

Trade of Plumbing

Module 3: Domestic heating/MMA Welding

Unit 2: Domestic Heating Systems

Phase 2

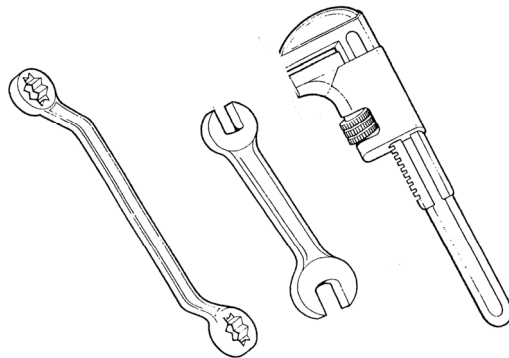


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June 2006	V.1.0	
17/02/14	2.0	SOLAS transfer

Module 3 – Domestic Heating / MMA Welding

Unit 2 – Domestic Heating Systems

Duration 10 hours

Learning Outcome:

By the end of this unit each apprentice will be able to:

- Describe the working principles and types of domestic heating systems.
- List the basic components of domestic heating systems and describe their function.
- List common and alternative sources of heat energy.
- Draw schematic representations of domestic heating systems.

Key Learning Points:

Rk	Principles of domestic heating systems.
Rk	Types of heating systems – open vented, sealed systems, underfloor heating systems.
Rk	Components of heating systems – boiler, vent pipe, pumps, cylinders, radiators, feed & expansion tank/expansion vessel, safety valves etc.
Rk	Pipework layout – one pipe, two pipe, reverse return etc.
D	Drawing of domestic heating systems.
Rk	Location and function of safety valves. Location and function of vent pipe, cold feed pipe.
Rk	Primary flow and return pipework, cylinders.
Sc	Gravity circulation.
Rk	Fully pumped circulation.
Rk	Function, location and components of circulation pumps.
Rk	Types of radiators and radiator valves.
Sc	Heat transfer in heating systems.
P	Filling arrangement for sealed systems.
Rk	Function, location, and size of expansion vessel in sealed systems.
Rk	Sources of heat energy – solid fuel, gas, oil.

Rk	Alternative sources of energy – solar, geothermal, wood pellets etc.
P	Communication.

Training Resources:

Classroom facilities, information sheets, sample heating components, domestic heating pump. Access to small heating system. Toolkit.

Key Learning Points Code:

M = Maths **D** = Drawing **RK** = Related Knowledge **Sc** = Science

P = Personal Skills **Sk** = Skill **H** = Hazards

Wet Central Heating

Introduction

Wet central heating relies on the heating of a quantity of water, circulating that water around the dwelling through pipework to heat emitters - normally referred to as radiators, and returning the water back to the heat source for reheating. In addition the heated water may also be used to heat water that can be used for washing and bathing.

From simple beginnings the modern wet central heating system has developed into a sophisticated heating medium, utilising both new and old technologies, to provide comfort and control for the customer.

The heated water may be circulated around the system by either gravity or by the action of a circulating pump and there are various pipework configurations, boiler types and electrical and mechanical controls that the installer will encounter when work on wet central heating systems. . -

Although there are many pipework variations, in general systems fall into two main categories - systems that are open to the atmosphere and those that are sealed from the atmosphere. We will begin to build our knowledge of central heating by starting with the basic pipework layouts of the more common open systems, and then work our way through the subject areas listed below:

- Pipework Problems
- Sealed Systems
- Boiler Types

This workbook is not intended to be a definitive guide to the design, installation, servicing or maintenance of wet central heating systems but has been developed to provide a foundation of information on which to build upon with experience and relevant training.

We would recommend that you work through the material in a logical sequence. However, each section has been developed as a stand alone section and you may wish to select those areas which you feel are more appropriate to your particular requirements.

Basic Pipework Layouts

Gravity Systems

Water circulation in a gravity system is achieved by the change in the density of the water as it is heated by the boiler, which is normally situated at the lowest part of system. A column of hot water weighs less than a column of cold water of the same volume and height, and the heated water will therefore rise from the boiler and the colder water will fall back via the pipework system to the boiler. The addition to the pipework of radiators and a heating coil within a storage cylinder utilises the circulating heated water to provide heating and domestic hot water, shown in the figure below.

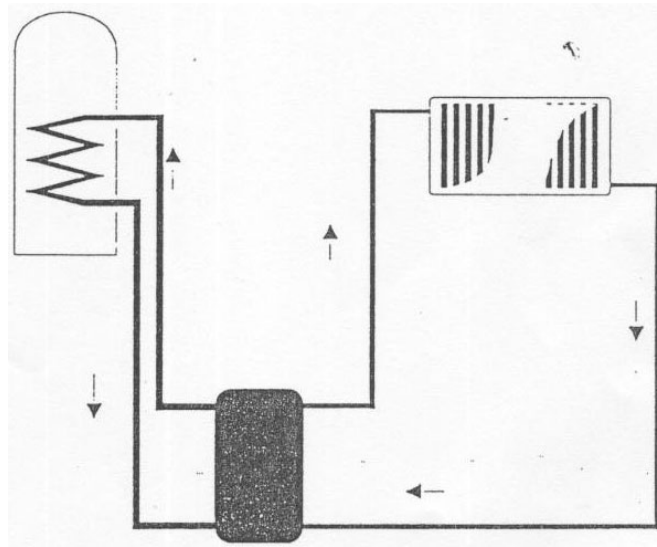


Figure 1. Gravity Circuit

The disadvantages of gravity central heating systems are that they tend to be uneconomical, inefficient, have a very slow heat up time the boiler must be located at the lowest point of the system and they use large and unsightly pipework.

