The 50plus Essential Home Plumbing Guide

For Repair and DIY Personnel

Includes:

- Safety and responsibilities
- Overview of household plumbing
- Maintaining plumbing and waste
- Fault finding:
    - Toilets
    - Water heaters and showers
    - Taps
    - Central heating
    - Cylinders
- Handy summaries

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The 50plus Essential Home Plumbing Guide for Repair and DIY Personnel

Other books in this series:

The 50plus Essential Home Electrical Guide for Repair and DIY Personnel

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The essential plumbing guide for repair personnel

Welcome. This book provides a guide to the plumbing systems found in UK households and how they operate. It is designed to be an aid to faultfinding, which is about breaking down problems into logical parts such that each step can be tested and the results verified.

Do use the book as point of reference. There is a comprehensive index to help with finding information. There is also a set of summaries at the end to provide a useful reminder.

I hope it goes without saying that water can do a lot of damage. Don't skip the safety and responsibilities chapter. If you are not confident in what you are doing, stop and get help.

There are, not surprisingly, regulations with regard to both the supply of water and the use of water fittings. The Water Regulations Advisory Service is a good place to start and contains details of key points such as prevention of backflow.

Note that electrical installations associated with plumbing must meet the requirements of the IET Wiring Regulations (BS 7671). The IEE (formally now the IET) publishes these. If you don't wish to purchase the regulations themselves it is worth having the 'On-site Guide'.

If you wish to comment on any aspects of this book please let me know by email at roger.runswick@the50plus.co.uk.

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Safety and responsibilities

We don't cover gas appliances in this book but note that is a legal requirement that anyone working on a gas appliance is Gas Safe registered. This restriction does not apply to central heating systems components outside a boiler such as pumps, motorized valves, thermostats and the like.

If installing a pressurised cylinder you should be competent to do so.

It may seem obvious but it is worth remembering that hot water can burn. Anyone working on heating systems needs to take care and should also know that where hot water is supplied for the use of the elderly then the use of items that prevent scalding such as temperature restrictors on showers or thermostatic mixing valves may need to need to be installed.

Clearly water leaks can cause substantial damage so everyone working on water systems has a duty of care to prevent such an occurrence. Similarly 'hot' work (use of e.g. a blowtorch) can lead to fires. The amount of necessary 'hot' work has reduced considerably with the advent of push fit and widespread use of compression joints so ensure that if 'hot' work is necessary adequate precautions are taken.

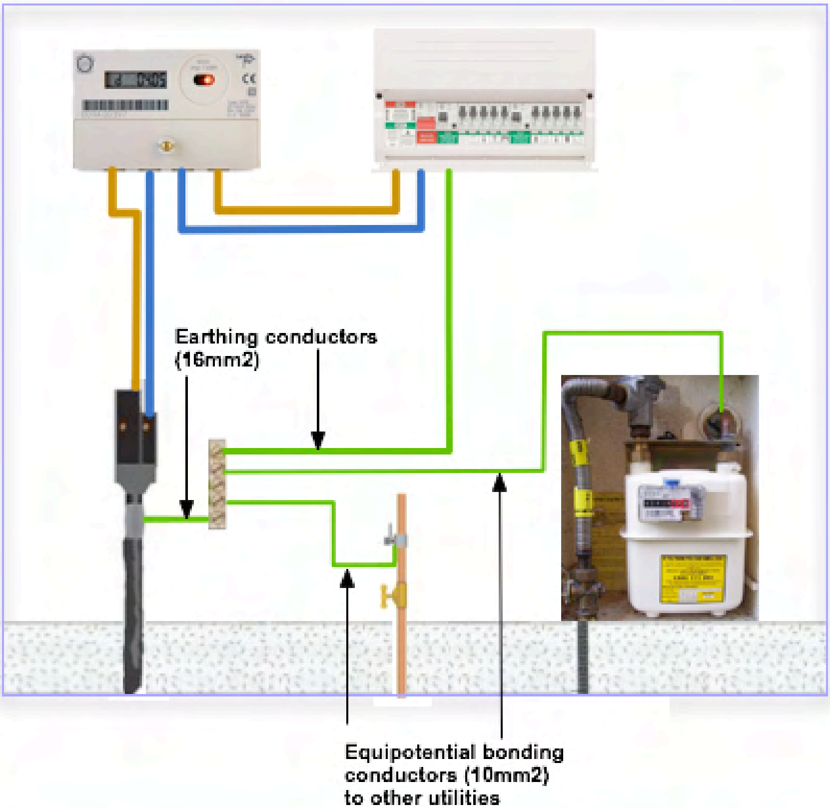
Lead pipes are still in place both within and the supplies to some homes. On the whole they do not represent significant risk, as they will have developed a coating of limescale internally. If there are concerns water companies can organize testing. Lead solder however is no longer allowed. Plumbers (who get their name from plumbum - the Latin for lead) have become ill through ingestion of lead through both contact and the inhalation of lead fumes given off when it melts.

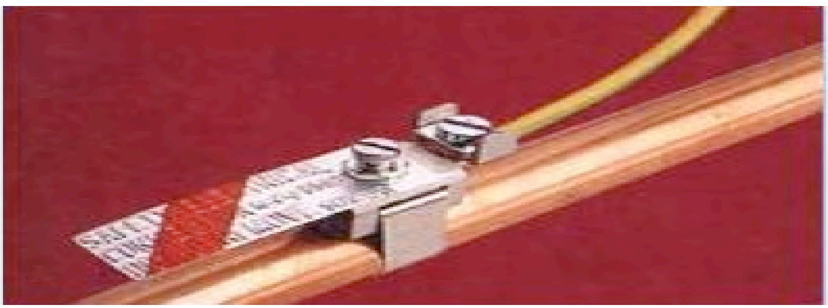
Underground water pipes no longer leak as often as they did in cold mid 20th century winters. Much lead piping has been replaced and the modern more malleable plastic pipes are buried much deeper. If there is a leak the boundary of responsibilities with regard to underground water pipes is on the whole the boundary of the property.

Water companies typically fit stopcocks on the supply to premises although beware that these can still be shared between premises. We are aware of companies charging for repair to external mains stopcocks as they argue that they no longer have to supply them, as they cannot isolate water for non-payment reasons. Typically though they will both locate and if necessary replace faulty external stopcocks on their systems without charge. The advent of metering, where the stopcock is often associated with the water meter, has improved access to water company stopcocks.

Plumbers need to be aware that the although use of water pipes as an electrical earth is no longer allowed, electrical equipotential bonding of incoming gas and water mains (except where the distribution pipe work is plastic) is a basic electrical safety measure and must not be removed or compromised. If replacing copper pipe work with plastic the electrical safety aspects should be considered. A diagram of equipotential bonding is shown as Figure 1. Similarly supplementary bonding (earth wires between pipes), often found in bathrooms and airing cupboards, should be maintained.

Figure 1 - Equipotential bonding





Overview of household plumbing systems

Conventional systems

Traditionally UK household water systems have used a header tank in the loft to supply cold water to taps (except the kitchen tap) and toilets. In a loft with two tanks the larger will be the cold-water header tank and the smaller the central heating header tank.

We typically find the layout shown in Figure 2.

Unless the property is one of the few with a private supply, water arrives from the company water main. Mains water pressure can vary widely but something around 4 bar is common. The minimum statutory requirement in the UK is just 0.7 bar. 1 bar is about equal to the atmospheric pressure on earth at sea level. The incoming main feeds, via an external and internal stopcock:

- The kitchen tap (as directly piped water is less likely to be contaminated than water stored in a header tank).
- Header tanks (where these are fitted)
- Possibly other facilities such as ground floor toilets or other ground floor taps. In modern households all cold taps may be on the 'rising main' as it is known.

Traditional systems are vented meaning that the hot water cylinder has a vent pipe which returns to the cold-water header tank allowing any expansion to be vented back to the tank.

In many modern houses with unvented (usually combi) boiler systems there is no need for header tanks and all cold water is at mains pressure.

Figure 2 - Water flows in a house (conventional heating)

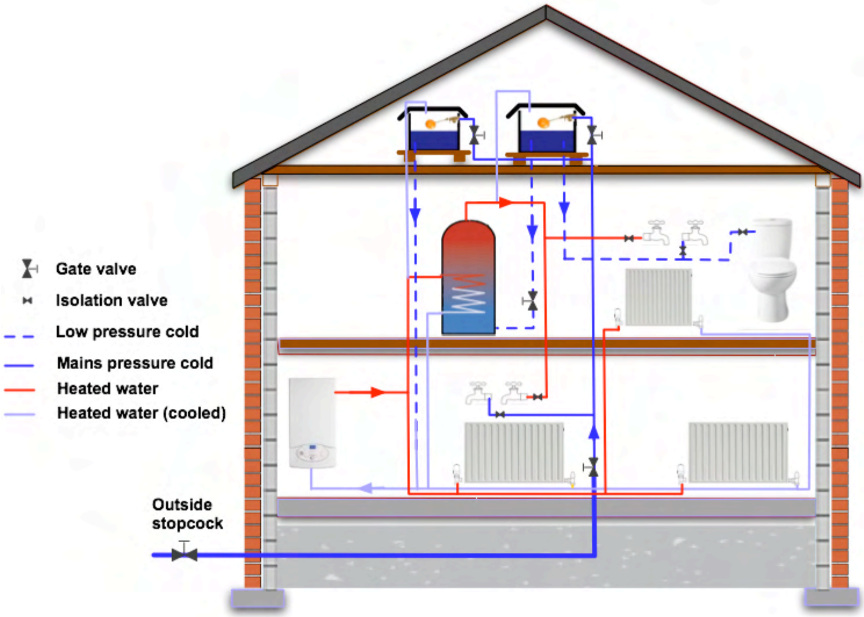


Figure based on an original idea by UWE

Cold water supply

It is frightening how many householders do not know where their internal stopcock is. It is common that many are boxed in or have kitchen units built around them. Still more remain permanently untouched and won't work when needed. Hence locating the internal and external stopcocks is a prerequisite of many plumbing tasks. A water meter is a boon; it generally means a simple to operate readily accessible external stopcock is available.

