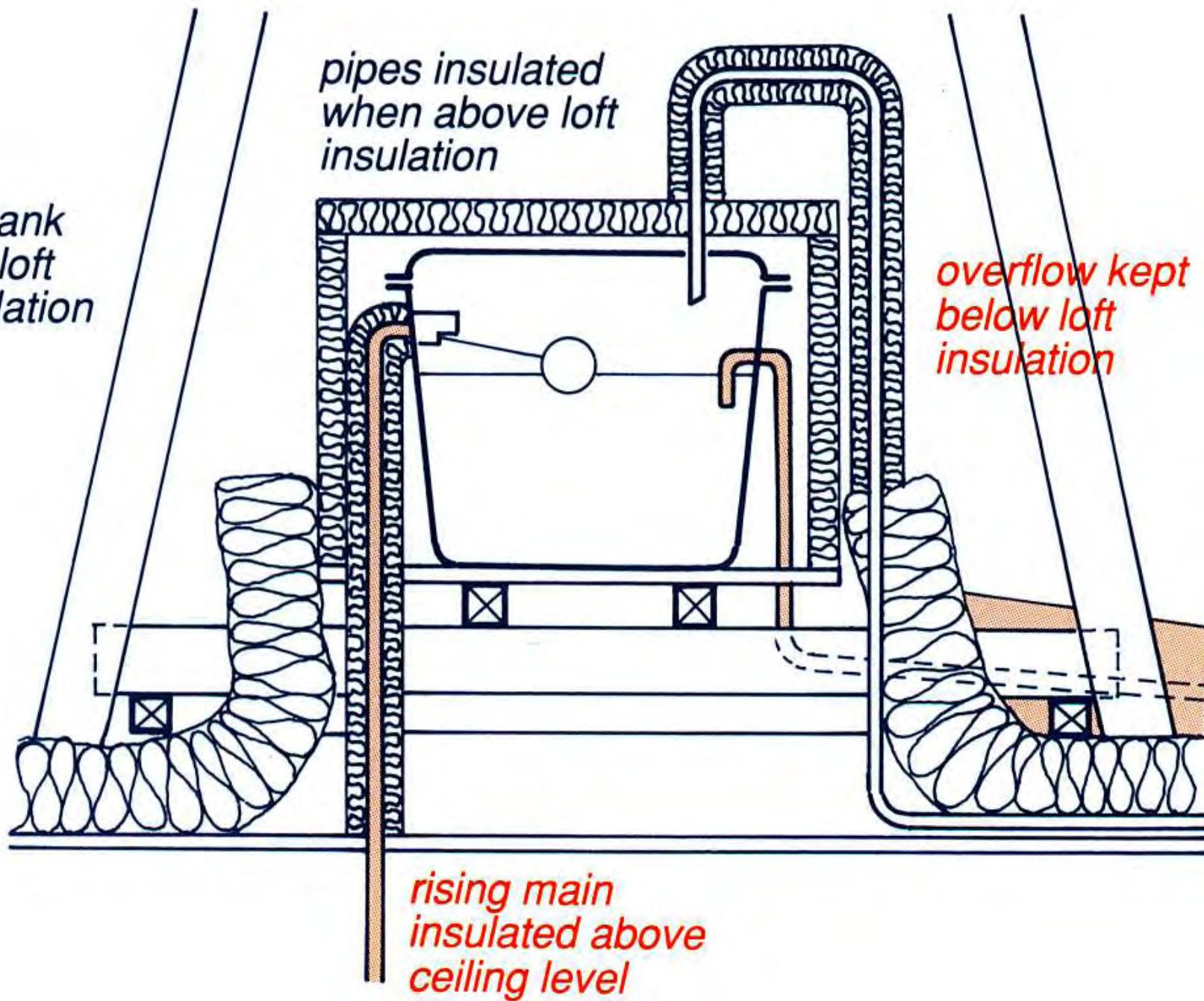
- 1 Water supplier's stopcock**
The water company uses this stopcock to turn off the supply to the house. Make sure it can be located quickly in an emergency.
- 2 Service pipe**
From the supplier's stopcock onwards, the plumbing becomes the responsibility of the householder. The service pipe enters the house through a draught pipe packed with insulant to prevent water freezing.
- 3 Main stopcock**
The water supply to the house itself is shut off at this point.
- 4 Draincock**
A draincock here allows you to drain water from the rising main.
- 5 Rising main**
Mains-pressure water passes to the cold-water cistern via the rising main.
- 6 Drinking water**
Drinking water is drawn off the rising main to the kitchen sink.
- 7 Garden tap**
The water supplier allows a garden tap to be supplied with mains pressure provided it is fitted with a check valve.
- 8 Float valve**
This valve shuts off the supply from the rising main when the cistern is full.
- 9 Cold-water storage cistern**
Stores from 230 to 360 litres (50 to 80 gallons) of water. Positioned in the roof, it provides sufficient 'head' or pressure to feed the whole house.
- 10 Overflow pipe**
Also known as a warning pipe, it prevents an overflow by draining water to the outside of the house should the float valve fail to operate.
- 11 Cold-feed pipes**
Water is drawn off to the bathroom and to the hot-water cylinder from the base of the cold-water storage cistern.
- 12 Cold-feed valves**
Valves at these points allow you to drain the cold water in the feed pipe without having to drain the whole cistern as well. Alternatively, they may be placed in the airing cupboard.
- 13 Hot-water cylinder**
Water is heated and stored in this cylinder.
- 14 Hot-feed pipe**
All hot water is fed from this point.
- 15 Vent pipe**
A vent pipe drains into the cistern to allow for expansion of heated water and to vent air from the system.
- 16 Single-stack soil pipe**
- 17 Sink waste**
Water from the sink drains into a trapped gully.
- 18 Trapped gully**

Indirect system

*lap tank
and loft
insulation*

*pipes insulated
when above loft
insulation*

*overflow kept
below loft
insulation*



FOOD FOR THOUGHT

- Buildings during construction and users after use prodigious amounts of water.
- Average consumption is 160 litres per head in the UK.
- One third of total due to high total used by agriculture and industry.
- A tonne of cement requires 3600 litres and a tonne of paper 2700000 litres.
- A litre of beer 9 litres of water in manufacture.
- To survive a human body needs 1 litre per day.

HOT WATER SUPPLY SYSTEMS

- Hot water can be supplied by a wide variety of appliances.
- Central and local systems
- Instantaneous and storage appliances.
- Heating and hot water can be run either in conjunction using the same source or separately using two or more boilers.

FLOW RATES, TEMPERATURE AND QUANTITY

The following flow rates, water temperatures and quantities should be available:

Outlet	Minimum flow rate [Litres/second]	Supply temperature [°C]	Volume [Litres]
Bath	0.25	60	60
	<i>or</i> 0.25	40	100
Shower	0.05	40	
Wash basin	0.15	60	
Sink	0.15	60	

These flow rates should be available to each outlet when only that outlet is open.

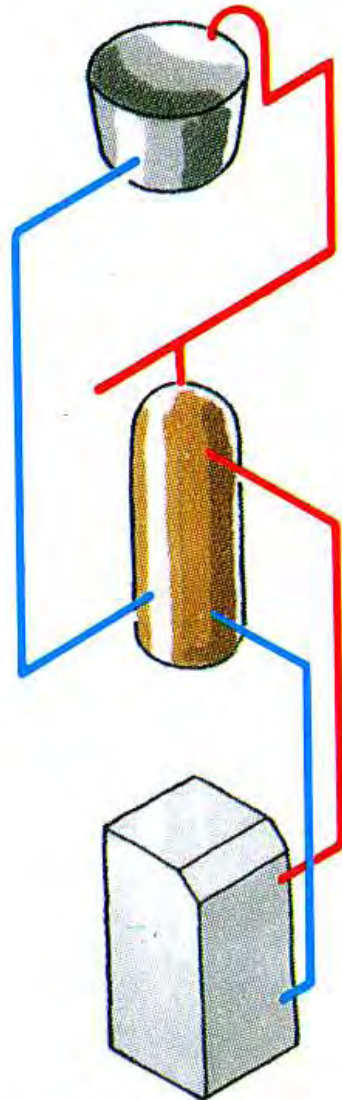
HOT WATER SUPPLY SYSTEMS

- Centralised Systems
- Local systems
- Direct System
- Indirect System
- Primatic cylinders.
- Unvented Domestic Hot water.
- Instantaneous Water Heaters