The circulation of water for the central heating circuit originally utilised one distribution pipe, as shown in the diagram, but variations of the pipework layout for the heating circuit were used to improve the effect of gravity to supply heated water to the radiators.

Although no longer installed, the gravity system had the advantage over modern systems that it could be controlled independently of any electrical controls.

The problems of using gravity to circulate water around the system in an efficient and controllable way was solved initially by the introduction of the circulating pump (sometimes referred to as an accelerator or circulator) to assist the flow of water.

Gravity Hot Water and Pumped Central Heating

Gravity is still used to circulate the heated water to the DHW storage vessel and a pump circulates the water around the heating circuit, shown in the figure below.

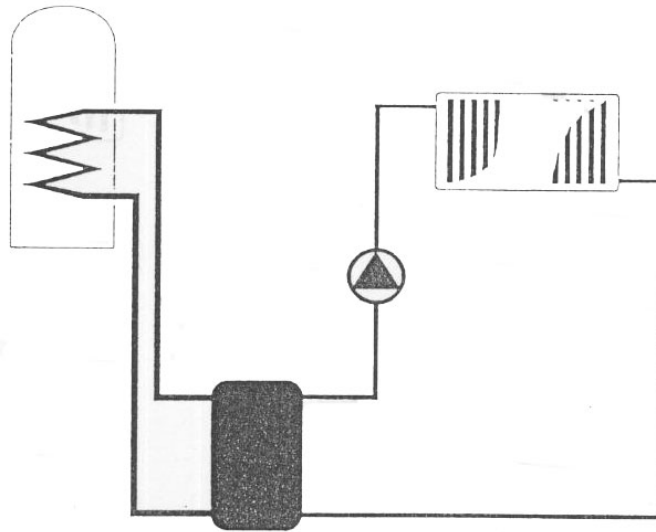


Figure 2. Gravity Hot Water & Pumped Central Heating

The addition of the circulating pump to the central heating circuit provides an opportunity to gain greater control of the system by the simple action of switching ON and OFF the electrical supply to the pump, subsequently turning on or off the central heating.

By linking the ON-OFF control to a temperature sensor (Thermostat) further control may be achieved which allows the central heating system to respond to temperature changes within the location of the thermostat

By using the pump to circulate the heated water also allows the diameter of the pipework to the radiators to be reduced thus making the installation of the system easier than a gravity system. The reduction in size of the pipework, to normally either 22mm or 15 mm diameter, gave rise to the description of a pumped heating circuit as a small bore system.

Fully Pumped DHW and CH System

The next logical step to further improve the efficiency and control of the system is the use of the pump to assist the circulation of water through the DHW circuit as well as the heating circuit. The position of the pump therefore has to allow the circulation to take place within both circuits, shown in the diagram below.

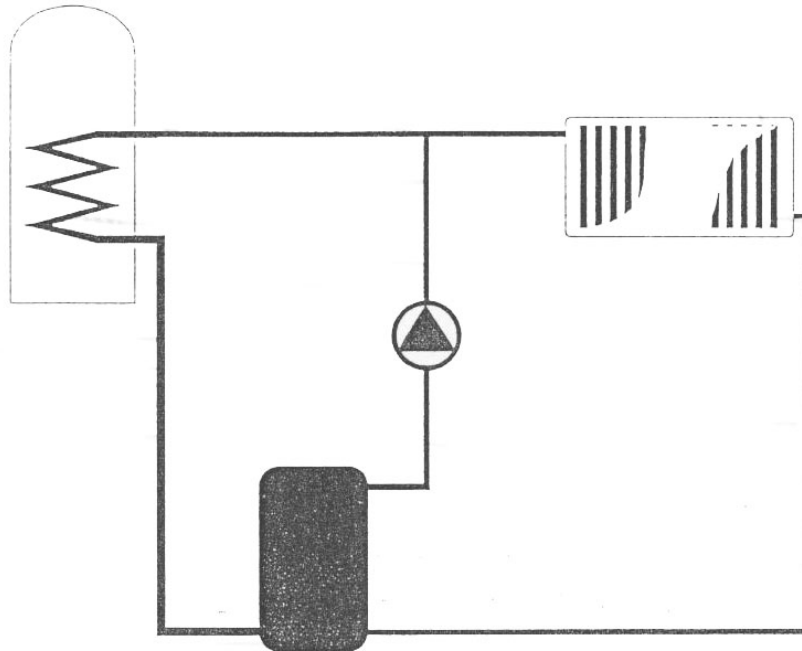


Figure 3. Fully Pumped DHW and OH System

The fully pumped system has the advantage of rapid heating of the DHW storage system and radiator circuits and as we shall see later gives greater scope for controlling both DHW and the OH circuits independently of each other.

So far we have looked at how heated water is circulated around the DHW and OH circuits by either gravity, the use of a pump, or a combination of both. We now have to consider the pipework system in more detail from the point of view of filling and maintaining the heating circuits with water, the provision of vent pipes to release air or overheated water and the relative positions of the cold feed, open vent and pump to ensure the system operates correctly.

Cow Feed and Open Vent Positions

The domestic hot water used for washing and bathing is normally supplied from a storage cistern situated as high as possible within the dwelling, for example the roof space.