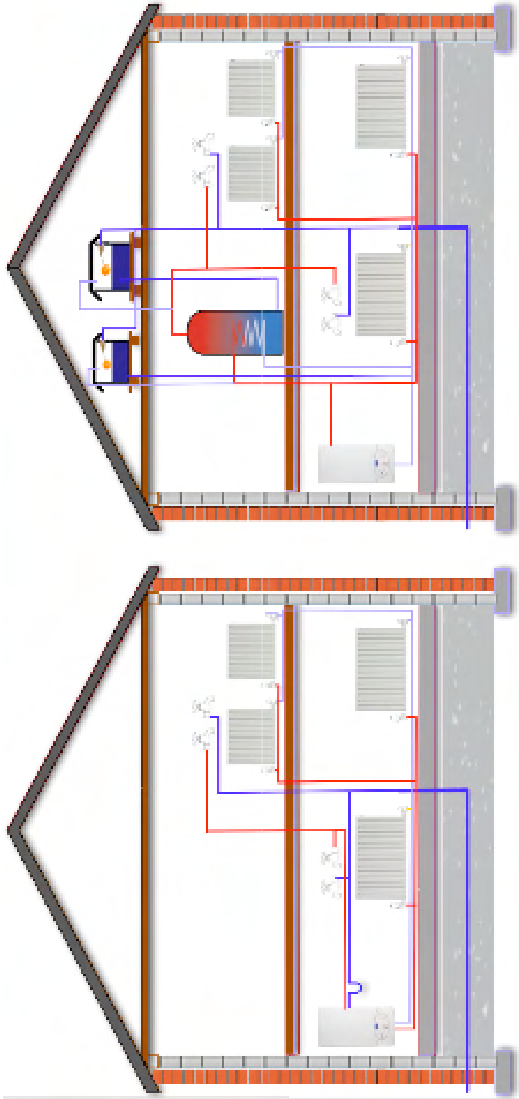
Cold water pipes need to be insulated. Burst pipes in cold winters are now uncommon due to the fact that we keep our centrally heated houses much warmer but exposed pipe work, particularly if it is in a relatively colder part of the house, for example a garage, is still at risk.

Combination boilers

Frequently we are seeing simplification of water distribution in properties, particularly smaller houses and flats.

The introduction of combination (combi) boilers in smaller properties with a gas supply has allowed header tanks to be dispensed with, saving both space and cost. Combi systems also offer the benefit that both hot and cold water pressure is similar (that of the incoming mains or the pressure reduced value thereof) allowing mixer showers to operate without the need for a ancillary pump and still provide adequate pressure. Combi's are generally only suitable for smaller households, as they cannot supply hot water for several people to use at the same time.

Figure 3 – Combi (left) and conventional systems



Figures based on an original idea by UWE

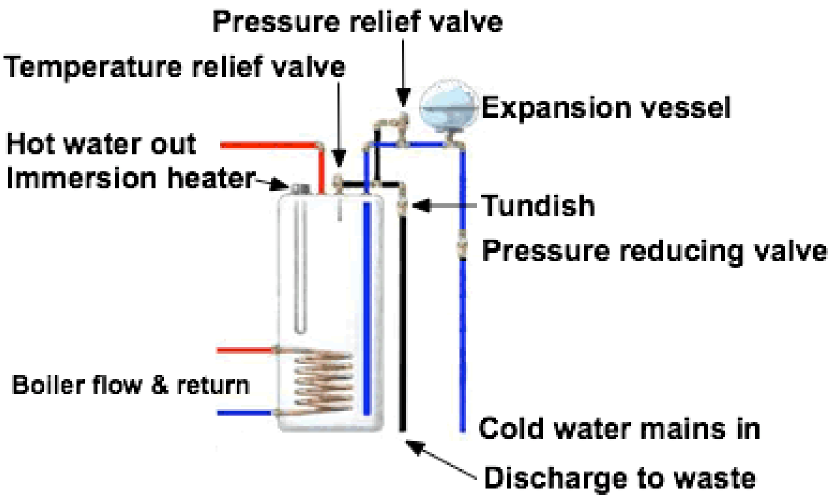
Pressurised cylinders

Increasingly pressurised hot water systems are being installed. These combine the benefits of a conventional system with pressurised hot water. The pressure, which is that of the water main, is introduced at the cylinder.

Such systems are identifiable by:

- The associated pressure vessel, required to accommodate the expansion volume as water is heated to 65 degrees,
- A series of valves as shown in Figure 4
- A tundish.

Figure 4 - Pressurised cylinder schematic



Electric only systems

In smaller properties and flats electric only heating and hot water is common. Space heating in such properties utilises electric night storage or panel heaters. From a plumbing perspective we find a variety of systems.

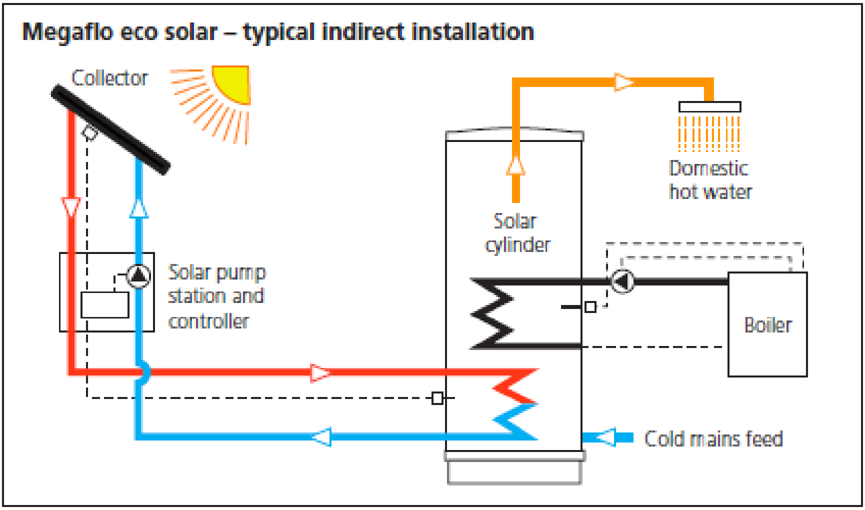
- A vented cylinder with one or two immersion heaters. In the latter case the upper element operates on the regular peak electrical supply and the lower element overnight only using off peak electricity. Fault finding immersion heating is covered in this book's companion electrical guide.
- An unvented cylinder with one or two immersion heaters.
- Undersink water heaters, either single or multi-point and either vented or unvented. These heaters are really just miniature versions of the familiar cylinder.
- On-demand water heaters, including electric showers.

Solar thermal heating

Solar hot water systems are becoming more common. Such systems are not to be confused with solar photovoltaic (PV) panels, which produce electricity.

Solar thermal heating uses a second coil in a vented or unvented cylinder. This second coil has a water/glycol mixture heated by roof panels pumped through it, thus heating the water. An overview of a typical solar thermal heating system is shown in Figure 5.

Figure 5 - Solar hot water system



Source: Megaflow

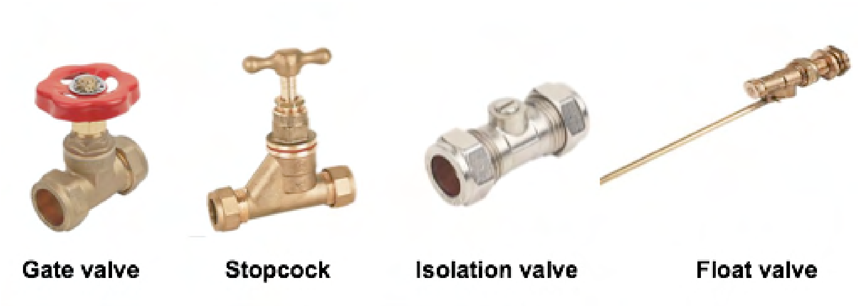
Solar hot water systems have their own control system to shut of the circulating pump (not unlike a central heating pump) when the temperature at the roof panel falls.

Maintaining plumbing

Most people recognize the need to maintain a boiler but few pay attention to maintaining plumbing systems. This is understandable as there is a limited amount that can be done. But some items do need attention from time to time.

Valves

Figure 6 - Common valve types



Gate valves (often with red handles) and stopcocks if left untouched will typically cease up and /or fail to operate satisfactorily. All gate valves and stopcocks should be:

- Operated periodically to keep them operational
- Not left fully opened. Open a valve fully then 'back it off' half a turn. This will assist with the prevention of seizing.

This advice particularly applies to stopcocks, which sometimes have to be used in an emergency.

In more complex systems valves should be identified by labeling so a householder and the next plumber knows which is which.

Float valves, usually found on header tanks and toilets also needs periodic maintenance to check the height of the water in the tank/toilet and adjust the valve if necessary.

Waste systems

Waste systems need to be maintained from time to time in order to keep them clear and prevent blockages. Bath, basin and shower wastes should be cleaned from times to time and any build up of residue removed. If the residue is not removable a small hooked wire can be used to pull up any build-up for removal.

Similarly 'U' bends should be cleaned if there is any indication of slow running.

External pipe work also needs maintenance. Drains should be kept clear of debris where exposed. If there are trees near to underground drains keep a careful eye on operation. Inevitably tree roots will get into nearby drains and a root cutter will be required to allow continued unimpeded flow.

Toilets and repairs

Toilet types

There are essentially two types of toilet:

- Close coupled; where the cistern sits on top of the pan and the pan and cistern must fit each other.
- Loose coupled; where there is a pipe between the cistern and the pan and the cistern and pan form separate components.