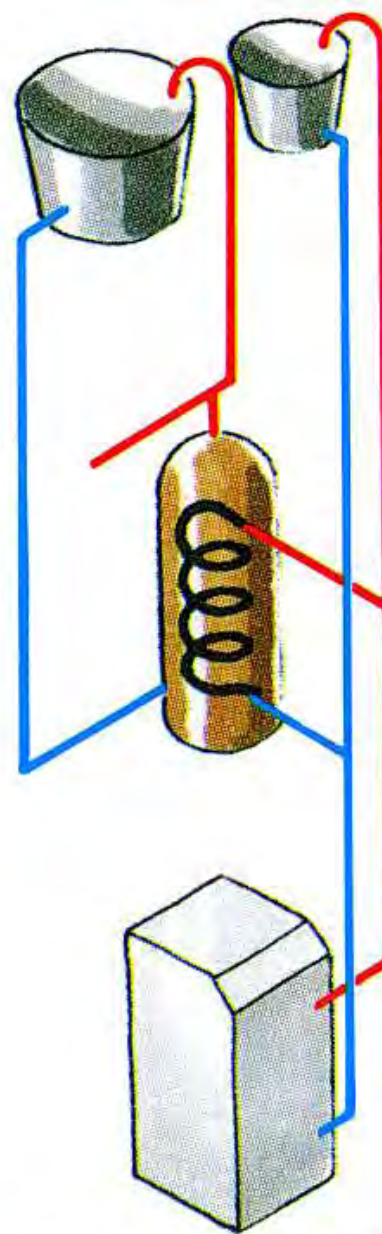
Typical pipe runs

Red: Hot water

Blue: Cold water

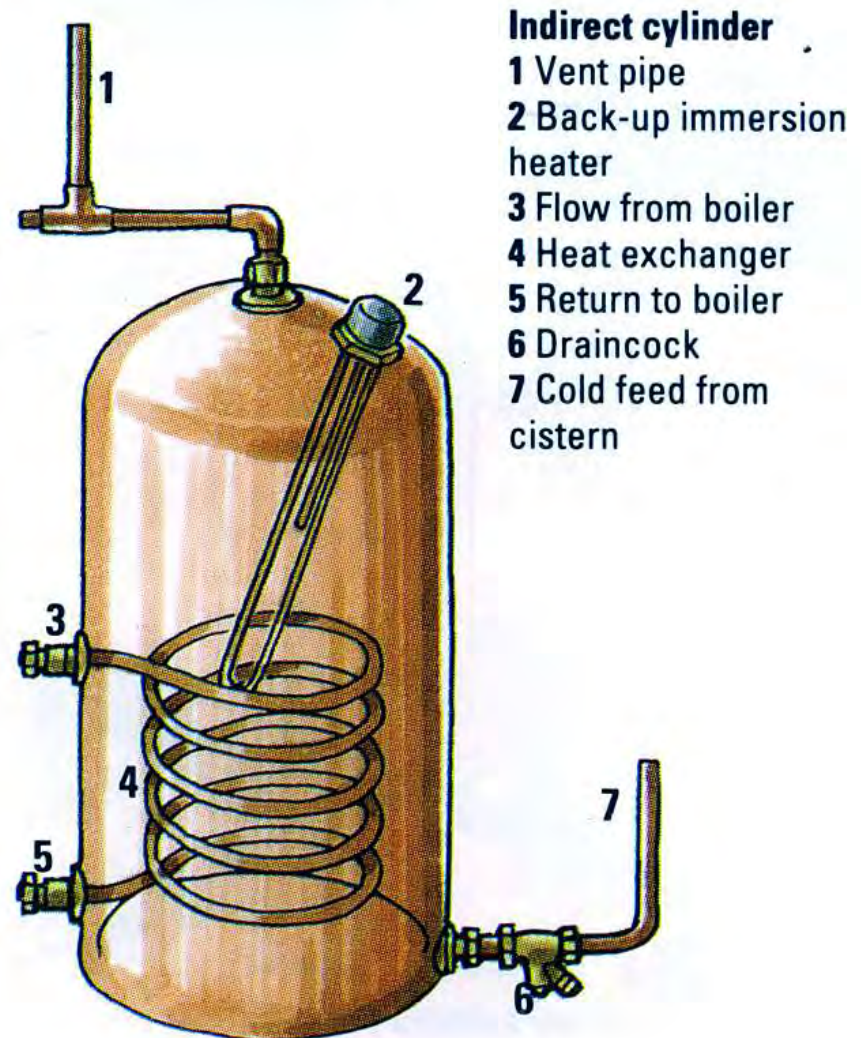
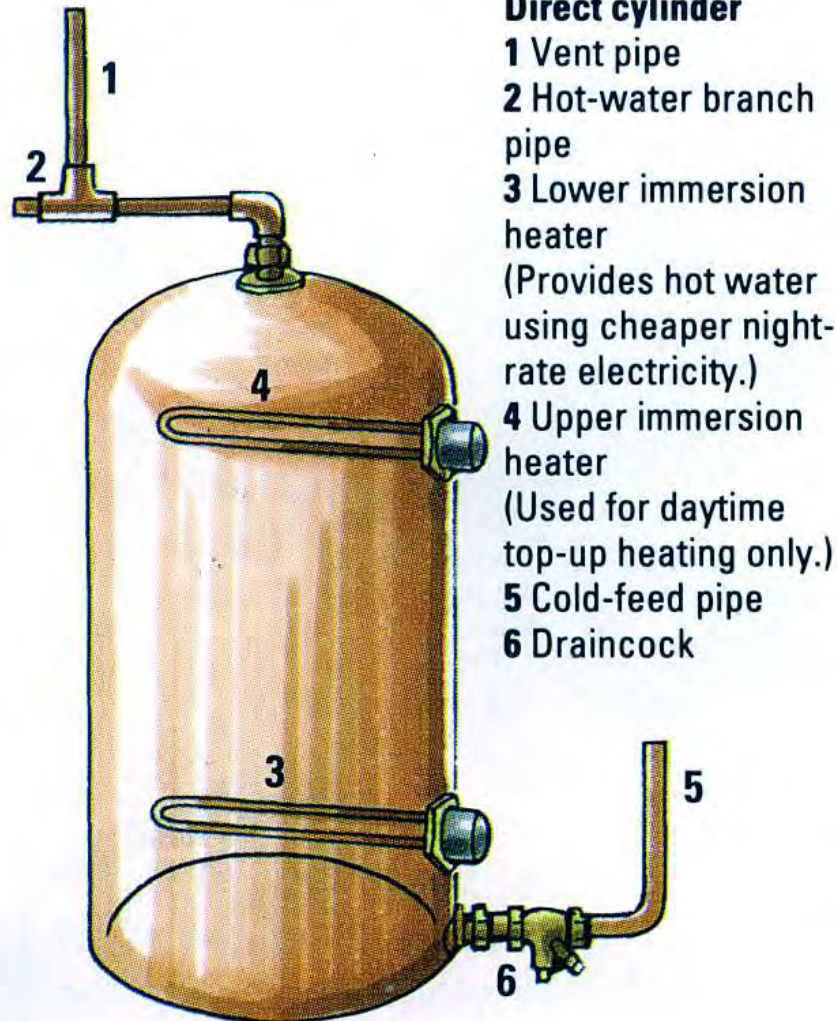


**Direct water heating
by means of a boiler**



**Indirect water heating
employs the central-
heating boiler**

HOT WATER CYLINDERS



HEATING METHODS

- Generally in the UK heating, rather than cooling is provided in dwellings and domestic scale buildings.
- This is due to a combination and interaction of:
 - Climate
 - Traditional constructional methods and building materials.
 - Occupants preferences in internal conditions.

HEATING METHODS

- In domestic buildings space heating is primarily needed to warm the dwelling from a cold condition and secondly to maintain the required comfort conditions.
- The most effective way to achieve this is to raise the air temperature within the space.
- Via emitters within the space or
- by introducing warm air in to the space or
- Open fires which radiate heat into the space plus heating the immediate building fabric.

HEATING SYSTEMS

- A modern heating system should:
- Warm a dwelling from cold within a reasonable period approx 1 hour.
- Be capable of user control, providing heating in specific zones and times to variable temperatures as required.
- Have understandable and user friendly controls.
- Be robust and reliable with ease of maintenance.
- Be efficient in the use of energy.

The provision of central, or whole home, heating is discretionary. Where it is provided, it should be designed to a recognised standard such as BS 5449 'Code of Practice for central heating for domestic premises' and based generally on the following as a minimum:

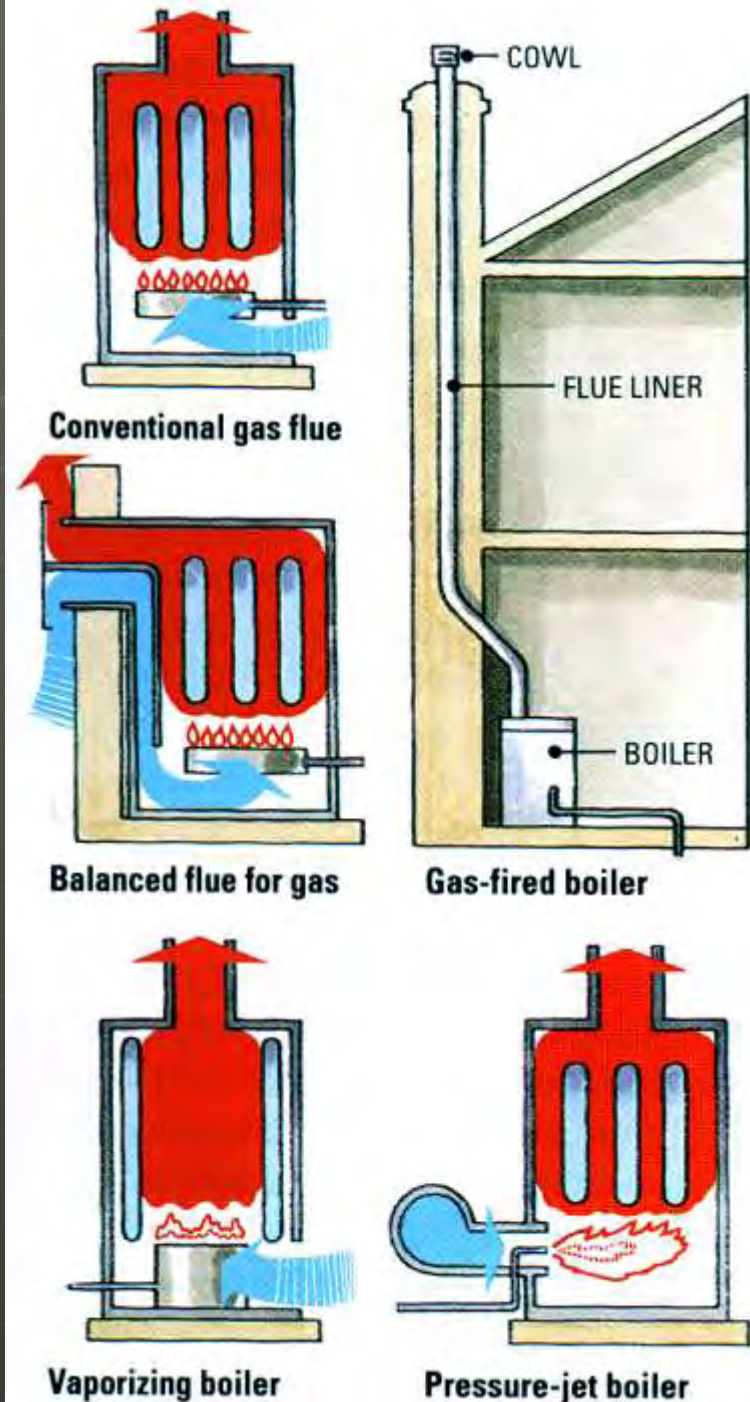
- external temperature -1°C
- the design temperatures and ventilation rates given in the table below:

Room	Design temperature [$^{\circ}\text{C}$]	Air changes per hour
Living room	21	1 ½
Dining room	21	1 ½
Bedsitting room	21	1 ½
Bedroom	18	1
Hall and Landing	18	1 ½
Kitchen	18	2
Bathroom	22	2
Toilet	18	2