To enable the heating system to be filled and maintained a separate smaller cistern (normally referred to as a Feed & Expansion Cistern) is utilised which should not supply water for any other purpose, shown in the diagram below:

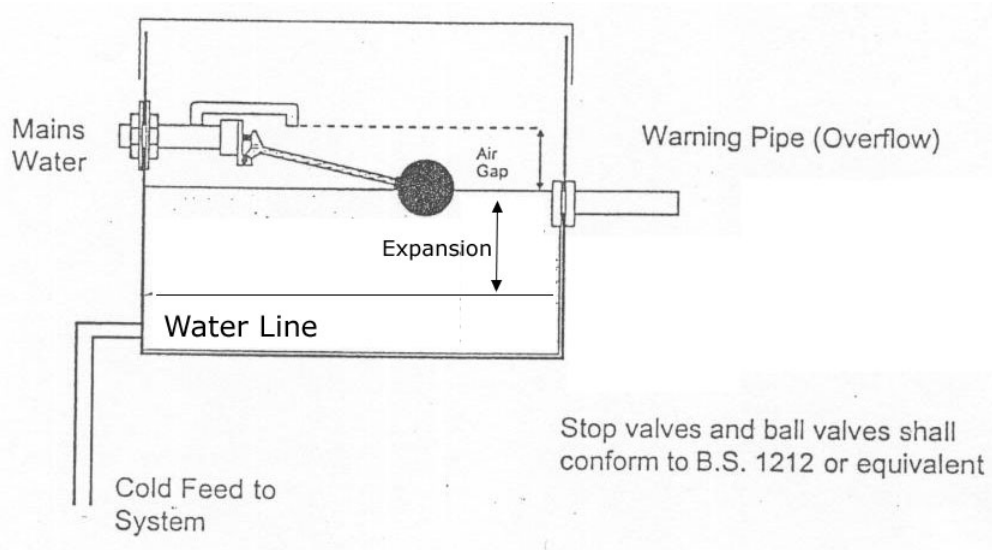


Figure 4. Feed & Expansion Cistern

To ensure that any contaminated water from the heating system cannot re-enter the mains water supply an air gap is provided between the two systems by utilising a ball valve and float. The cistern should also be fitted with a lid to prevent debris falling into the water and when installed in a roof space an insulating jacket should also be fitted.

The heating circuit cold feed allows the system to be filled and any water lost during normal operation, or in the event of control failure, to be made-up automatically.

A separate open vent pipe from the heating system, terminating above the F&E cistern, releases the air from the system on initial filling and allows heated water to expand into the feed and expansion tank during normal operation of the boiler.

The open vent pipe also provides a route for overheated water and steam should the boiler thermostat malfunction, shown in the figure below.

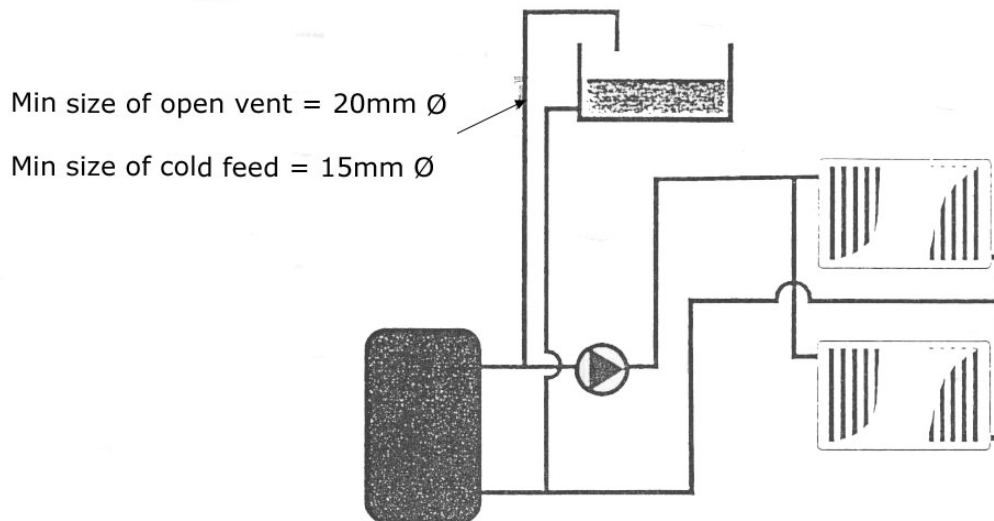


Figure 5. Cold feed and open vent

Both the cold feed and open vent must be connected to the system in accordance with specific manufacturer's instructions, but where no such specific information is available the following may be used for general guidance.

Cold Feed Pipes Combined

The cold feed should be of non-ferrous metal, or equivalent and not be smaller than 15 mm diameter. Unless the boiler manufacturer clearly states otherwise, the cold water feed pipe should be independent of the open vent pipe and should be connected directly from the feed and expansion cistern to a return circulation pipe as close to the boiler as is practicable.

Where the manufacturer indicates a combined cold feed and open vent may be used, the boiler must be fitted with an overheat thermostat that will require manual resetting. A combined cold feed and vent layout is one where both pipes are connected to each other prior to connection to the system, or at the point of connection to the system.

Open Vent Pipes and Safety Valves

The open vent pipe of non-ferrous material and minimum diameter of 22mm should be sited so that it can discharge into the F&E cistern above the overflow level. The pipe should rise continuously and avoid any horizontal runs. Any heated water which may be discharged from the boiler must have a clear unobstructed path via the open vent pipe to the F&E cistern.

No valves or components, other than full bore pipe fittings, must therefore be fitted at a point between the boiler and the discharge point of the system.

In addition to the open vent pipe, a safety valve should be fitted on the boiler or on the flow pipe as near to the boiler as practicable. The location should enable visual indication if the valve has lifted, but should not be in a position that could be a hazard to any person or electrical

components in the event of discharging. Safety valves should conform to B.S. 759

In our previous diagrams we have shown the ideal locations for the cold feed and open vent, in practice however you may find that they are actually part of the pipework circuit from the boiler, show in the diagram below.