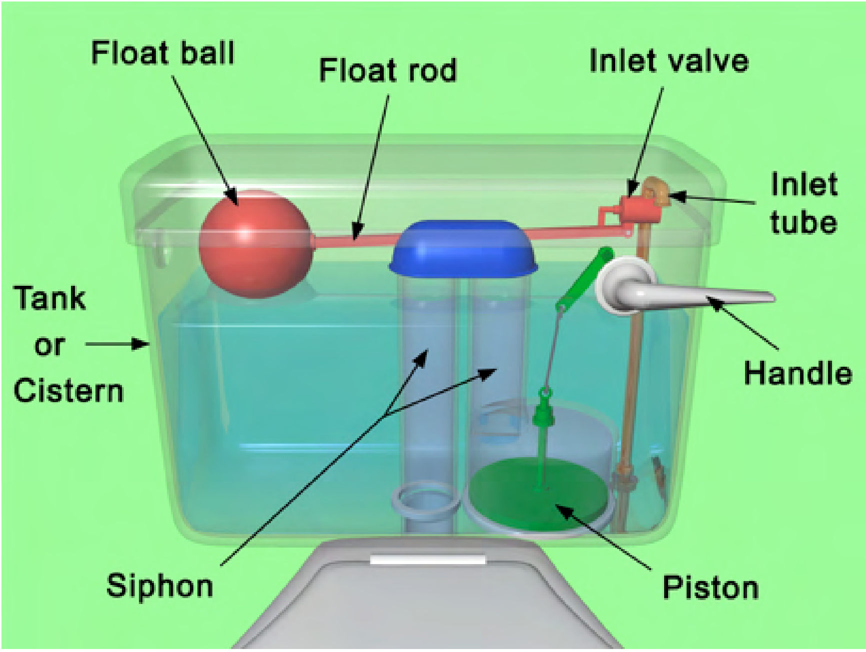
Back to wall and wall hung toilets are increasingly common. They are loose coupled. Back to wall means the rear of the toilet has extended wings, which enclose the soil pipe. The cistern (a separate item) is concealed behind the pan within a piece of furniture or stud wall. The cistern flush is extended to one or twin (short and long flush) push buttons mounted on the stud wall or furniture.

Cistern components

Once upon a time a toilet cistern contained a fairly standard set of components: a float valve, flush mechanism and overflow. Those days are long gone. Although the functions remain the same there are now a wide variety of mechanisms, partly driven by requirements to save water.

Figure 7 is a cutaway view of a toilet cistern and shows the principle components. One that is always invisible is the washer/gasket generally known as a ‘donut’, which sits between the cistern and the pan. Once removed this inevitably needs replacing to prevent leaks.

Figure 7 - Cutaway view of toilet



Source: Wikipedia Commons: Mcgill

Older toilets cisterns will have the more traditional components as shown in Figure 8 where a traditional lever, flush valve, float valve with ball and an overflow to a separate overflow pipe are used. Compare this with Figure 9 where a dual flush mechanism allows short and long flushes (selected by the two push buttons on top of the cistern, which actuate the gray or white semicircular flush mechanisms), a bottom entry fill float inlet valve and an overflow back into the pan are used. The dual flush and inlet valves are typically clipped in using a twist arrangement making servicing simple – if one has the correct spare. Pneumatically operated versions of the dual flush valve are available allowing the push buttons to be mounted away from the cistern.

Figure 8 - Older style toilet cistern mechanisms

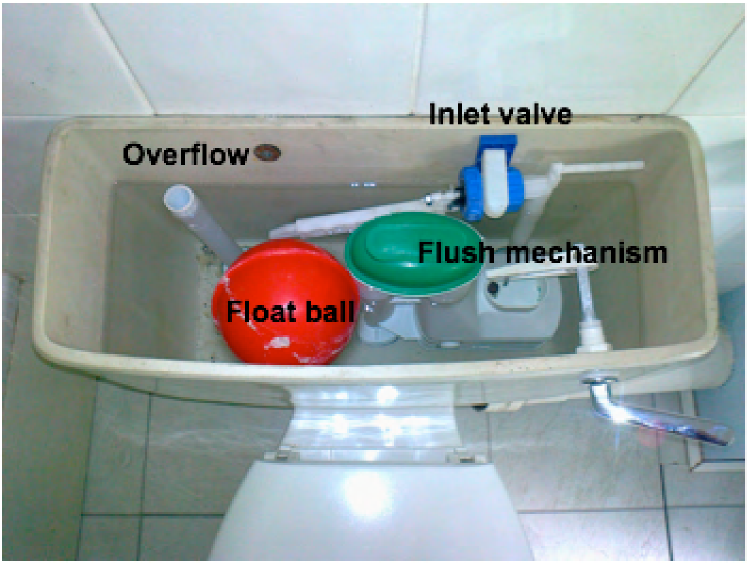
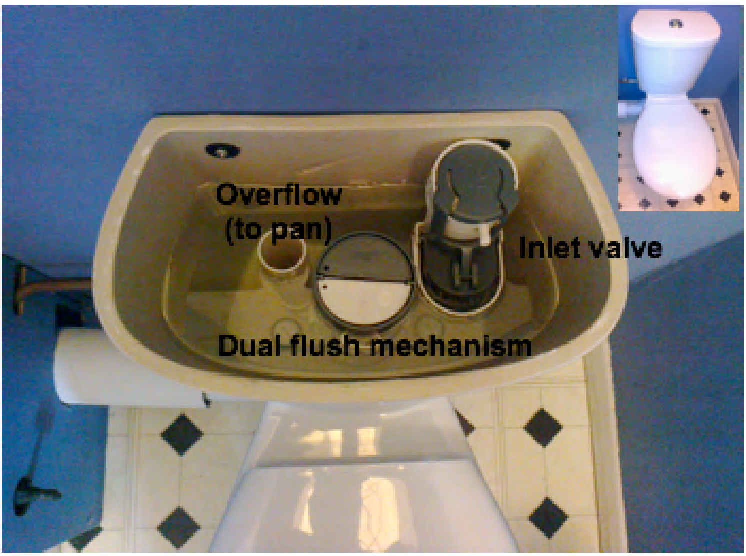


Figure 9 - Newer toilet cistern mechanisms



The other common mechanism is the Torbeck valve. Used on the inlet these have a miniature float, which uses a small sealing washer to allow water pressure to actuate or allow flow past the main sealing washer. These can fit easily in small cisterns but can fail if a small piece of waste becomes lodged in them.	

Because of the wide differential in fittings for toilets seeing if the manufacturer can be identified is always recommended when seeking spare parts. If not removing the faulty component and taking it the to plumbers merchant is a good next step if the requisite spare is not to hand. For a view of the variety of spares that can be purchased visit www.shop.lunns.net/.

Typical faults and remedies

Over filling resulting in the overflow running is one of the most common faults with toilets. The usual cause is the valve or the washer within it has become worn. Frequently a simple washer can be replaced. To do so one has to isolate the water supply. If there is an isolation valve for the toilet then this is easy. If not the first step is to ascertain from where the toilet is supplied. It will be one of:

- The rising main, in which case turning off the main stopcock will stop the water supply to the toilet or
- A header tank, in which case either the tank outlet needs to be stopped with a bung or the main stopcock turned off or a tank feed gate valve turned off if one is fitted and the tank drained down.

If turning off the supply using a gate vale, which doesn't fully isolate the water supply (a typical gate valve issue), check if it is also feeding a bath and /or basin. If this is the case open a bath or basin tap to allow the water to run thus restricting or stopping the flow to the toilet. Bath taps are usually best as they are at the lowest level.

If the float valve and float are both encrusted with scale then replacement is a sensible course of action. The parts are comparatively cheap. If replacing a simple washer and removing a split pin in the traditional float valve assembly use a repair kit which will have a set of components making the job easier.

Figure 10 shows a float valve washer (on the top of the green flush mechanism) being replaced. Remember to check the adjustment of the float level after replacing the washer.

Figure 10 - Float valve washer replacement

Not flushing well usually means a replacement flush mechanism is required. Whilst relatively simple to fit many do require the cistern removing from the pan as the nut holding the flush mechanism in place is often between the two. In this case also replace the washer/gasket 'donut' which sits between the cistern and the pan.

Leaks can come from a variety of sources amongst them:

- The joint between the cistern and the pan (in a close coupled toilet) in which case replacement of the donut is required
- The pipe from the cistern to the pan (in loose coupled toilet). Ensure the alignment is good and replace any rubber washers / connectors
- The overflow pipe, in which case replacing / repairing the float valve will stop the immediate overflow problem whilst the overflow pipe is repaired
- The incoming water supply pipe. To repair this the water supply will need isolating as described above. It is worth fitting a flexible hose either with a built in isolation valve (easiest route as shown in Figure 11) or with a separate isolation valve. If installing a combined push fit valve and hose ensure the copper supply pipe is cut cleanly using a pipe cutting tool and that any paint on the pipe is removed with fine sandpaper.
- The soil pipe. Modern pan connectors rely on gaskets to maintain the seal and these can fail over time, particularly if the toilet is not firmly fixed, thus allowing movement. Leaks of this nature can be slow and go unnoticed. The entire toilet will need to be removed to replace the pan connector. Replacements come in several types (straight, offset, right angled, space saver, flexible and more) so always select the

correct or suitable replacement. Again replace the 'donut' between the cistern and pan in a close-coupled toilet.

Figure 11 - Push fit flexible hose with isolation valve and (below) 'space saver' pan connector

- A cracked cistern is not unknown. If it's not obvious where the water is coming from examine the cistern carefully and use toilet tissue to dry areas whilst looking for leaks.

A toilet seat or fixings that are broken means a replacement. Components are available but a new seat is the usual course of action. If the old fixings are plastic then this is a straightforward job. If they are metallic and rusted and if an application of lubricant fails it may be necessary to carefully cut through the old fittings in order to remove them.

Note that back to wall toilet seats fittings require expanding well nuts such as those shown on the right and that these need to be the correct size. This is because there is no access to the area beneath the seat fixings.	

Blockages and macerators

Toilet blockages, out-with public facilities, are relatively rare. The first step is to check if it is the actual toilet that is blocked and if so is a macerator fitted.

An example of a macerator is shown in Figure 12. This one is connected to the toilet only but some models may also have a basin and or shower / bath waste connected as well. These devices use a rotational blade to liquefy waste and pump it into a small bore pipe, which is connected to a standard soil pipe some distance away. If a macerator is fitted then check all other drains are working and if so check the macerator is functioning. Macerators turn on automatically via a float valve and are powered from a fused spur. The usual problem is the use of the toilet for disposal of items the macerator can't handle in which case it will need removal, dismantling and if possible repair. It's not complicated but it is messy. Companies such as Saniflo provide a service and their agents carry the requisite spares.