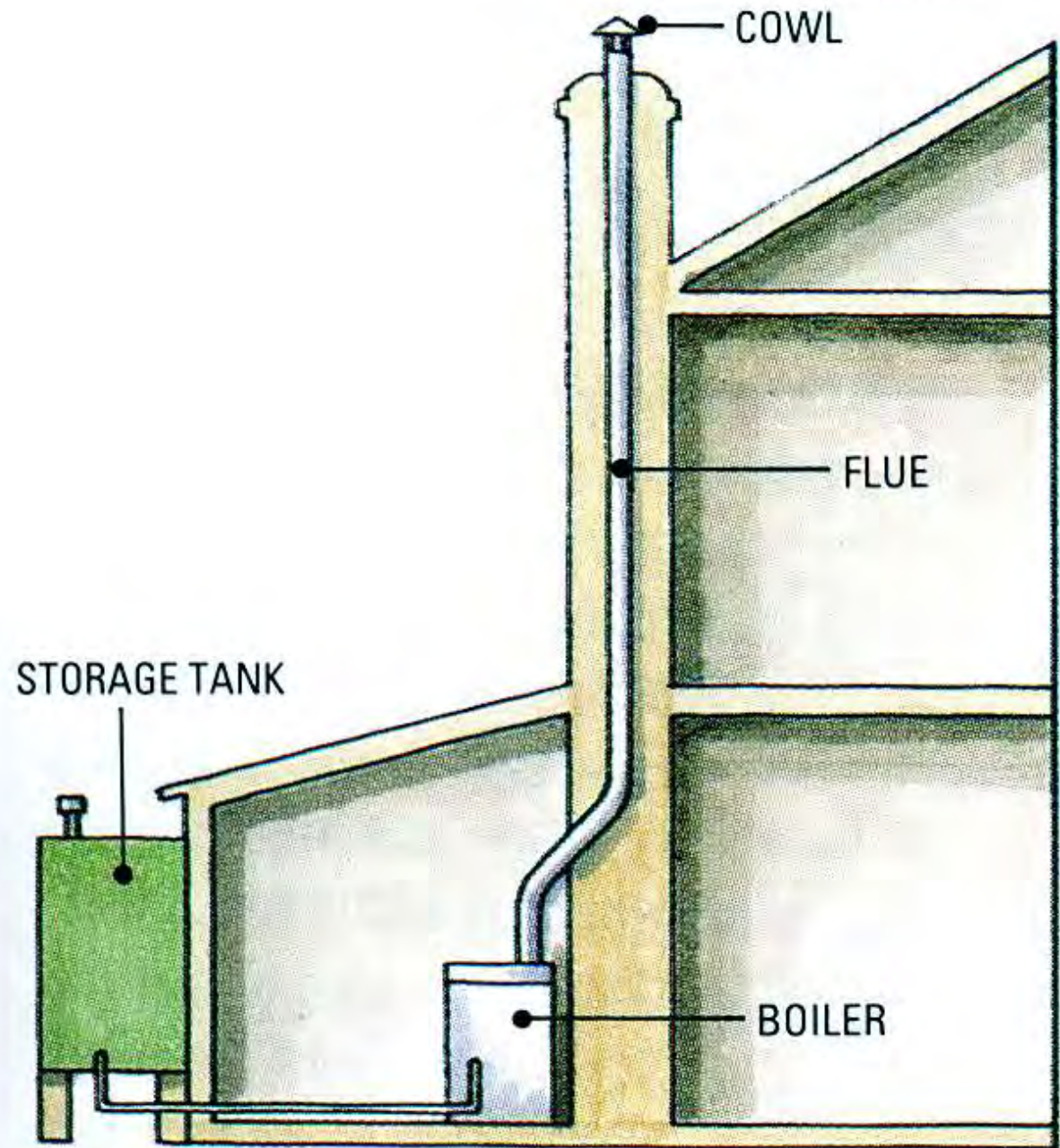
GAS BOILERS

<https://www.youtube.com/watch?v=-83oZUuuE8Y>

<https://www.youtube.com/watch?v=OTkpaY38vTU>

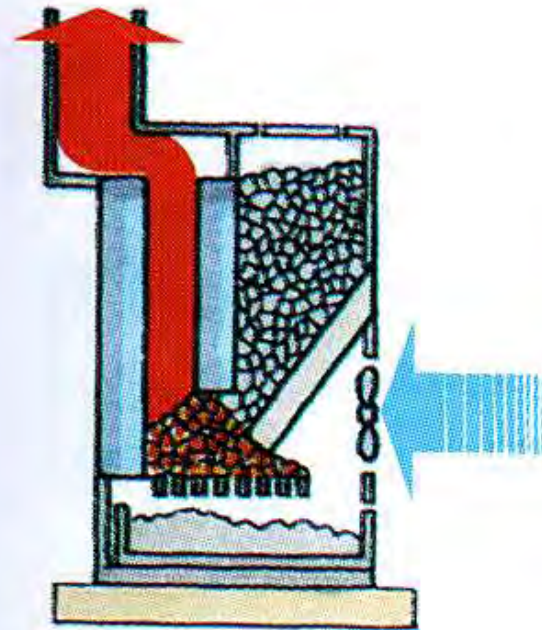


Oil Fired Boiler

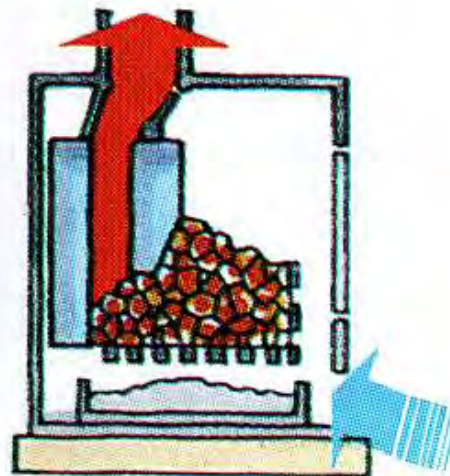


Oil-fired boiler

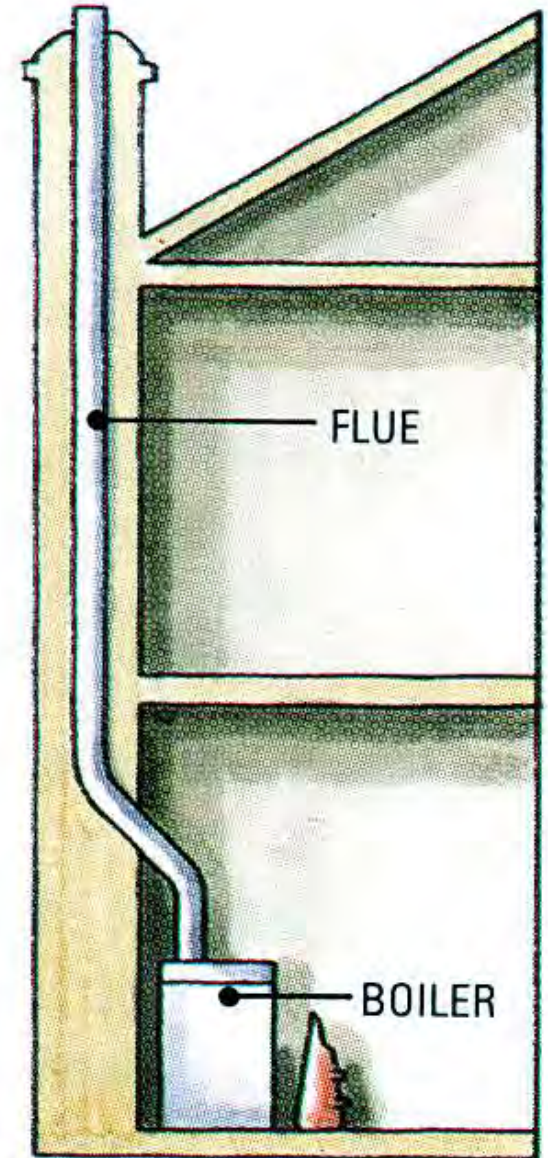
Solid Fuel Boiler



Hopper-fed boiler



Solid-fuel back boiler

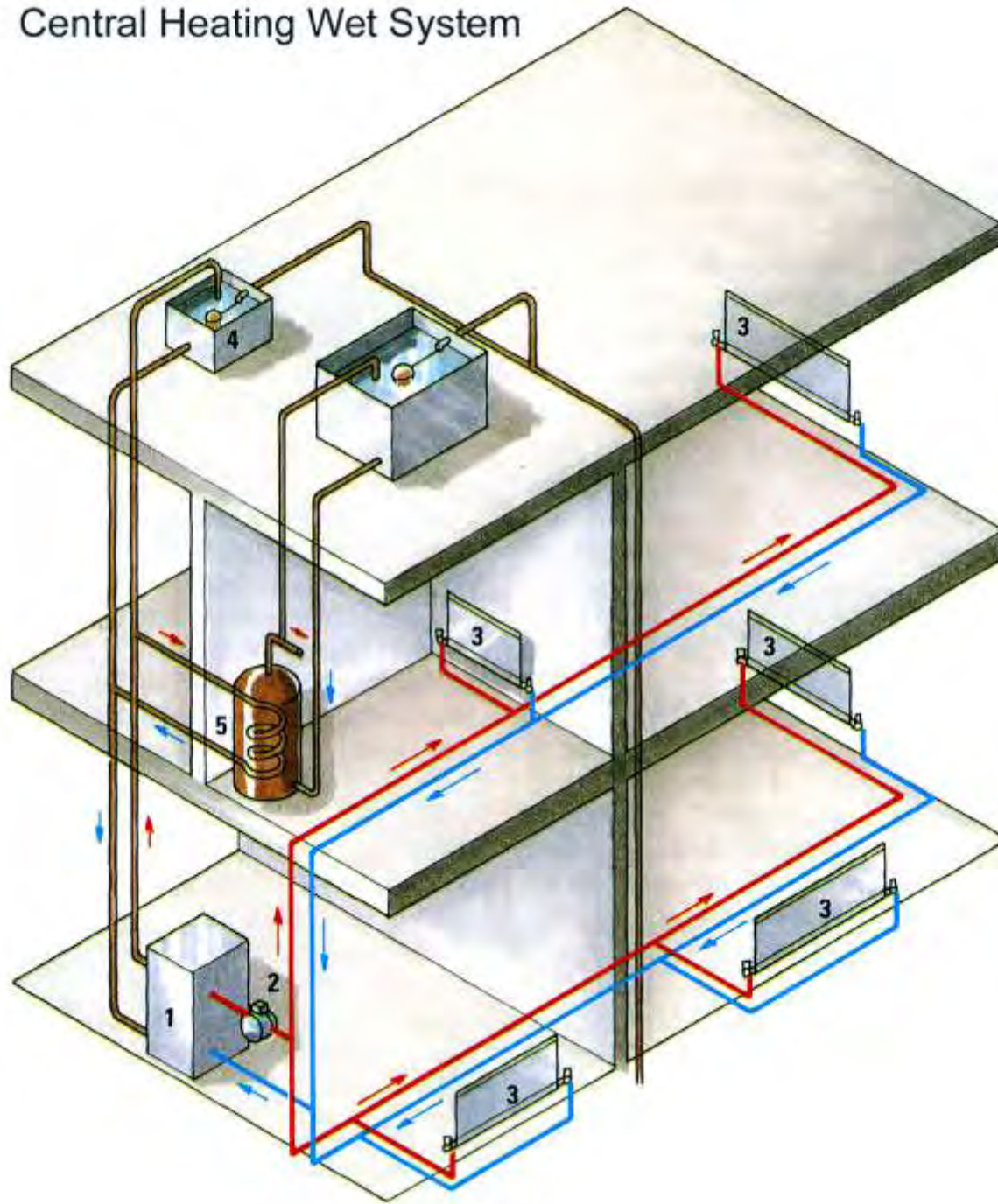


Solid-fuel boiler

Central Heating System (Hot Water)