Providing there is no contravention of any of the general rules or manufacturer's instructions, regarding feed and vent pipes, this configuration is acceptable. Practically it is far more easier to achieve, where the location of the boiler is such that the pipework from the F&E cistern would be difficult to install and has therefore become a popular method of installation.

However, there may be a risk of entraining air into the system with this configuration if the system has not been designed correctly and we will examine this problem later within this workbook.

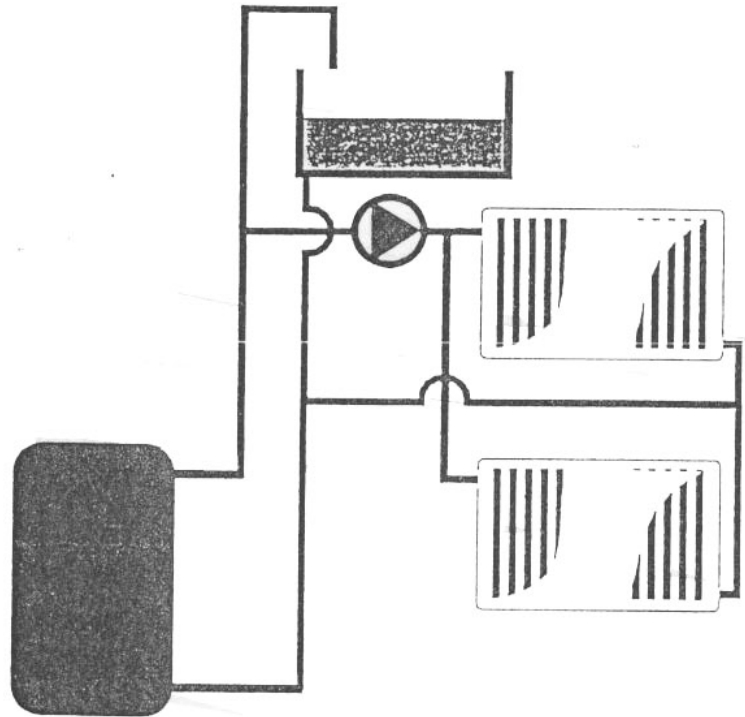


Figure 6. Feed and vent pipes as part of the heating circuit

A further layout which has proved to be popular is where the cold feed and open vent pipe are actually connected within 150 mm of each other on the flow pipe. This system, normally referred to as a close coupled system, shown in the figure below, is regarded as being suitable for some fully pumped systems.

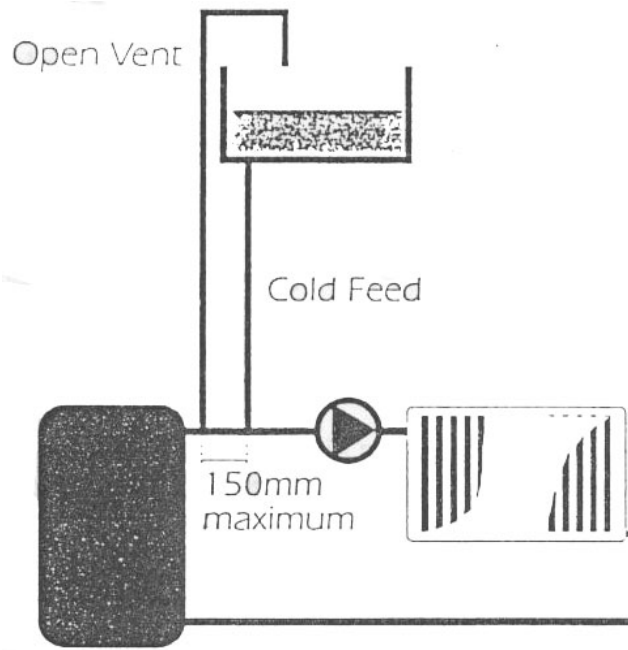


Figure 7. Close coupled systems

With this pipework arrangement, the cold feed is now connected to the flow, and it would be impossible for the water to flow back to the boiler if the open vent was discharging. To overcome this, the design of the system should be such that there is always a cold water feed path to the boiler when all automatic controls on the pipework circuit are closed.

On all of our diagrams we have shown the pump on the flow from the boiler. Do you think a fully pumped system would work if the pump was installed on the return? Indicate your answer in the box and we will come back to this question when we have covered the appropriate information

Note: Combined cold feed and vent is not acceptable under IS 813.
IS 813 are the guidelines for gas installations.

Self Assessment Questions

1. List the main differences between a gravity system and a fully pumped system.
2. What is the main purpose of the open pipe on an open system?
3. Complete the diagram to indicate a close coupled system.

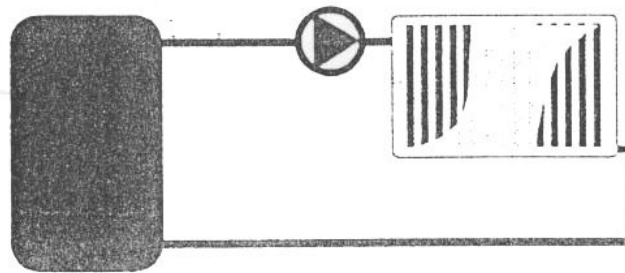


Figure 8. Self assessment diagram

4. What is the main difference between the pipework used to connect a gravity system in comparison with that used to connect a fully pumped system?
5. What prevents contaminated water from the heating circuit re-entering the mains water supply on an open system.

Position of the Pump

We have considered the position of the open vent and cold feed on the open system and we must now turn our attention to the circulating pump. The position of the pump is crucial to the correct operation of the system. The location must ensure that water is not pumped out of the open vent pipe nor air drawn into the system under normal operating conditions, including when the pump initially starts.