If the blocked toilet has a regular waste connection then check all other wastes in the house and if other houses or flats are nearby check the neighbours if possible. If all are OK then the probability is the toilet itself is blocked in which case a plunger should free the blockage. If other waste outlets also have issues the next step is to identify and lift drain covers to see if the problem is external to the property, in which case it's time to call in a drain clearance company, who usually jet out blockages.

Figure 12 - A macerator behind a toilet

Source: Saniflo

Water heaters, showers and repairs

Types of water heaters

There are two types of electrical water heaters found in households:

Immersion type heaters, which heat up water on a timed or continuous basis. Examples of these include the common immersion, as found in cylinders in airing cupboards. Similar examples can also be found over and under sinks. They all have an electric element, which is immersed in the water to be heated, a thermostat and in all modern units a means of preventing overheating should the thermostat fail. This is frequently in the form of a cutout. All water heaters of this type store the hot water within the heater cylinder. Electrically they are characterized by being rated at up to 3KW (3000 Watts) and as such can be fed from a 2.5mm cable.

This book's companion electrical guide details the electrical aspect of immersion heater repairs. The immersion cylinder section of this book deals with identifying and replacing immersion fittings and cylinders.

Instantaneous water heaters provide instant hot water without the need for storage. These come is a considerable number of differing types and include the common electric shower and simple over sink hand wash unit. Instantaneous water heaters do not store heated water but heat the water as it flows through the device. This requires more power, albeit for a shorter period. The larger devises such as electric showers are rated at up to 11KW (11,000 Watts). This type of power demands a 10mm cable and an MCB rated at 50 Amps.

This book's companion electrical guide details the electrical aspect of instantaneous water heater repair. The following section deals with the plumbing aspects.

Shower repairs

The majority of showers fall into one of three categories.

Electric showers are fed with cold water only and use electricity to heat the water as it passes through the shower. To heat an adequate supply of water quickly requires a substantial amount of electrical power. Because of this electric showers have their own supply from the consumer unit. Most models are fully integrated in a single unit but some have a remote heater and pump unit and a (low voltage) control in the shower space. It is uncommon for problems to arise with the electrical supply to showers; the most frequent problems arise with the shower units themselves and most commonly comprise leaking and operational failure.

Electric showers are fed from a rising mains supply with a minimum running pressure of 1.0 bar and should have a gate valve or isolation valve in the water supply pipe. Locating this is always the first step when making plumbing repairs. Remember that showers should always have a de-scaled head and if there is any hint that debris has got into pipe work (e.g. from insulation in a header tank) a clear inlet filter. Both issues can cause malfunction of the main unit.

If a repair to the shower unit itself is to be attempted check the shower spares web sites for component parts list, diagrams and costs. The cost of electric showers has fallen in the last few years to the extent that it is frequently more cost effective to replace a faulty electric shower than try and repair it, particularly in hard water areas where scale builds up over time reducing shower life expectancy.

If obtaining a replacement shower, try to locate a unit with a similar ‘footprint’ (electrical and plumbing connections), as this will keep the installation costs down. Some replacement showers with multiple entry points for water and cabling are also available. You can check footprints on the shower-spares web sites. Don’t be fooled into thinking the same model some years later necessarily has the same footprint; frequently they don’t.

Note that the consumer unit supplying the shower must (for new installations) or should (for pre 2008 installations) have an RCD fitted, if not a 'shower consumer unit’ comprising and RCD and MCB can be fitted to supply just the shower. New installations have to be certified and notified to Building Control under Part P of the Building Regulations. . Some older installations have a smaller supply cable so check the required cable size if replacing a shower with a higher wattage unit. There is a table available in the technical support section of www.the50plus.co.uk.

Adequate earthing and equipotential bonding is essential for safety. Unless the building’s electrical installation is to post 2008 standards supplementary bonding is also required in or near the bathroom.

Power showers comprise a pump housed with a mixer valve. They utilize hot and cold supplies that must be of equal pressure and cannot be used with a combi boiler. They also use a good deal of water so an adequate supply is needed meaning tanks must be large enough. A 50-gallon minimum tank size (or two 25 gallon tanks in parallel) is recommended. The cold supply to the shower should be direct from the cold tank in the loft and the hot directly from the hot water cylinder via an Essex or Surrey flange. This is to prevent hot taps being impacted when the shower is working and also to prevent the shower sucking in air. Some small combination cylinders are unsuitable for use with power showers due to restricted water capacity.

Similar points to electric showers apply: locating the incoming gate or isolation valves before repairing; the economics of repair versus replacement and checking heads and inlet filters are clear.

Shower mixer valves come in thermostatic, non-thermostatic, concealed and exposed models. Shower mixers utilize hot and cold supplies in the same way as power showers and follow the same rules with regard to water supplies. Many installations have a **shower pump** to boost the flow. This is relatively low power and fed from a fused spur (or RCD spur if the consumer unit does not have an RCD).

Most mixer valves have a 'cartridge' as shown in Figure 13, which is replaced as a single unit and can cost into three figures for the part. Remember to check the cartridge type: gravity, pumped or combi. The cartridge is often colour coded to indicate the type of water supply it works with: gravity, combi or pumped.

Typical issues with shower mixer valves are leaks from the front in which case the water runs into the shower tray or bath or from the rear in which case the wall gets wet. The usual problems are the ‘cartridge’ or, if you are lucky, just the seals which may or may not be available separately.

Figure 13 - Shower cartridges

Source: Aqualisa

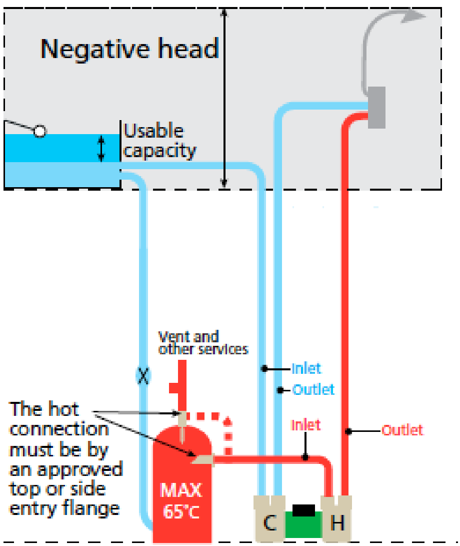
The first step is to identify the make and model of mixer valve, not always easy as many are unmarked. A photograph is often useful as there are pictures or diagrams of most models, both current and past, on spares web sites. Once spares are on hand the hot and cold water supplies need to be isolated for the parts to be fitted. If isolation valves have not been fitted shut off the hot water by turning off the inlet valve to the cylinder and the cold supply at the tank.

If replacing the entire fitting go for a similar model if possible or check the inlet pipe spacing, some newer models have adjustable pipe widths. If the valve is concealed (i.e. in the wall) de-tiling may be required so check for availability of spare tiles.

There are many differing makes and models of showers so if in doubt about how to dismantle check the spares web sites for diagrams.

Shower pumps come in positive and negative head versions. A positive head shower has the water tank from which the water 'head' is derived well above the level of the showerhead when in use. A negative head shower has the water tank less than a 0.6m or so above the showerhead OR below the level of the showerhead when in use as shown in Figure 14. Negative head shower pumps are identifiable by the vacuum tank located on the side of the pump (but note there are 'universal' pumps which are similarly equipped). An example is shown in Figure 15.

Figure 14 - Negative head pump installation

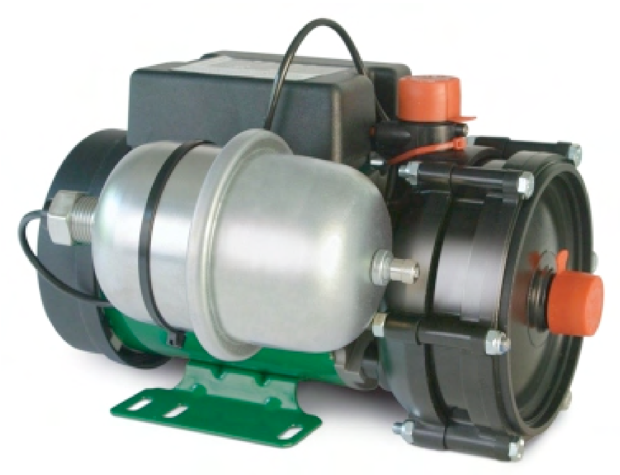


Source: Salamander Pumps

A positive head pump will not work in a negative head situation. If you find a pump has intermittent operation but works when the showerhead is lowered then a negative head pump is needed.

Shower pumps can develop leaks in their seals and if this is the case then the pump should be replaced. Most have isolation valves on the inlets and outlets associated with the flexible hoses so the job is relatively simple. Occasionally items such as bearings fail and this also means a replacement pump.

Figure 15 - Negative head shower pump



Source: Salamander Pumps

Under and over sink water heaters

Under and over sink water heaters are common in all electric domestic properties and commercial installations. They come in two forms, over and under sink.

Over sink are wall hung and usually fitted with an open vented spout that hangs over the sink. Such units have a cold-water feed only. Some are instantaneous and operate in a similar manner to an electric shower with similar trade offs between temperature and flow rate, some store water and are small immersion cylinders. Note that these are generally vented.

Under sink water heaters come in both single point and multipoint variations with the latter feeding one or several taps. Some are vented so if no expansion vessel or tundish is seen ensure when changing taps that the correct vented tap is used and note that these are designed to 'drip' from time to time. Fitting standard taps will result in a pressure build up and is dangerous.

An example of a multipoint unit is shown right and in Figure 16 where it is fitted with pressure reducing and release valves and a tundish and is supplying standard taps.

Source: Heatrae Sadia

Water heaters have elements very similar to those found in immersion cylinders but of a differing size. They can be tested and replaced in much the same way as immersion elements as detailed in this books companion electrical guide.