- A centralised hot water heating system has five basic elements:
- Boiler for heat generation.
- Heat distribution circuit.
- Heat emitters e.g. radiators
- Pump
- Controls and regulators

Central Heating Wet System



COMBI BOILER SYSTEM

- Instantaneous Hot Water using a combination boiler and a circuit of radiators consisting of:
- Balanced flue combination boiler.
- Space heating controls with electronic programmer capable of whole week preset / timing.
- Thermostat in living room space.
- Feed and expansion tank for space heating.
- Descaler for cold water supply to boiler (only necessary in hard water areas and requires regular cleaning).

STORED HOT WATER

- An indirect hot water system consisting of:
- One boiler with balance flue.
- A circuit of radiators.
- A hot water storage tank.

CONDENSING BOILERS

- The most efficient gas central heating regime contains:
- Condensing gas boiler with fan balanced flue. This is a highly efficient boiler which uses heat exchangers to extract heat from flue gases. Efficiencies of 85% compare favourably with 65% obtained by conventional domestic boilers.
- Thermostatic valves on radiators except:
- Living room space which is controlled by its own thermostat.



Single-panel radiator

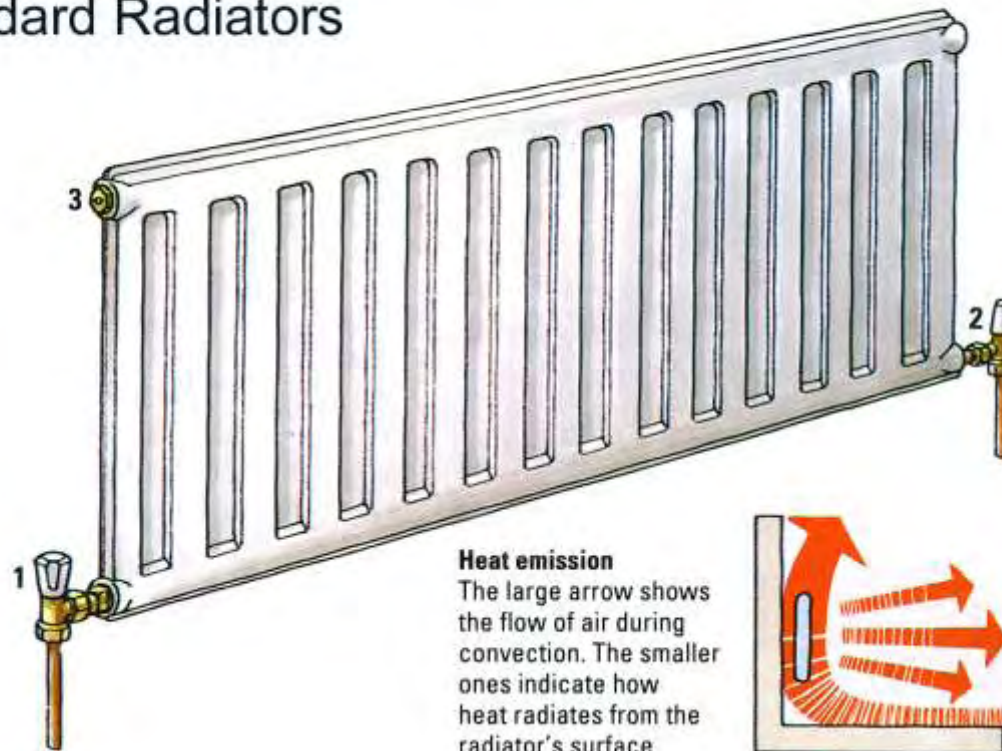


Double-panel radiator



Finned radiator

Standard Radiators

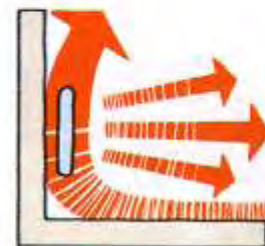


Panel radiator

- 1 A manual valve turns the flow on or off.
- 2 A lockshield valve is set to balance the system.
- 3 A bleed valve disperses airlocks.

Heat emission

The large arrow shows the flow of air during convection. The smaller ones indicate how heat radiates from the radiator's surface.



OTHER HEATING SYSTEMS

- Open fires and wood burning stoves
- Electric systems using storage heaters run on off-peak electricity.
- Warm air systems.

ELECTRICITY

- Electricity flows because of a difference in 'pressure' between the live wire and the neutral one and this difference in pressure is measured in volts.
- Domestic electricity in Britain is supplied at 240 volts 'alternating current' by way of the Electricity Company's (provider) main service cable.
- The cable enters the home underground, although in some areas electricity is distributed by overhead cables.

ELECTRICITY

- The main cable terminates at the service head or cutout which contains a service fuse.
- This fuse prevents the neighbourhood's supply being affected by any serious fault in the circuitry of the house.

<https://www.youtube.com/watch?v=edO3qb0RtiU>



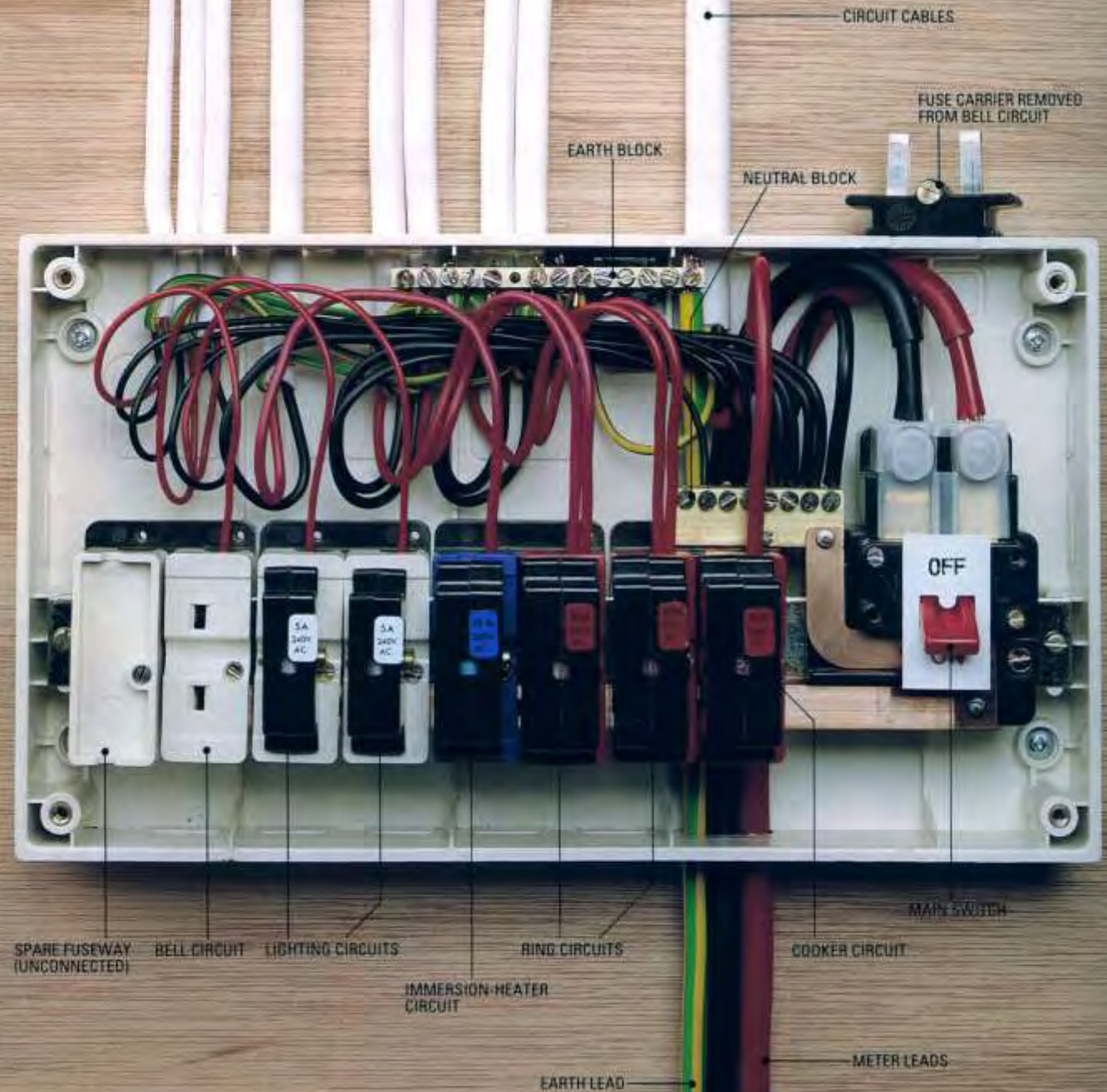
SWITCHING OFF THE POWER

In an emergency, switch off the supply of electricity to the entire house by operating the main isolating switch on the consumer unit.

Before working on any part of the electrical system of your home, always operate the main isolating switch and then remove the individual circuit fuse or miniature circuit breaker (MCB) that will cut off the power to the relevant circuit. That circuit will then be safe to work on, even if you restore the power to the rest of the house by operating the main switch again.