In our previous diagrams we have shown the pump located on the flow from the boiler. However, here may be systems you encounter where the pump has been located on the return pipework. What we need to consider is whether it can make a difference to the system whether the pump is located on the flow or return.

In practice the pump will normally move the water away from the boiler and around the circuit in the direction that water would normally flow if it was a gravity system. The pump, when started, will have the effect of raising the pressure on its outlet side and lowering the pressure on its inlet side, shown in the diagram below.

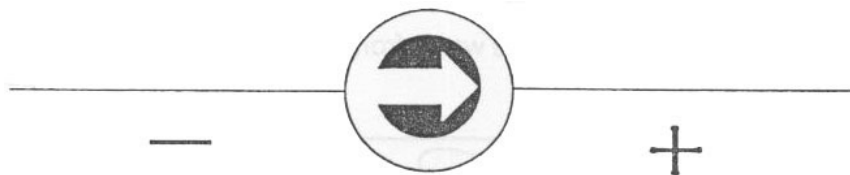


Figure 9. Negative and positive pressure

But as the pump is part of a continual circuit there must be a point where the pressure changes from positive (or pushing) to negative (or pulling).

In fact that point tends to be where the cold feed enters the system due to the static head of water of the cold feed pipe and feed and expansion cistern.

If we now consider the above diagram with the addition of a cold feed pipe into the return we can see the parts of the circuit which are under positive pressure and the parts which are under negative pressure, shown in the diagram below.

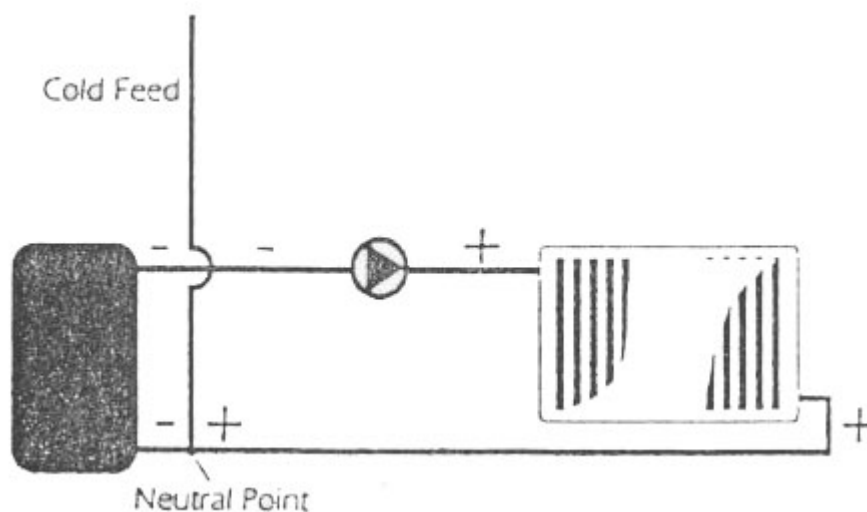


Figure 10. Neutral point

Can you think of any reasons why it would be an advantage for most of the system to be under a positive pressure?

If all of the system operated at a negative pressure it could have the effect of drawing air into the system. With the pipework layouts we have considered only the section between the inlet of the pump and the cold feed would be under negative. But consider what would happen if the pump was placed on the return of the boiler and the cold feed was left in the same position, as shown in the diagram below.

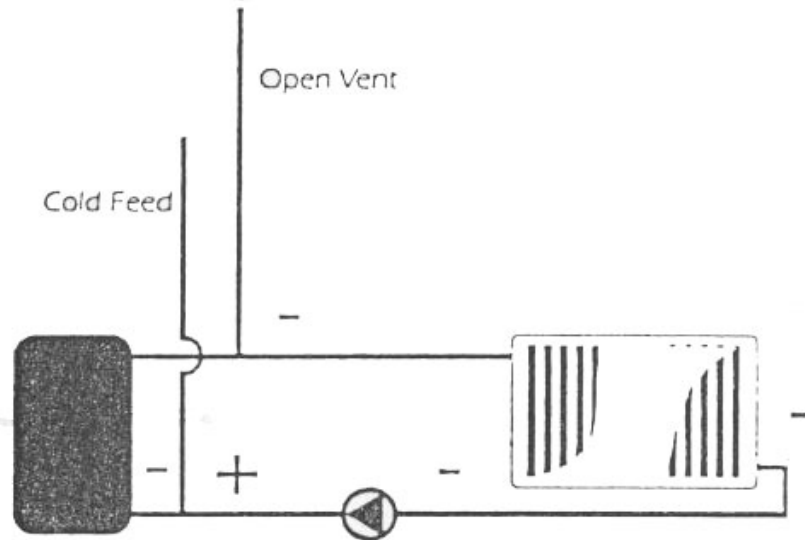


Figure 11. Pump on Return

Using the positive and negative principle only the section from the outlet of the pump to the cold feed is under positive pressure whilst almost the entire circuit is under negative pressure increasing the possibility of entraining air into the system. The most obvious solution is to move the cold feed to the inlet of the pump, that cures our problem of the system operating at negative pressure, as shown in the diagram below. But what about the open vent connection?