Replacement of external pressure release valves is sometimes necessary if they leak/let by, usually resulting in water in the tundish. Ensure the correct value (of bar) valve is fitted and that the unit is vented and preferably cooled before working on it.

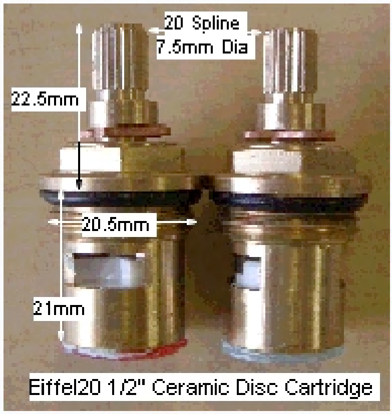
Figure 16 - Multipoint heater installation

Multipoint heater installation in an under sink cupboard with (from left to right): fused spur, heater with pressure release valve on top, expansion vessel, pressure reducing valve and tundish.

Taps and repairs

It all used to be so simple. The tap dripped, the water was turned off, the spanner was applied, the tap came apart and a new washer was inserted. Such simplicity is fast disappearing. Today there are over 200 varieties of tap washers and cartridges, examples of which are shown in Figure 17.

Figure 17 - Tap washers (left) and cartridges (right)



Source Lunns - www.lunns.net

There is an increasing move to the use of cartridges of various sorts in place of the previously ubiquitous washer. Ceramic cartridges are more durable over a longer period of time than the old washers. They are also usually maintenance-free; until such time that they stop working. Most can't be repaired but you can try cleaning for a short-term fix. Although there are a number of 'standard' sizes it is generally a case of locating the correct cartridge or replacing the tap.

For hot taps (assuming there is no isolation valve) the inlet to (or outlet if fitted) from a cylinder will probably need to be turned off by way of a gate valve (usually red) and these often fail if not maintained. Approach stiff ones with care; too much force often results in a snapped shaft in which case a drain down and new valve will be required.

Where there is a combi boiler the hot water can be turned off at the boiler. Where there is a pressurised cylinder the hot water can usually be turned off at the cylinder.

In hard water areas taps with washers can sometimes be 'reseated' but if they have been dripping for some time they are best replaced. Reseating tools are available from many tool stores and plumbers merchants.

There are a number of taps, which produce water suitable for making hot drinks on the market; these are either:

- A single very hot water only tap or
- Multi-use combination taps whish offer cold, hot and very hot water supplies.

Both varieties deploy a tap connected to an under sink water heater. Although the parts are unique to the specific models the faultfinding process is similar to regular taps and/or under sink heaters. Note that in hard water area they do need to be serviced regularly as scale build-up can cause malfunction.

Central heating and fault finding

To repair central heating one needs to be both a plumber and electrician and as systems become more complex the electrical aspects are becoming increasingly important.

Some of what goes wrong with central heating and hot water systems is centred on:

- The system controls, which are fully described in this books companion electrical guide and which addresses the associated faultfinding.
- The boiler, which is outside the scope of this book.

The following sections address the plumbing problems that can be encountered.

Types of central heating systems

Although there are many variations and refinements the majority of installations (excluding night storage and panel heaters) are either sealed or conventional (vented) based systems powered by gas or oil.

The term 'central heating' systems is taken to mean a system that provides heating through a common central boiler which also provides hot water.

The two most common systems are:

- A 'combi' boiler with a sealed system operating under pressure.
- A system with a conventional boiler and indirect hot water cylinder.

The two systems are shown in Figure 18.

Figure 18 – Common forms of central heating system

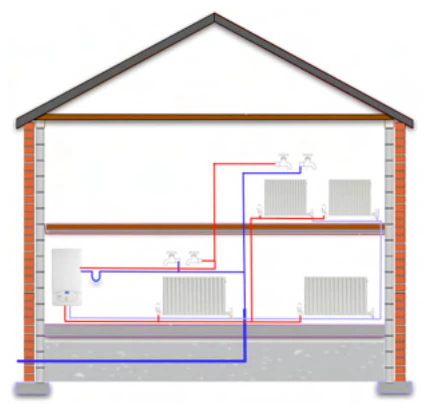
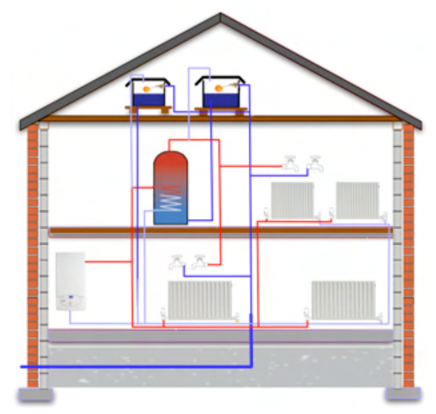
Combi sealed system	Conventional system
	

Figure based on an original idea by UWE

The types of plumbing problems associated with heating and hot water systems include the following, which are in alphabetical order and addressed in detail below.

- Airlock
- Blockage(s) in systems
- Failed / jammed radiator valve
- Individual radiators failing to operate
- Leaking cylinder
- Leaks into floors
- Poor circulation
- Pressure loss
- Warm/hot water in cold water header tank.

Airlock

Airlocks can occur in both water supply and heating systems. They generally occur after draining down and system refilling. They are most common where there lengthy horizontal, uphill or up and over pipe runs.

Airlocks are best addressed by venting a system, which works in most cases although some require a good deal of patience and frequent operation of radiator bleed valves (Figure 19) for central heating systems.

Figure 19 - Radiator bleed valve with key inserted

If required a degree of pressure can be applied, thus forcing the air out. The source of such pressure is the cold water mains.

If the problem is a hot water system and there are separate hot and cold taps at the kitchen sink then connecting the two together with a hose will suffice. If a mixer tap with a combined spout exists it can be worth trying to block the spout and turn on both the hot and cold, thus forcing cold water back up the hot supply pipe.

If the issue is with a vented central heating system then connect the cold water main to the heating system drain down point: look for a radiator valve such as the one shown in Figure 20. Be aware that the central heating header tank could be back filling and as such a watchful eye is required to ensure it does not over fill.

Figure 20 - Radiator valve with drain off point

Drain-off points may be independent of a valve and/or fitted elsewhere in systems or sometimes may be found connected to a pipe which runs to the outside of the premises.

Blockage(s) in system

Blockages in systems are usually caused by ingress of foreign matter. Typical sources are insulation, which has found its way into a roof tank (ensure they are covered) or similarly rodents or birds. The first task is always to deal with the source in the header tank(s). If animal matter has entered the cold-water header tank then drainage and a flush through of supplies to all taps with a sterilising fluid is recommended.

If the blockage is in the hot water supply (fed from the main cold tank) then the chances are the gate valve to the cylinder will have caught the debris. After isolating the supply to the header tanks(s) or tying up the ball valves, drain the tank and run off the water in the cylinder until it is below the level of the gate valve, remove the gate valve and fit a new one (it's an opportune moment). Small rodents have been found in pipes before but are usually caught at the tap so it is possible but unusual that a single tap may need opening up.

Also check inlet filters to shower pumps.

It is unusual for debris from central heating header tanks to get into the system as very little water is drawn off under normal circumstances.

The poor circulation section below deal with central heating sludge and pump issues.

Failed / jammed radiator valve

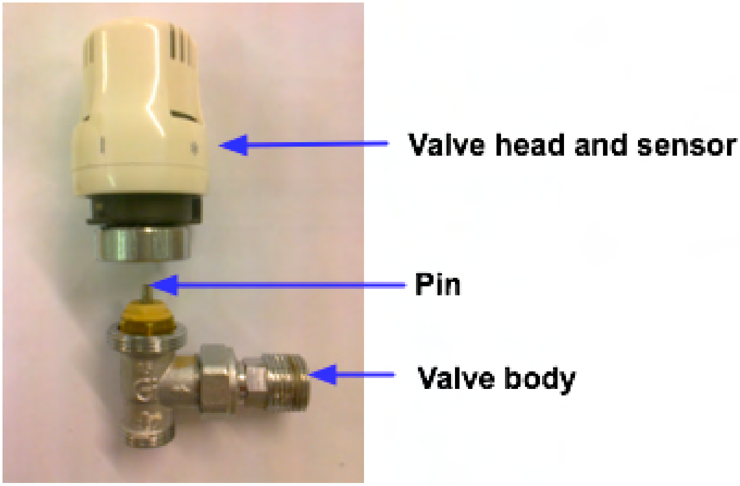
Radiator valves come in two types: manual and thermostatic. The latter should always be fitted on the flow side of the radiator.

If a manual valve is jammed and won't free up with the application of lubricant then it will need replacing. This means a systems drain down from the drain down point (Figure 20) remembering to tie up the ball valve in the header tank and when refilling to add an inhibitor to prevent corrosion and sludge build up.

If a thermostatic valve has stuck then the first step is see if it can be freed.

Thermostatic valves, as shown in Figure 21, operate by using gas or liquid filled bellows in the valve head. The gas expands as the room temperature rises, causing the sprung pin in the body to be depressed which restricts the water flow through the radiator. Turning the valve head alters the distance between the bellows and the pin, thereby altering the room temperature at which the valve actuates.

Figure 21- Thermostatic valve



The pin itself can stick, particularly after a period of inactivity such as the summer months. Frequently a repair is possible without having to change the valve and therefore without the need to drain down.

If a thermostatic valve fails to operate remove the valve head by unscrewing the retaining ring (located at the base of the valve head) and thus exposing the pin. See if the pin is moving freely – it should be 'up' when the valve head is removed and push down easily with e.g. pliers, if not your finger. If it doesn't move freely apply lubricant and if required apply gentle assistance with snipe nosed pliers (pull up). When the pin is free, lubricated and moving freely, refit the valve head.

Individual radiators failing to operate

If an individual radiator fails to operate and this is a recent event there are two potential causes.

Air in the radiator. Bleed it as shown in Figure 19. If air is released then keep going until water is let out of the bleed valve. The radiator should then rapidly heat up.