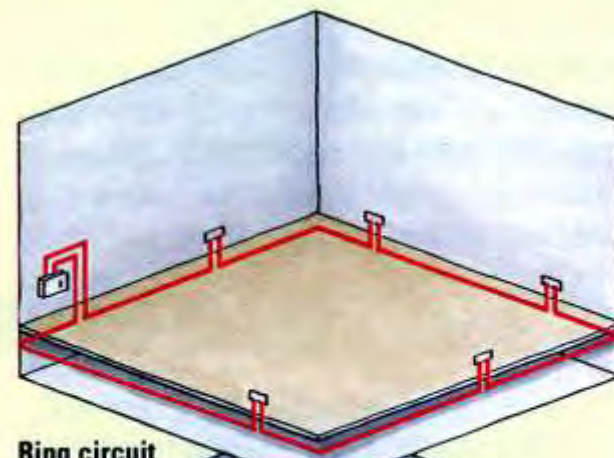
Consumer Unit



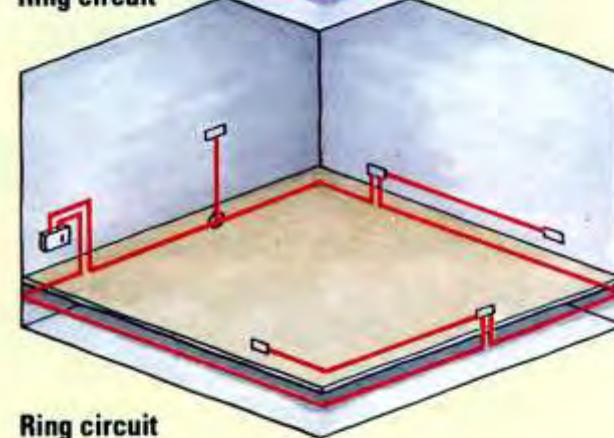
A typical cartridge-fuse consumer unit
Your consumer unit may have different circuits.

Domestic Circuits

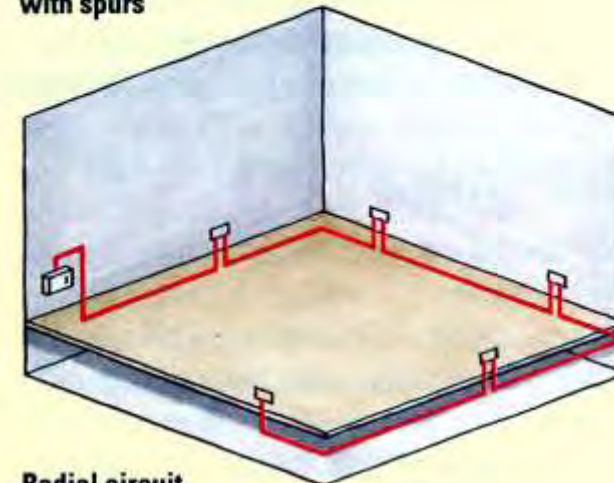
- To comply with the current IEE Regulations
- Ring circuit is the most common form for feeding socket outlets.
- A cable starts from terminals in the consumer unit and goes around the house connecting socket to socket and arriving back at the same terminals.
- Power can reach any of the socket outlets from both directions thus reducing the load on the cable.



Ring circuit



Ring circuit with spurs

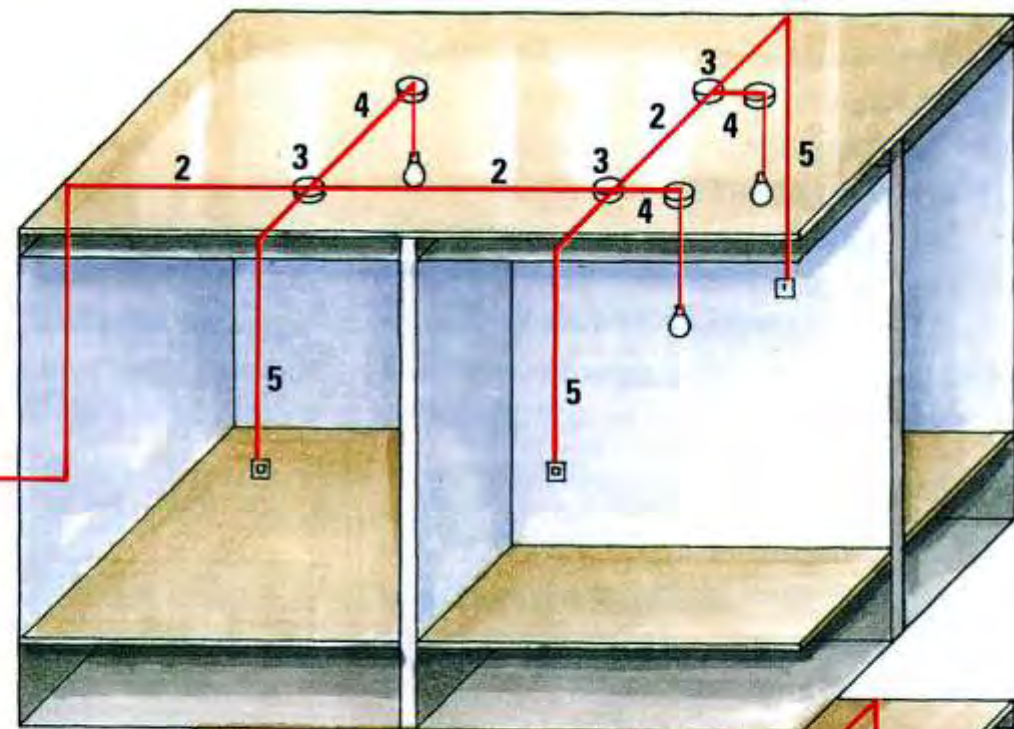
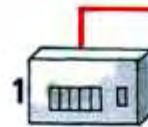


Radial circuit

Lighting Circuits (radial circuit)

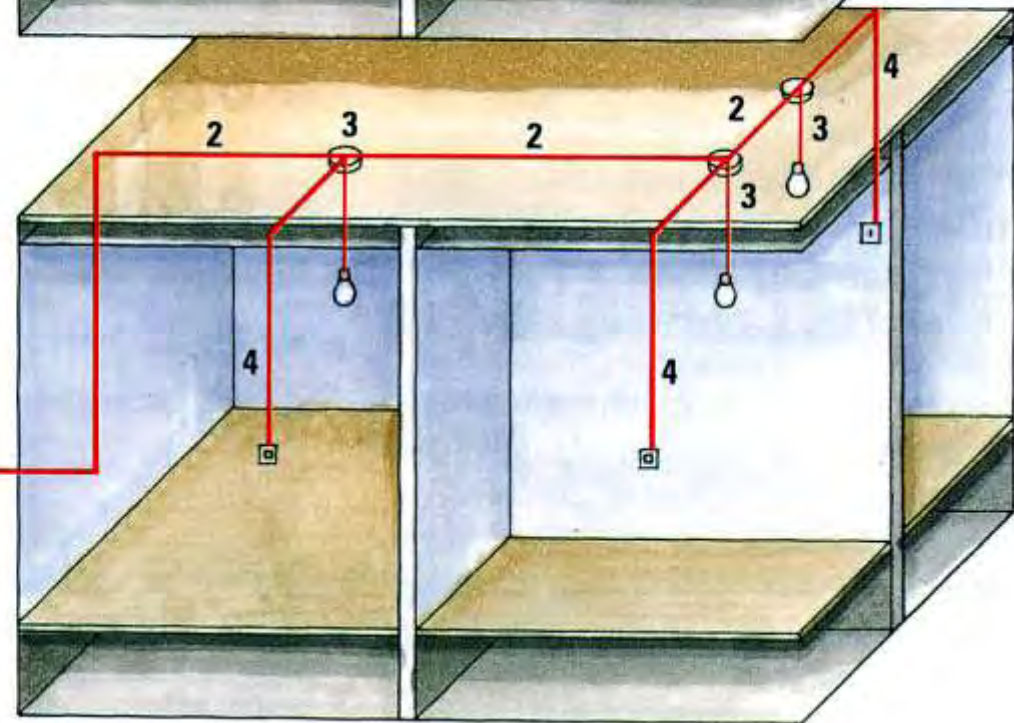
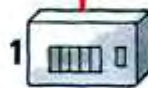
Junction-box system

- 1 Consumer unit
- 2 Circuit cable
- 3 Junction box
- 4 Light cable
- 5 Switch cable



Loop-in system

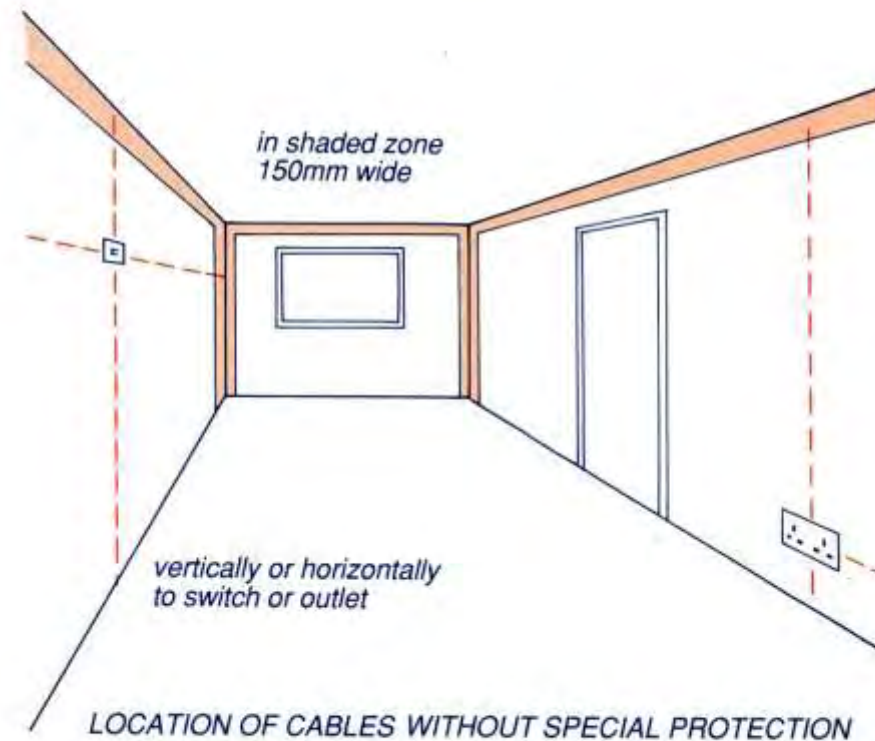
- 1 Consumer unit
- 2 Circuit cable
- 3 Ceiling rose
- 4 Switch cable



Electrical Cable Distribution

In order to comply with the IEE Regulations, cables without special protection, such as an earthed metal conduit, must be positioned as follows:

- vertically from the outlet or switch being served, or
- horizontally from the outlet or switch being served, or
- within the shaded zone in the diagram below
- not closer than 50mm to any ceiling where cables are within a timber floor or below a concrete floor.