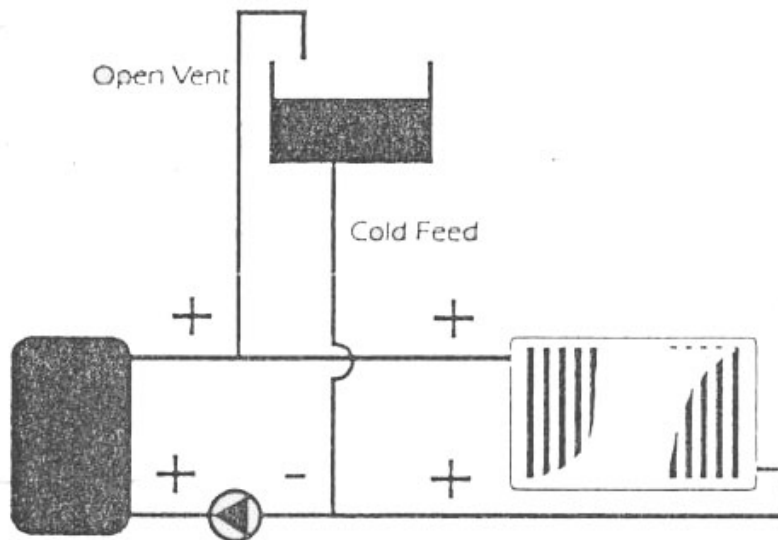


Figure 12. Pump on Return/Cold Feed on Pump Inlet

In this configuration the majority of the system is under positive pressure and some older systems may be found installed in this configuration. The main reason for the pump to be located on the return however, was that older pumps were unable to withstand the high

temperature of the water leaving the boiler from the flow. The older system may have operated satisfactorily, but consider the effect on the system where the open vent connection is made.

In simple terms the water has two choices - either go around the radiator system or straight up the open vent. With an older pump installed, if the system was made of glass, you would in fact see the water level in the open vent rise as the pump was turned on. The problem arises where an old pump is replaced with a newer, more powerful version.

Modern pumps are much more powerful than their predecessors and the water level in the open vent could rise dramatically and in some cases 'pump over' into the F&E cistern.

To overcome this problem, the position of the modern more powerful pump, which was designed to withstand the higher flow temperatures, was switched to the flow pipe

Check your answer to the question regarding the effect on the system of the pump position.

Apply the positive and negative theory to the fully pumped system, which has the cold feed on the return and the open vent on the flow, shown in the figure below.

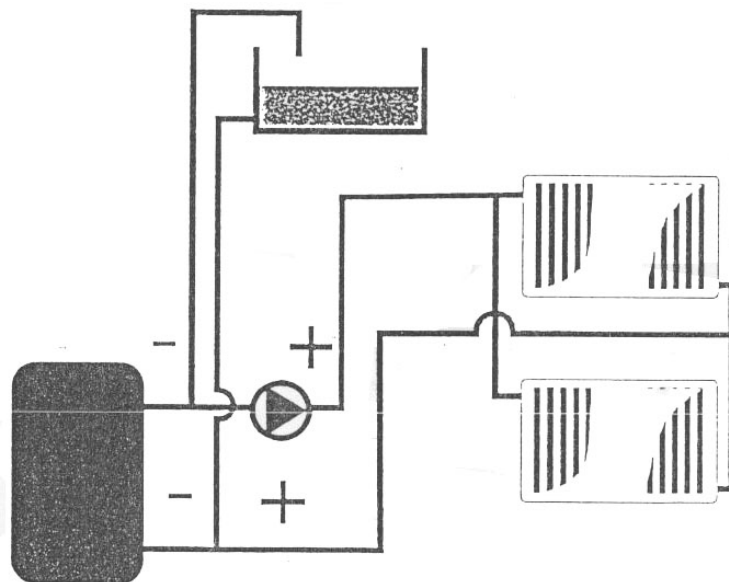


Figure 13. Fully Pumped System

Although the system will be under negative pressure from the cold feed to the inlet of the pump, the majority of the system is under positive pressure. When the pump is initially started the water level within the open vent pipe may move downwards slightly, but in the majority of cases this will not affect the operation of the system and as such this has become a recommended configuration for many fully pumped systems.

In most domestic installations this will not be a problem unless the height of the water level in the open vent is less than the height which the water level will fall.

An example where this may occur is where the open vent is part of the system as shown in the diagram below, and dimension A is not high enough - this could result in air being drawn into the system via the open vent.

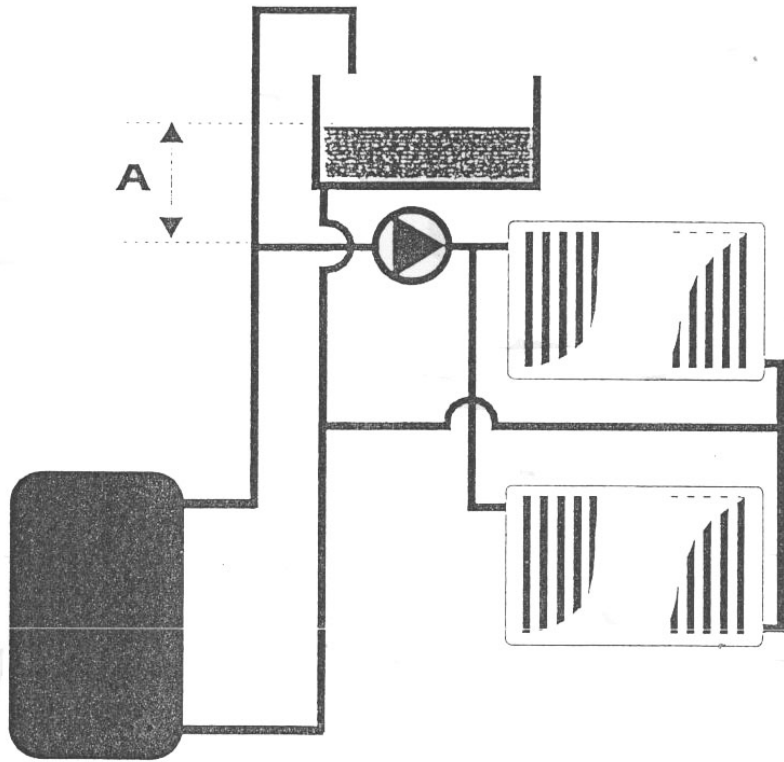


Figure 14. Open Vent as Part of the System

When the pump is operating the resistance of the boiler will contribute to the drop in pressure at the inlet of the pump. If the resistance of the boiler increases so it becomes easier for the pump to 'pull' water down the open vent rather than through the boiler, shown in the diagram below.