A faulty thermostatic valve. Refer to the previous section.

If the radiator has been cold for some time then there is a possibility that the radiator has become clogged up with sludge. Sludge is caused by the corrosion of the heating system components and is why an inhibitor is added to the circulating water to prevent it. If there is also excessive noise from parts of the system, poor circulation and cold spots elsewhere then sludge is a likely cause. Individual radiators can be turned off, the radiator removed (protect carpets well) and flushed through with a hose. If the whole system is seemingly the problem a good first step is to add a proprietary cleaner to the system at the central heating header tank, give it time to circulate and then flush the system through by draining down. The process may need repeating. If the water drained from the system is not clear then it needs cleaning and flushing. Remember to add an inhibitor for the final fill. It may be necessary to power flush the system to remove contaminants.

Leaking cylinder

Refer to the section on immersion cylinders.

Leaks into floors

Poor joints or corrosion can cause leaks into floors from pipes in floors. Copper pipes in screed must be sleeved or laid in truncking to prevent the screed attacking the copper. If a leak in a floor is suspected then the floor will need to be excavated where the leak is thought to be and a repair made.

Listening carefully is a good way of finding leaks, which can often be heard. Otherwise follow the damp but also use pipe detectors if the pipe run is unknown.

Poor circulation

A failed pump is the primary cause of poor or no circulation, assuming it's not sludge or a 'no circulation' situation caused by a controls issue such as a faulty electrically actuated valve.

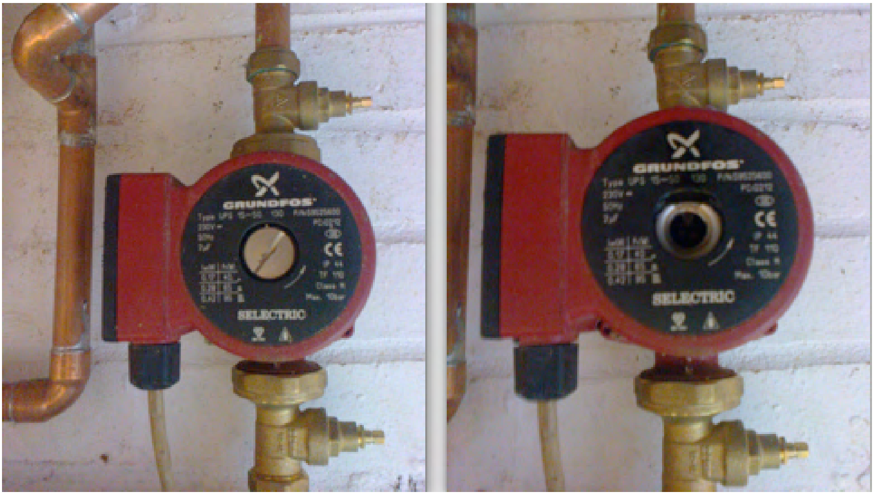
If you think the pump is not operating try changing the speed switch, usually 3-position and located on the side of the pump where the cable comes in, which should produce an audible change.

Check that the hot water on the inlet is flowing through to the outlet. If a pump is very hot and there's no flow then it probable the pump has ceased.

You should be able to 'feel' a pump running by checking the pipe temperature on either side of the pump (beware – these pipes can be hot enough to burn) and/or by placing a screwdriver tip on the pump and your ear on the handle of the screwdriver.

To check the mechanics of the pump, power off the central heating and remove the pump bleed screw; be careful if the water is hot and have a cloth ready. Insert the screwdriver and test if the pump can be turned – they often cease up during the summer months. A pump with and without its bleed screw is shown in Figure 22.

Figure 22 - Central heating pump bleeding and checking



Note the two isolation valves either side of the pump in Figure 22 enabling the pump to be isolated prior to undoing the two large nuts, which attach the pipe work to the pump.

Pumps are directional; always re-install the same way, unless you believe the initial installation was incorrect. In Figure 22 the flow is into the bottom and out of the top, imagine a line that includes the rotational arrow on the pump. Most pumps have the flow direction marked on them. Always buy washers when replacing a pump, as the old ones inside the two large nuts will not be reusable.

Pressure loss

If pressure loss is occurring on a combi system there are two common causes:

- A leak in the central heating pipe work. A good inspection of pipe work (including radiator valves) and flooring on apparent pipe runs is required. If this doesn't show any signs of dampness re-pressurise the boiler (Figure 23) and check the loss again. If it's still leaking start looking at accessing pipe work.

- A pressure release valve is letting by. Check any metallic outflow pipes from the boiler (a plastic one should be condensate). If there is a discharge a gas safe person will be needed to investigate the boiler.

Figure 23 - Combi boiler filling loop (designs vary)

A combi boiler filling loop, usually located under the boiler or nearby. With the isolation valve open (right of picture) open the valve to the left until the pressure gauge on the boiler reaches the required value.	

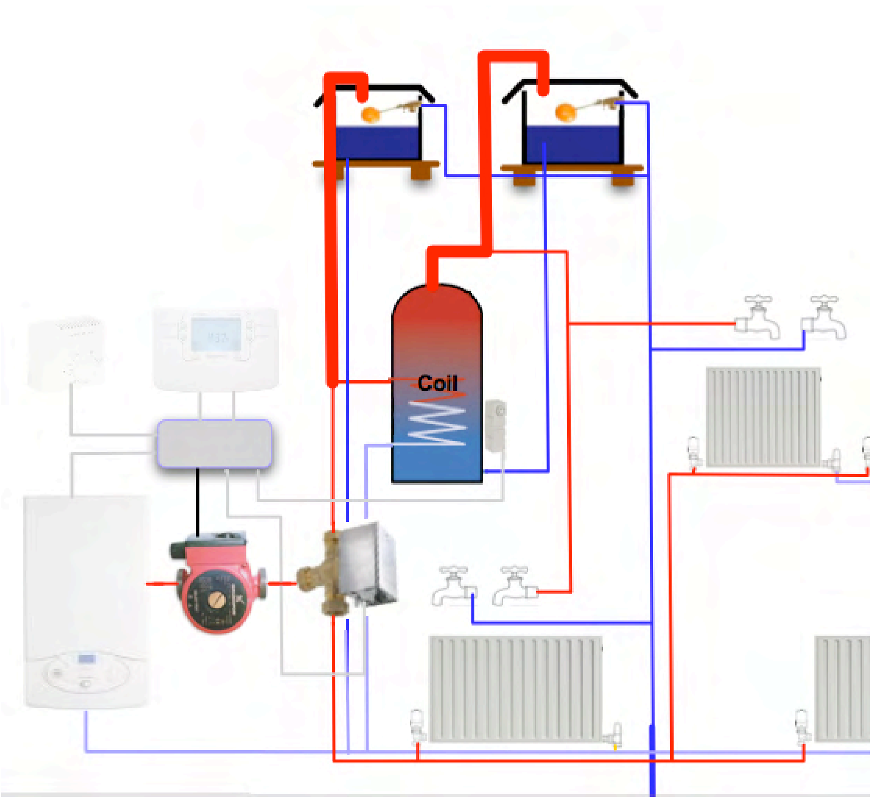
Warm/hot water in a header tank.

A range of problems can cause warm or hot water in a header tank.

The first step is to ensure that there are no blockages in the system causing the water to be pumped up an expansion pipe instead of around the system, typically to the smaller central heating header tank on the left in Figure 24. Run a check for all radiators being hot and the hot water heating satisfactorily. You can try reducing the pump speed but if all was well previously this will not be the root cause.

A not infrequent cause is a leak in the coil in the cylinder. This causes the heated water in the cylinder / central heating circuit to pump water into what should be the separated usable water part of the cylinder. This then overheats or pumps the water flow up the cylinder expansion pipe to the cold water header tank, on the right in Figure 24. If possible stop water flowing into the cylinder circuit. In the case of a system configured as in Figure 24 this can be achieved by using the controls to tell the system only central heating is required, causing the 3-port valve to allow pumped hot water to the radiators only. If a failed coil is suspected a new cylinder is required.

Figure 24 - Hot water reaching one or more header tanks



Immersion cylinders

UK cylinder types

A range of cylinder types can be found in UK homes. The most common types are:

- Direct (electrically heated only)
- Indirect
- Combination (also known as Fortic)
- Pressurised.

You may also find:

- Self priming / primatic
- Harco packs.

These are shown in detail in the following paragraphs.

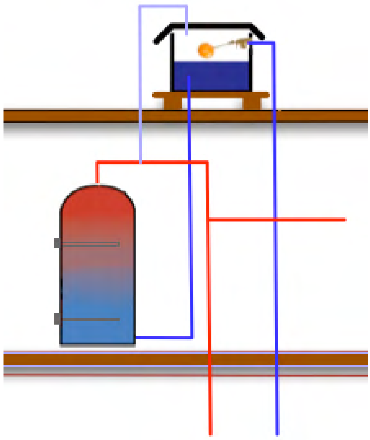
Figure 25 - Direct cylinder installation

Direct cylinder

Direct cylinders typically use one or two immersion elements to heat the water and have no coil.

Some very old systems can also have hot water from the boiler circulating directly through the cylinder

Fittings are usually fittings 2 x 1″ female iron tappings.



Indirect cylinder

Indirect cylinders have a coil through water heated by a boiler is either pumped or circulates naturally (gravity fed system). This is the traditional cylinder used in many family households. It is suitable for use with a variety of boilers.

Fittings are usually two 1″ female (top and cold in at the base) and two 1“ male tappings (on the coil).

Figure 26 shows an actual immersion cylinder installation together with associated pipe work and valves.

Figure 27 shows the schematic of a typical arrangement.