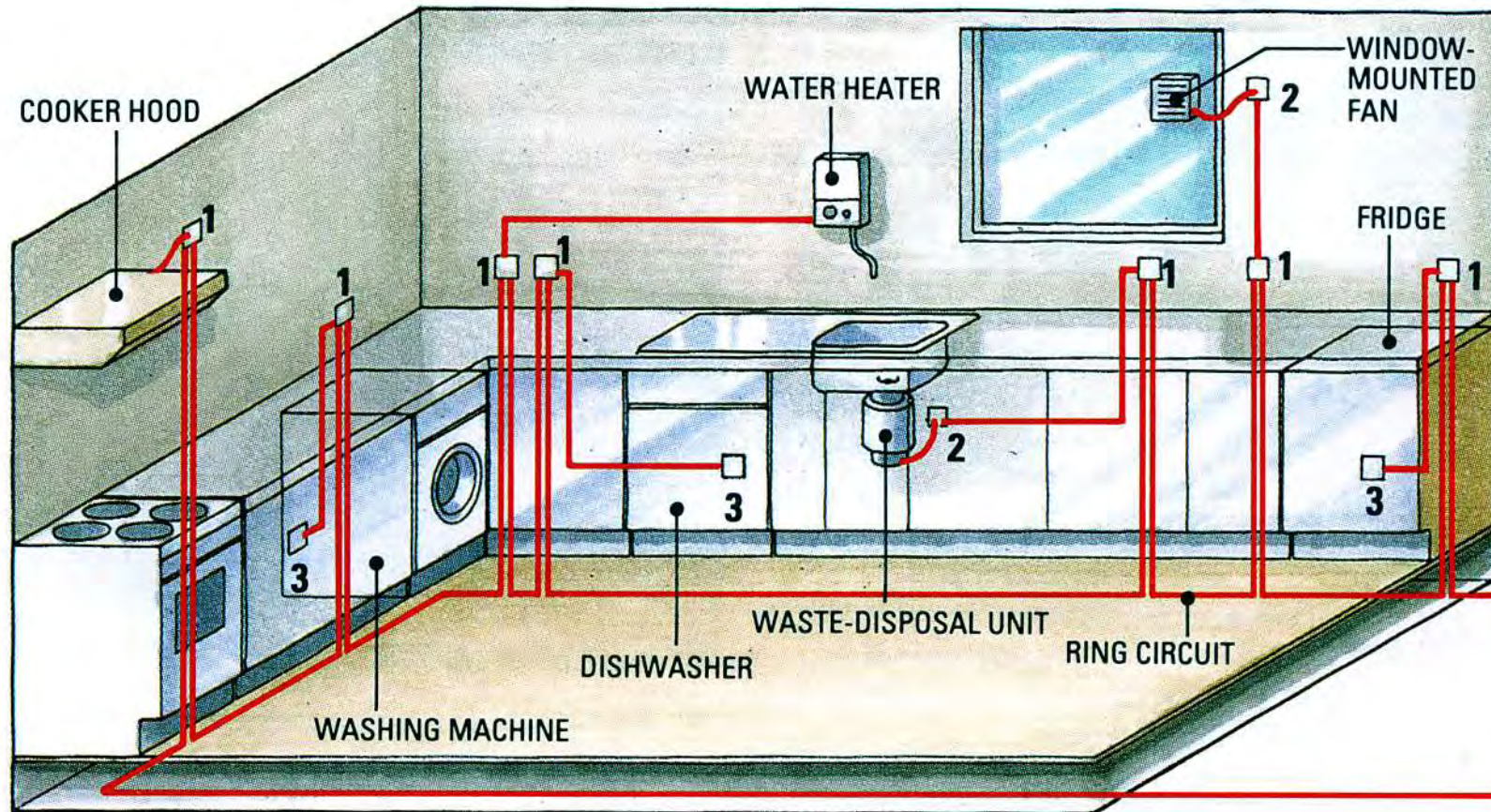
Where cables are fixed vertically to studs, fixings should be not more than 500mm apart.



Kitchen Circuits

Kitchen equipment circuits

- 1 Connection units
- 2 Flex outlets
- 3 Socket outlets



Type of Light Switches

A modern switch is of the rocker type; it is pushed in at the bottom to turn the light on and in at the top to turn the

light off, except in a two-way switch system where the switch may be on or off in either position. A single switch plate

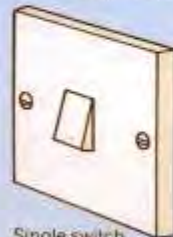
3½in (85mm) square can have one, two or three switches, and a double plate 3½in (85mm) high and 5½in (148mm) across

can have four or six switches. The switchplates fit over standard single or double flush or surface-mounted boxes.

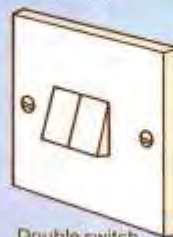
PLASTIC SWITCHES

The most common light switches are white plastic, designed to blend with light-coloured paintwork.

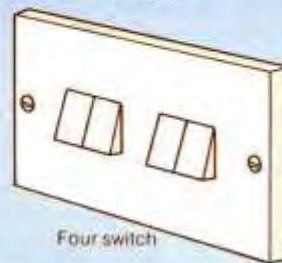
There is no earth terminal for the cable behind plastic light switches; it is in the mounting box.



Single switch



Double switch

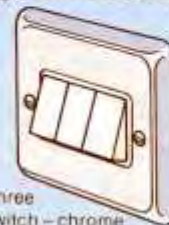


Four switch

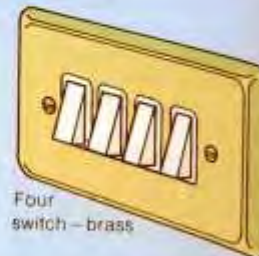
METAL SWITCHES

Metal switches are made in satin finish or shiny brass or chrome; some have decorative scrolling at the edge. Be sure to choose makes

of switch that have earth terminals. The switch rockers are fixed on plastic inserts.



Three switch - chrome



Four switch - brass

SLIM ARCHITRAVE SWITCHES

The switch can be fitted to a door architrave or in limited wall space - for example, where two door frames are so close together that there is not enough space between them for a standard switch. Mounting boxes are made to suit them.



Single brass



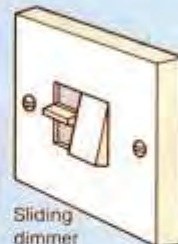
Double plastic



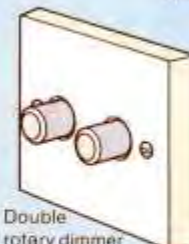
Single plastic

DIMMER SWITCHES

In place of a standard rocker switch, you can fit a dimmer which controls the amount of light the bulb gives. Some dimmers have a sliding or turning switch; some have a touch switch that makes the brightness go alternately up and down when the plate is touched, while a quick touch turns it on and off. Dimmers cannot be used with fluorescent lights.



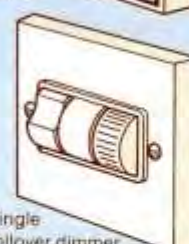
Sliding dimmer



Double rotary dimmer



Double touch dimmer



Single rollover dimmer

PULL-CORD SWITCH

A pull-cord switch is convenient over a bed and must be fitted in a bathroom to keep the mechanism well out of reach of anyone who is using the bath or shower.



Pull-cord switch

REMOTE CONTROL SWITCHES

An infra-red signal from a control unit triggers wall-mounted receivers which act as switches. The receiver must be in sight of the control but can be up to 30ft (10m) away. The system is useful for disabled people. The control can be held in the hand or wall mounted.



Hand-held control



Wall-mounted receiver

WEATHERPROOF SWITCH

A dustproof and moisture-proof seal fits over the switch and makes it suitable for fitting out of doors - in a porch or a greenhouse or on a patio. The switch is a rocker of the usual type but you cannot push it directly - only through the plastic 'bubble'.



Light bulb is the usual name for a tungsten filament lamp, which is the commonest home light source. Fluorescent tubes are used most often in kitchens.

Halogen lamps bring out natural colours and can give a softer light than most filament lamps. They are dear, but give more light and last twice as long.

Most bulbs have bayonet caps (BC) to push into a lamp-holder. Some have Edison screws (ES); these fit a special lampholder.

Filament light bulbs are made in a range of wattages, and last about 1000 hours. Long-life bulbs give a little less light and cost more, but last twice as long.

PEAR-SHAPED LIGHT BULBS

The most common light bulbs are General Lighting Service (GLS) bulbs. They are used in pendant lights and table and standard lamps. Some are squatter than others and described as mushroom-shaped. Clear bulbs give extra sparkle to glass lampshades while pearl bulbs diffuse the light more. White bulbs diffuse the light even more and reduce dazzle where the bulb is not covered by the lampshade. Coloured bulbs can give a soft glow, while brighter colours make special effects for parties.



Clear



Pearl



White

HALOGEN LAMP

Halogen, a chemical additive to the gas in this lamp, gives high luminosity. It is interchangeable with normal lamps, is dimmable, gives 25 per cent more light than lamps of the same wattage, and has a 2000 hour life.



CANDLE-SHAPED AND ROUND BULBS

These bulbs for wall lights and small lamps may have small bayonet caps (SBC) or small Edison screws (SES).



INTERNALLY SILVERED LAMPS

A reflective back reduces scatter and directs light in a wide cone. ISLs are for recessed fittings.



CROWN SILVERED (CS) LAMPS

A reflective coating at the front makes the light form a narrow cone as it bounces off the reflector of a spotlight or downlight.



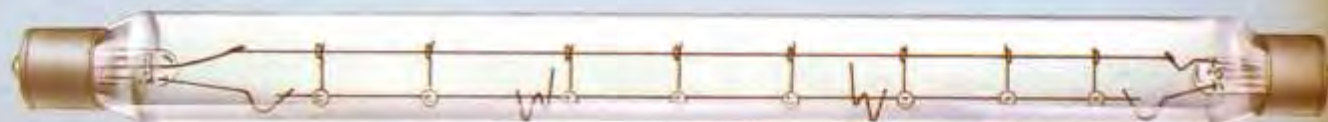
PRESSED GLASS (PAR 38) LAMPS

A parabolic reflector at the back intensifies light directed through the toughened glass at the front. The lamps are sealed, and so are safe for outdoor use. The version for floodlights has a wider beam than that for spotlights, which gives a very strong beam and is suitable only for fittings that can stand the heat it gives off.