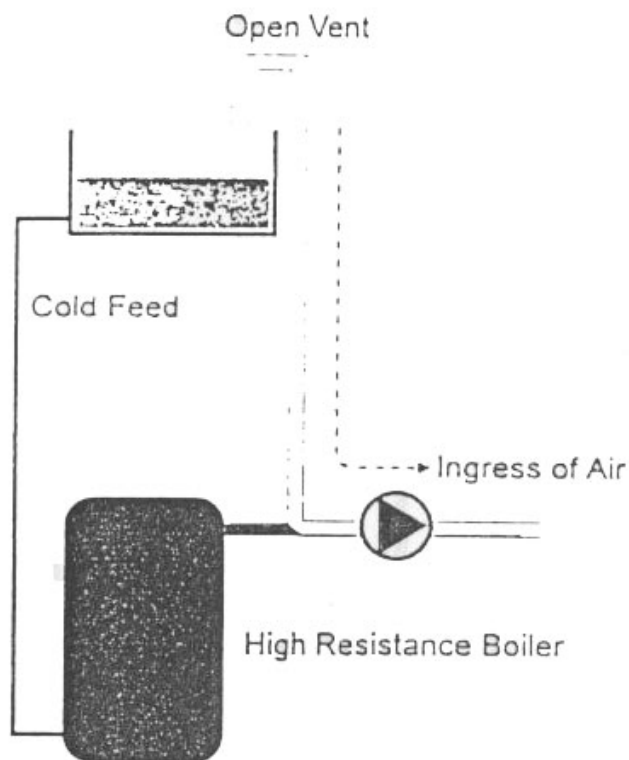


Figure 15. High Resistance Boiler

An instance where this could happen is where a system has been working perfectly satisfactorily and then the boiler is exchanged for one with a much higher resistance. Suddenly the system starts to draw air down the open vent with the following possible consequences:

- The pump fills with small air bubbles and its momentum is lost
- The water level rises back up the open vent
- The pump regains its momentum and the cycle starts all over again.

The result - the pump bearings keep running dry and eventually the pump burns out. The next action is to exchange the pump - which also burns out, and so the problem persists.

The same problem may also materialise if for some reason the resistance of the boiler increases, for example if the waterways become partially obstructed with scale etc.

Many of the problems that are inherent to existing and newly installed central heating systems may be attributed to poorly designed systems, incorrectly sited pumps, cold feeds, and open vents. So you can see the importance of having a basic understanding of the hydraulics of a central heating system, irrespective of whether you install, service or maintain.

Using the information we have covered so far go back to the close coupled system in Figure 7 on page 19 and work out if this system would operate correctly with a boiler with a high resistance?

Check your answer with the explanation given on the next page.

The problems of air entrainment and pumping over can be minimised on the close coupled configuration when used with a boiler with a high resistance. The action of the pump on both the cold feed and open vent is significantly reduced as they tend to act like the limbs of a U gauge, with each column of water supporting the other one, as show in the diagram below.

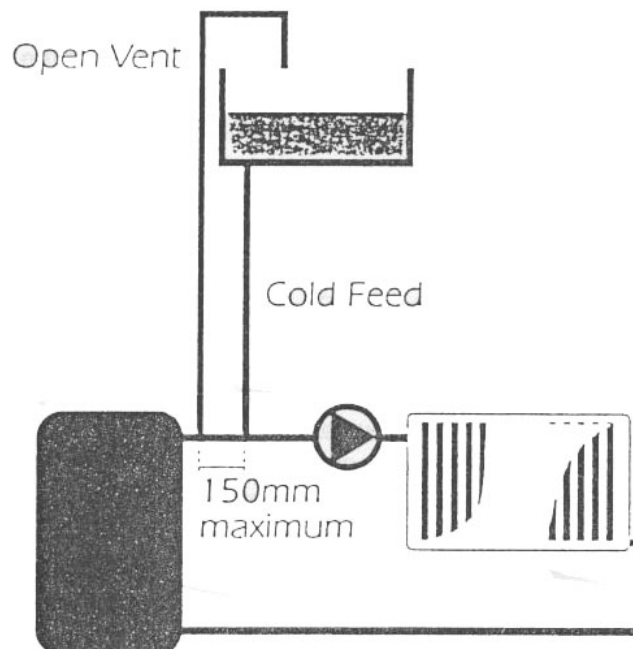


Figure 16. Close Coupled System

Unfortunately, central heating systems are not installed in glass and the pipework within the structure of the house is not always easy to locate and work out the pipework layout that has been used. There are however some practical methods that can be used to check that a system is not pumping over or drawing air in.

Pumping Over

A visual inspection of the open vent, especially when the pump first starts the system is subjected to a sudden surge, will determine if a problem of pumping over is occurring.

Modern pumps can be adjusted to provide the correct pressure for the system which may be obtained from the manufacturer's data.

Care should be taken if a pump setting is increased to solve a problem of poor flow around the circuit. The additional pressure from the pump may be enough to 'lift' the water up the open vent and into the F&E cistern.

Air Entrainment

In extreme cases the problems of air entrainment may be identified by air being drawn into the system when the pump is running, either through small leaks on the system or when a radiator air vent on the highest part of the system is opened.

The effect of water being drawn down the open vent can be visually observed by placing a receptacle, for example a clear bottle filled with water, over the open vent when the pipe is running. The water level will generally drop in the bottle when the pump starts, but If all the water is sucked out of the bottle this may indicate a problem with the system.