Figure 26 - Immersion cylinder installation

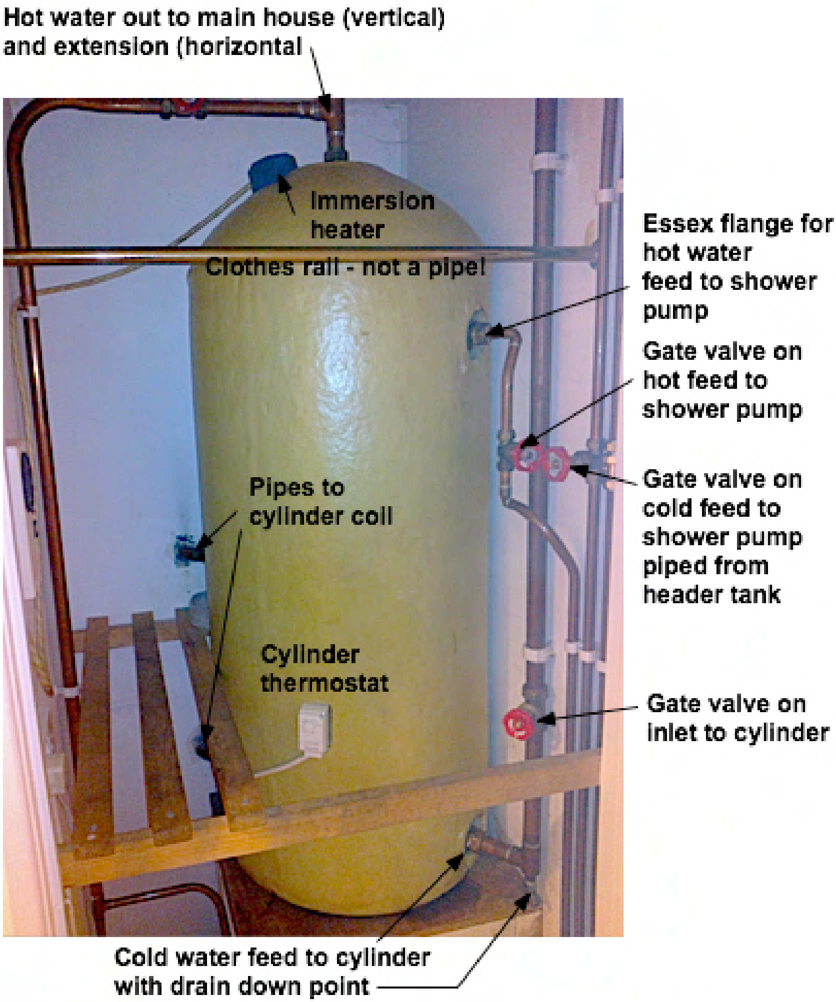
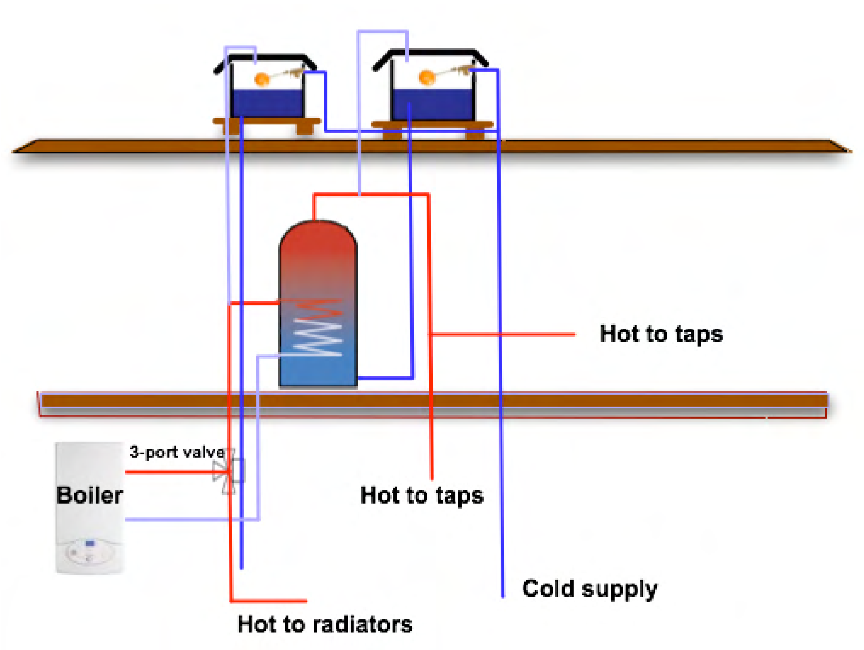


Figure 27 - Indirect cylinder arrangement



Combination / Fortric

Combination cylinders, also known as 'Fortic', a brand name, combine a cold-water header tank and hot water cylinder. The cold-water tank is located as an integral part on top of the cylinder with the feed and vent pipes built in. They are often used where space is limited. Figure 28 shows direct versions i.e. heated by one or two immersions. Combination cylinders are also available as in-direct models i.e. with a coil but these are less common.

Figure 28 - Combination cylinder

Pressurised cylinders

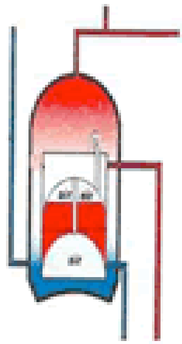
Pressurised cylinders are increasingly popular. It's the hot water that is pressurised, not the primary. Benefits include better shower pressure without the need for a pump (which can't be fitted). The pressure is typically set at 1 bar when cold. Figure 4 shows a schematic of a pressurised cylinder installation.

Self-Priming / Primatic

Self-priming or primatic cylinders incorporate a patented heat exchanger designed to provide two airlocks to prevent the primary and secondary water systems mixing. This removes the need for a separate expansion and feed system for the primary circuit. They are identifiable by the absence of the second smaller header tank. Typical fittings are two 1" male on the primary and two 1" female on the cold inlet and hot water outlet.

Figure 29 - Self priming cylinder

Self-priming cylinders are no longer fitted, are not suitable for use with any form of pumped shower and are not suitable for use with inhibitors in the central heating circuit as failure of the air bubble could cause contamination of the direct hot water by the indirect.



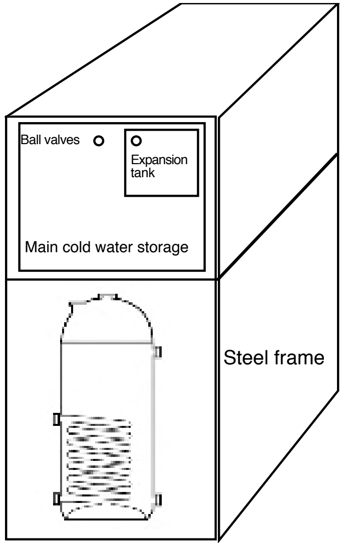
Harco packs

Harco packs are a way of combining a cold-water tank and immersion cylinder on a single frame. They were popular in flats, usually public housing. Refurbishment programmes have resulted in many being replaced by combination boilers.

Figure 30 - Harco pack

<table>
<tr>
<td>Harco packs came in both direct and indirect varieties (indirect shown with expansion tank).

Fittings are typically two 1″ female (top and cold in at the base) and two 1″ male tappings (on the coil).

If a shower is required in a property with a Harco pack fit an electric one to prevent issues with the availability of water.</td>
<td>
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Cylinder and header tank sizing

Cylinders and header tanks need to be suitably sized for the intended use. Installing pumped showers can cause a lack of hot water in a short space of time.

Hot water usage varies with the type of building, its uses and the number of occupants. Occupant usage may vary depending on their level of activity, age, and water usage by other facilities such as appliances.

In modern homes hot water usage varies between 35 and 45 litres per person per day but power showers can significantly increase this. Total water usage varies considerably but around 160 litres per person per day has been measured (Ofwat, London 2004-09 average).

Usage rates are around the following.

- A wash hand basin tap will use 0.15 litres per second at 40 degrees C
- A kitchen sink will use 0.20 litres per second at 60 degrees C
- An average bath can use 60 litres of hot and 40 litres of cold water
- Modern showers can use up to 50 or more litres of blended water per minute so need good sized header tanks and hot water cylinders.

Hot water temperature setting

The hot water temperature is normally set at between 60 - 65 degrees centigrade. The temperature on a cylinder should be set at a minimum 60 degrees to prevent legionella developing.

The settings are in theory:

- 60 degrees to keep legionella in check
- 65 degrees to restrict survival to a few minutes.

70 degrees and over can cause the formation of lime scale.

If there is a need to restrict water temperature such as in homes for the elderly then mixer valves should be used to restrict the temperature at taps and showers to 45 degrees. A number of mixer showers have this facility built in.

Replacing a cylinder

Cylinder replacement is a relatively straightforward plumbing job. Areas to be aware of include:

- System drain down and refill. This is something that should be straightforward but often isn't. Non-operational gate valves which need replacing and airlocks when re-filling can cause delay.
- When replacing an un-lagged cylinder allow an additional 50mm (2") for lagging on the new cylinder of the same nominal size. Some suppliers offer cylinders with reduced insulation thickness enable fitting in a tight space. A new or recent cylinder has factory fitted foam insulation, which is usually blue or green. Older cylinders can be green or orange or have no insulation around a bare copper.
- There are a wide range of cylinder sizes and some older sizes, which are no longer available. Measure up both the existing cylinder size and the available space when seeking a replacement.
- Watch out for 'gas board' cylinders. A number were supplied with only a ¾" outlet which is not suitable for many showers as it constricts the flow rate.

Replacing immersion heaters

Fault finding immersion heater elements and thermostats is covered in this books companion electrical guide.

To replace an immersion heater element (after turning the power off), start loosening the element before draining the cylinder. This offers the benefit of the weight of water in the cylinder holding it in place. If the element is reluctant to loosen heating can sometimes assist. If the element has been fitted with a jointing compound it may not be possible to free it and a new cylinder will be required.

Check the inlet gate valve is functioning before draining down and have a beware that the drain down cock and /or its washer; both can fail if unused for a long time.

Elements come in a range of sizes so consider which is required when purchasing; most come with a thermostat. For hard water areas, elements with a metallic covering that is less susceptible to corrosion are available.

Resealing baths and showers

Resealing a bath or shower is a job that is often required and frequently under estimated.