LINEAR FILAMENT LAMPS

The long, slender bulbs can have a cap at one end or at both. They are often fitted under shelves or over mirrors.



LED Lighting



An LED lamp is an electric light or light bulb for use in lighting fixtures that produces light using light-emitting diodes (LEDs). LED lamps have a lifespan and electrical efficiency which are several times greater than incandescent lamps, and are significantly more efficient than most fluorescent lamps.



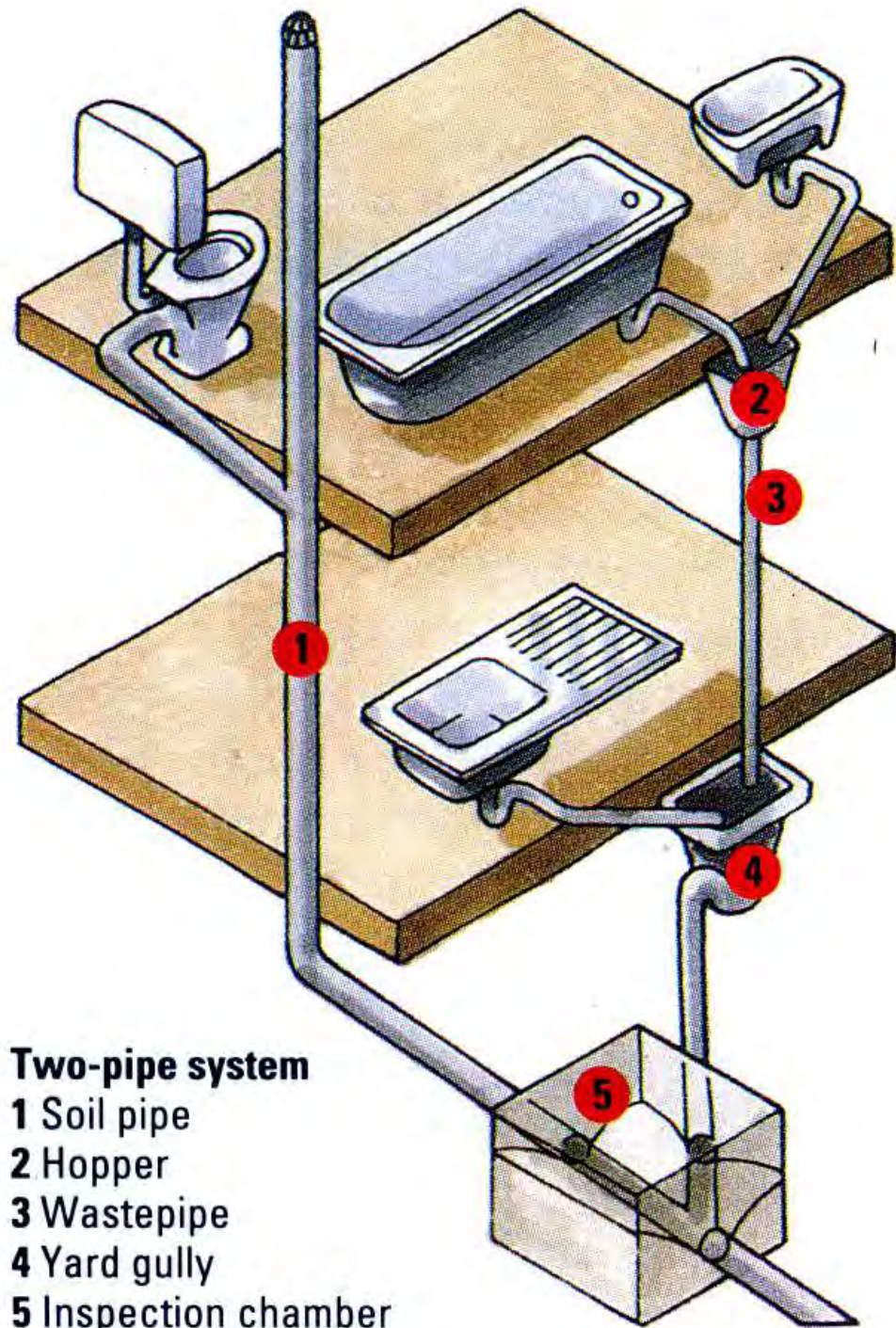
DOMESTIC DRAINAGE

- Used and excess water and any waste produced needs to be carried away from the building and disposed for health amenity reasons.
- Design of drainage installations is divided:
 - Drainage above ground.
 - Drainage below ground.

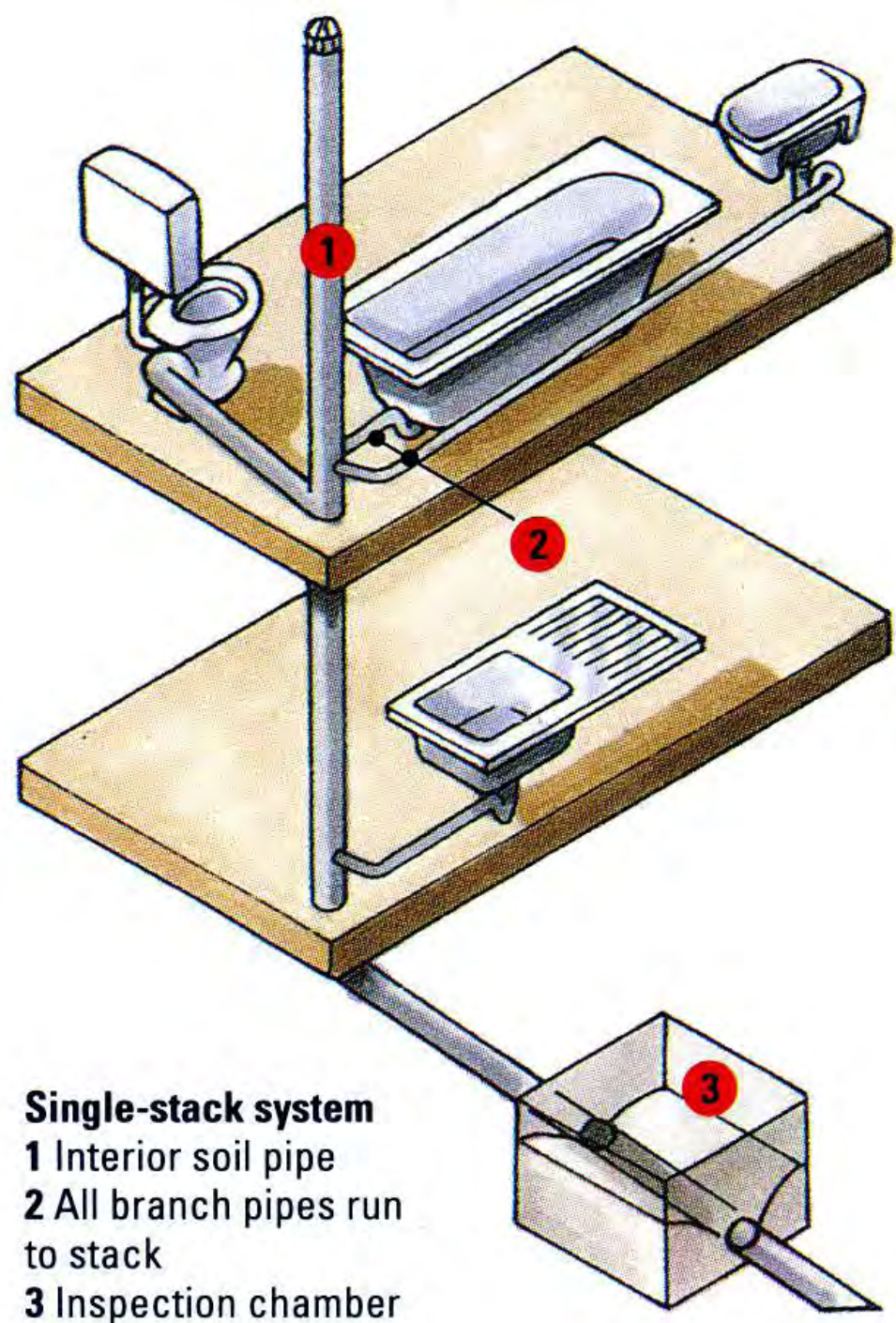
DOMESTIC DRAINAGE

- Waste and Soil Systems.
- Water which has been used within the building has to be carried away, the system contains:
- Waste pipes carry water from cooking and washing
- Soil pipes carry waste containing excrement.
- Rainwater pipes remove water that has fallen on or around the building especially from roof and paving.