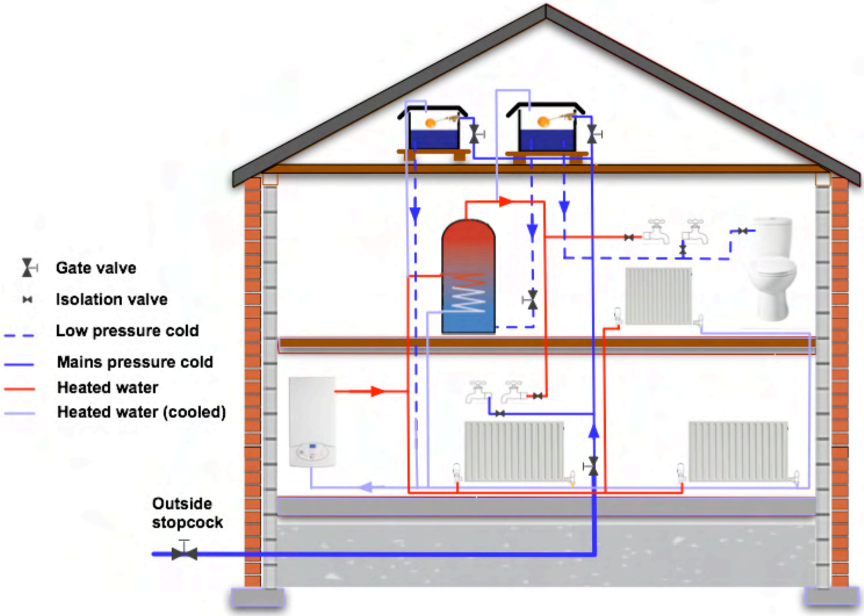
Sealing on top of old sealant can fail so old sealant needs to be removed. The best method is to cut as much as the old sealant away as possible, a thin bladed hobby knife is useful for this, then use a sealant remover (solvent) to finish the job.

Sealant is not a gap-filler. If there is a significant gap (more than around 2mm) then this will need something like gripfill to provide a base for the sealant.

If a bath or shower tray is moving such that when in use the gap between the bath or tray and tiles is changing the replacing the sealant is not the answer. The underlying cause of the movement needs to be resolved first, otherwise any leak will reoccur.

Summary – Overviews

Typical household plumbing



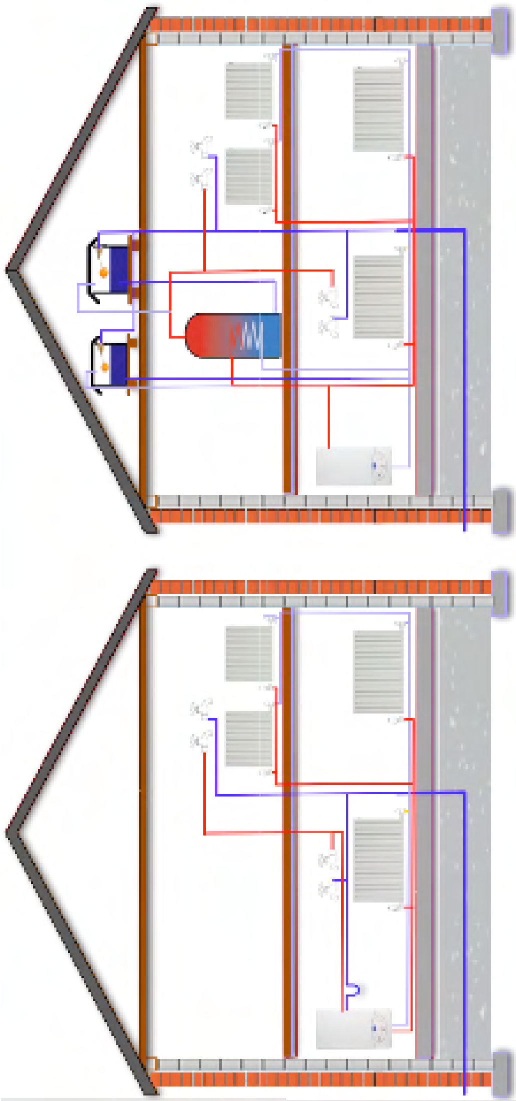

Gate valve


Stopcock


Isolation valve

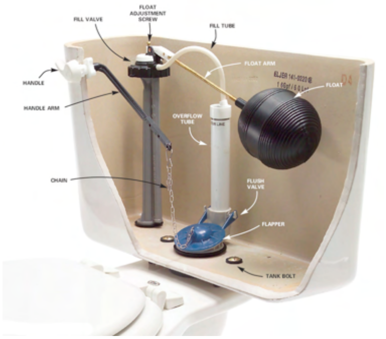

Float valve

Combi (left) and conventional systems



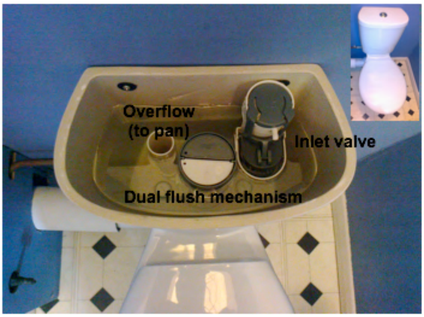
Summary - Toilets

Cutaway view



Older style

Newer style



Connections

Macerators pump liquidized waste via a bath/basin waste sized outlet pipe allowing a toilet o be located where a standard sized soil pipe is difficult to install

Summary – Water heaters and showers

Types of water heaters

Immersion type heaters, which heat up water on a timed or continuous basis

Instantaneous water heaters provide instant hot water without the need for storage.

Electric showers fed with cold water only and use electricity to heat the water as it passes through the shower

Power showers comprise a pump housed with a mixer valve. They utilize hot and cold supplies that must be of equal pressure

Shower mixer valves come in thermostatic, non-thermostatic, concealed and exposed models

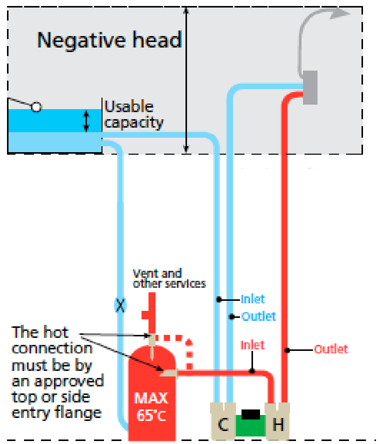
Thermostatic

Manual

Shower valve exterior

Shower pumps come in positive and negative head versions. A positive head shower has the water tank from which the water 'head' is derived well above the level of the showerhead when in us.

A negative system is shown to the right and a negative head pump below.



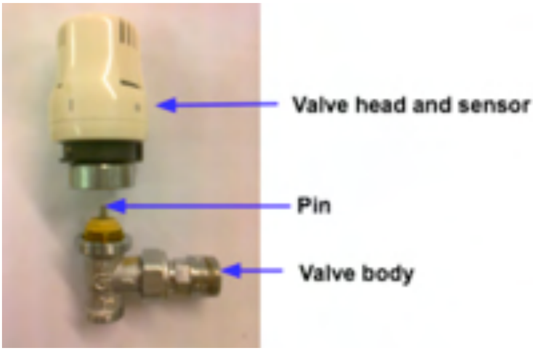
Under sink water heater installation with a pressure cylinder, pressure release and pressure reducing valves.

The heater is run from the fused spur to the left of the picture.

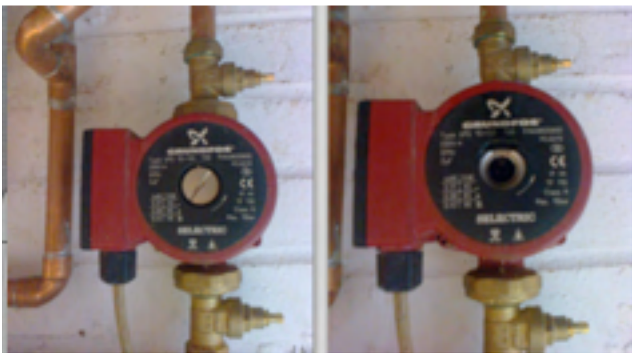
Summary – Central heating and cylinders

Radiators bleeding and a drain down point

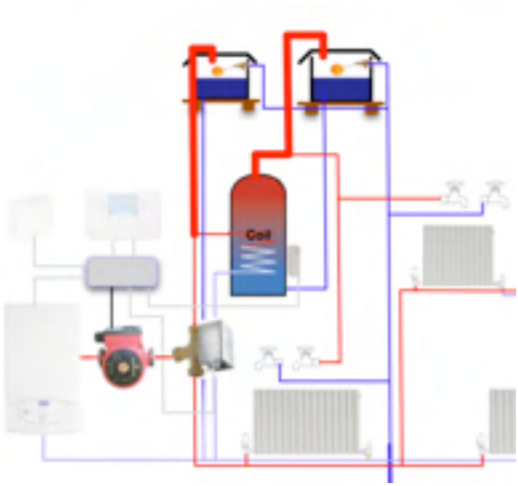
Thermostatic radiator valve and combi filling loop



Central heating pump bleeding and checking

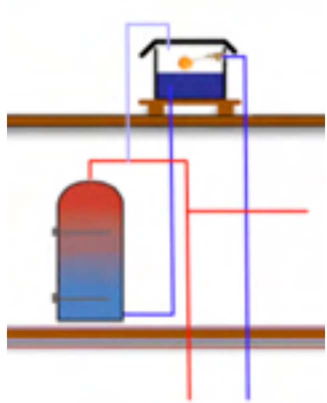


Blockages or leaks in cylinder coils are typical causes of hot water in header tanks.

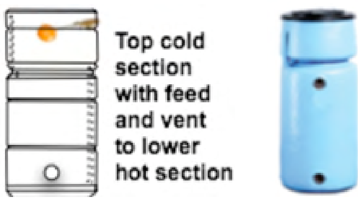


Indirect cylinders (above) have a coil through water heated by a boiler is either pumped or circulates naturally (gravity fed system).

Direct cylinders (right) typically use one or two immersion elements to heat the water and have no coil.



Combination cylinders, also known as 'Fortic', a brand name, combine a cold-water header tank and hot water cylinder.



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