Old Two Pipe System



Single-stack System

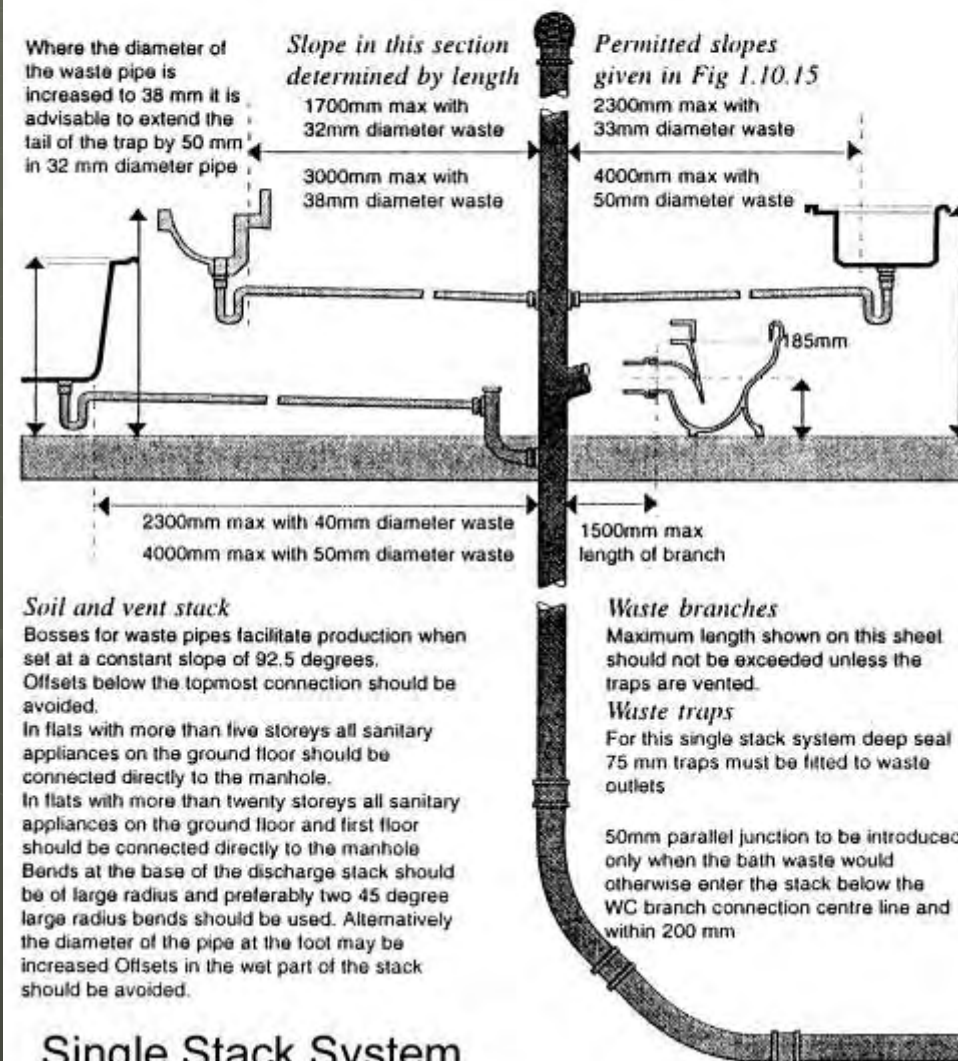


Stack vents

should terminate at such a height and position that foul air does not cause a nuisance or a health hazard. This will be achieved if the stack vent is not less than 900 mm above the head of any window or other openings into the building within a horizontal distance of 3 m. Stacks should also be positioned away from parapets and corners of buildings. Note that air admittance valves installed in accordance with manufacturer's instructions may be used.

Where waste branch connections are directly opposite each other on the stack at similar levels, it is preferable to adjust their positions to exactly the same height to minimise the effects of cross flow.

The WC branch connection should be swept in the direction of flow with a 50 mm minimum radius at the invert.



Soil and vent stack

Bosses for waste pipes facilitate production when set at a constant slope of 92.5 degrees. Offsets below the topmost connection should be avoided. In flats with more than five storeys all sanitary appliances on the ground floor should be connected directly to the manhole. In flats with more than twenty storeys all sanitary appliances on the ground floor and first floor should be connected directly to the manhole. Bends at the base of the discharge stack should be of large radius and preferably two 45 degree large radius bends should be used. Alternatively the diameter of the pipe at the foot may be increased. Offsets in the wet part of the stack should be avoided.

Waste branches

Maximum length shown on this sheet should not be exceeded unless the traps are vented.

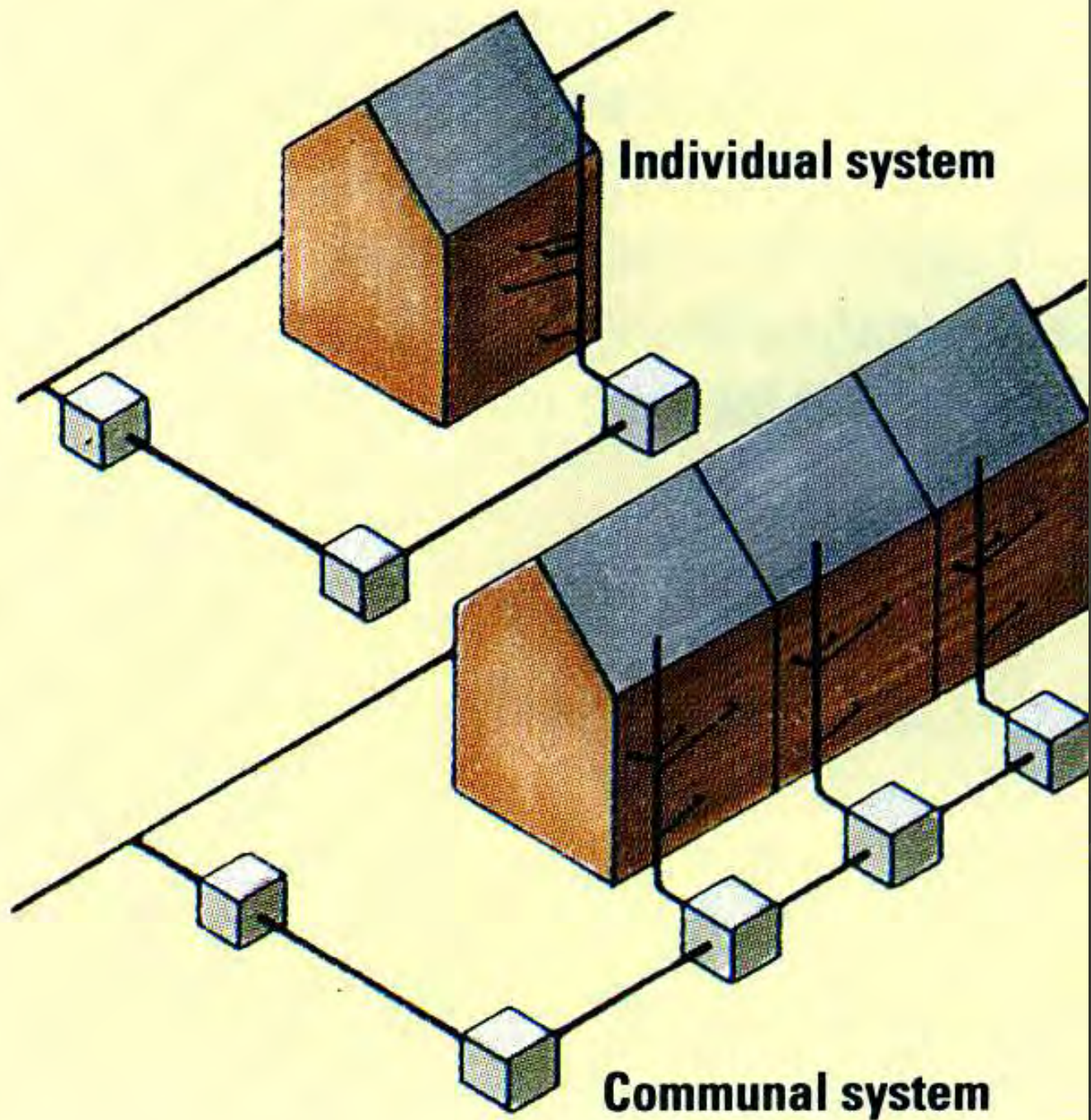
Waste traps

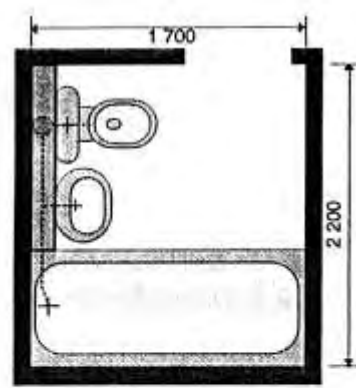
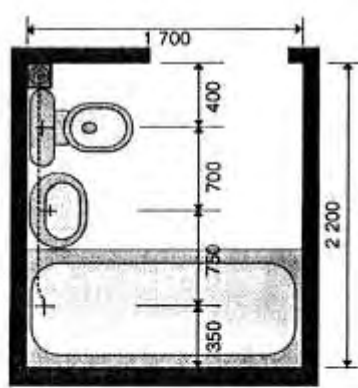
For this single stack system deep seal 75 mm traps must be fitted to waste outlets.

50mm parallel junction to be introduced only when the bath waste would otherwise enter the stack below the WC branch connection centre line and within 200 mm.

Single Stack System

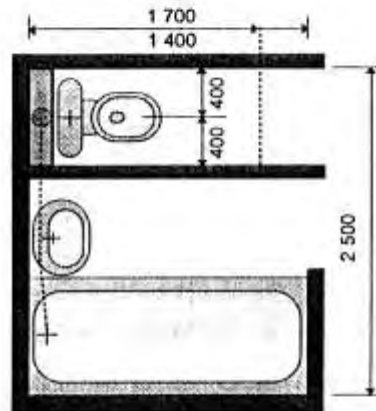
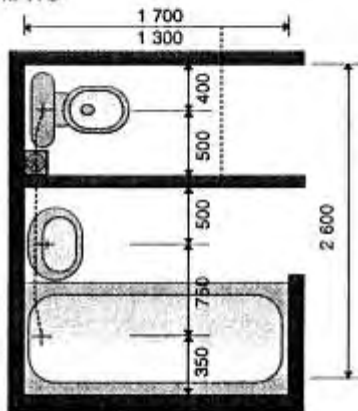






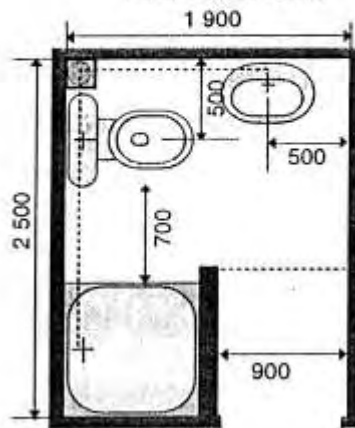
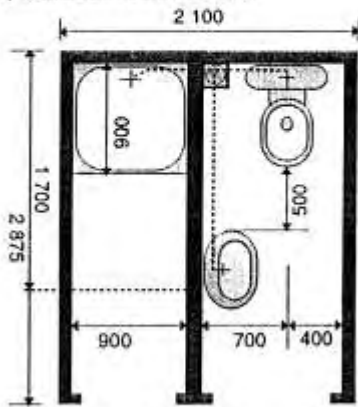
Economical layout of combined bathroom and WC

with duct (1500 x 200)



Separate bathroom and WC

with duct (800 x 200)



Separate shower-room and WC

Combined bathroom and WC

Reading List & further info

- **Environment and Services**, Burberry P. 1997
- The Macmillan Encyclopedia of Architecture and Technological Change 1979
- **Architects Journal** *Focus*
- *Welsh Water Bye-Laws*
- *Hall F Building Services and Equipment 1977*
- *Vale B & R - Green Architecture*
- *Ecohouse 2 – Sue Roaf, Manuel Fuentes, Stephanie Thomas July 2003*
- *The IEE Regulations Current Edition*
- J.J.Norwich. *The World Atlas of Architecture* p154.
- *The Building Regulations Part G and H*