Every system when it is first filled with water contains air and this air must be expelled to prevent the system from working inefficiently or for corrosion of the system to take place.

Removal of Air from the System

On the majority of systems air is released from the system by the open vent or from the radiators which are fitted with their own air vent. However, the separation of air bubbles from the water and subsequent removal from the system can also be achieved by the use of an air separator, installed within the system pipework, shown in the diagram below.

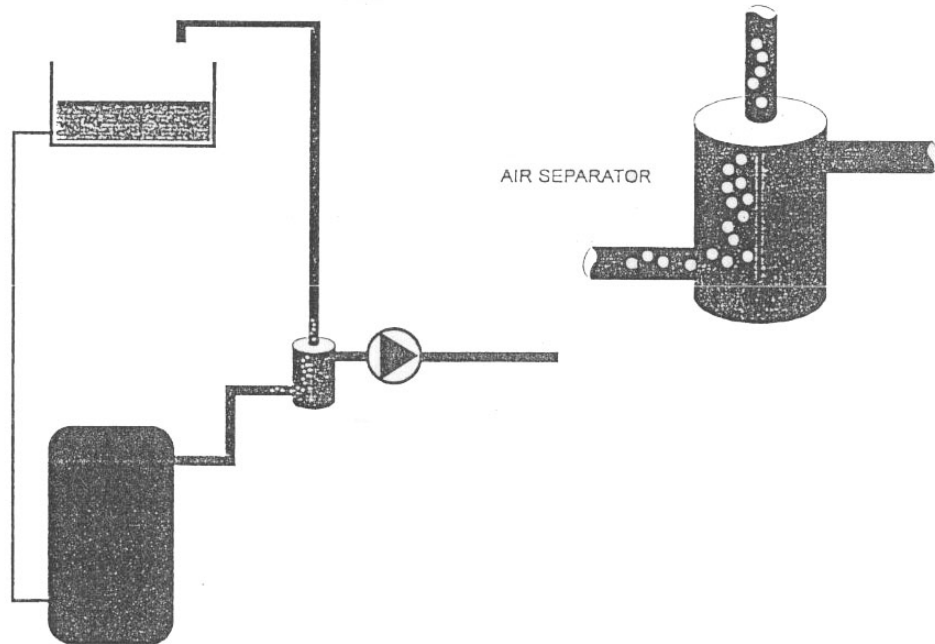


Figure 17. Typical Air Separator

As the water from the boiler flow pipe, enters the air separator, which has a greater cross sectional area than the pipework, the air bubbles are at a different velocity than the water and they separate and rise upwards through the open vent.

A typical air separator can assist the open vent in removing large air bubbles from the system when filling the system with water. However, they will not reduce the amount of air dissolved within the circulating water and cannot, therefore, correct a badly designed system.

Care should be taken if an air separator is used to cure a system which has an inherent problem of air entrainment. Although solving the problem of continually having to remove air from the system via the radiators, a further problem may be created which will not be apparent until corrosion of the radiators takes place.

Further information on corrosion is given later on in this workbook.

So far we have concentrated on the general pipework of central heating systems including typical cold feed, open vent and pump positions. We now have to examine the pipework configurations that can be used to connect the radiators to the heating circuit.

Single Pipe Heating Circuits

Heated water from the boiler is delivered to each radiator by a single pipe which returns to the boiler to complete the circuit, shown in the diagram below.

This method of connecting the radiators was very popular in the early days of central heating, but it is rarely used on a modern system.

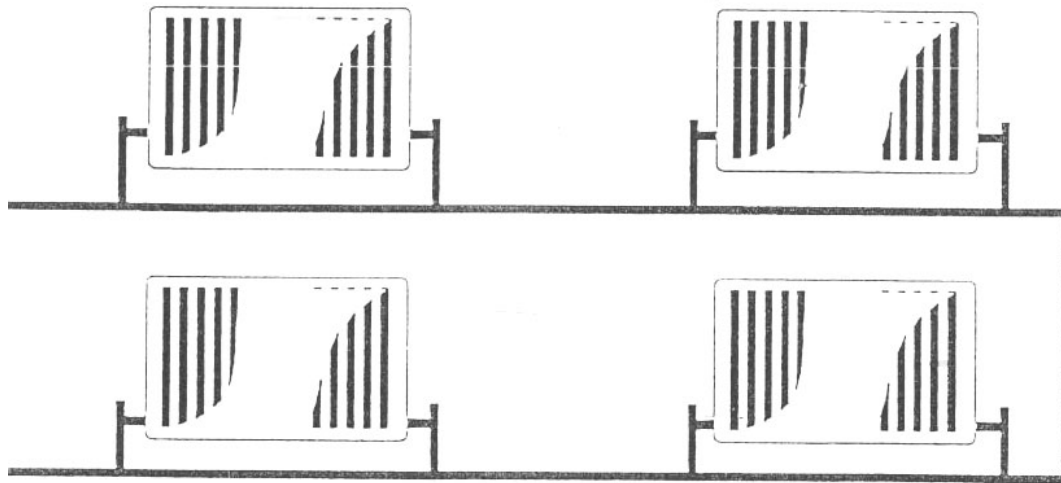


Figure 18. Single Pipe Heating Circuit

Heated water passing to the radiators is cooled by the return water entering the pipework from the previous radiator or radiators on the circuit. Consequently, radiators have to be sized to take this into account to ensure that they are able to deliver the required heat output.

Two Pipe Heating Circuits

To provide greater flexibility in system design and control the two pipe system was introduced and is the most common configuration used today Fig 18.

Heated water, close to the temperature of the water leaving the boiler flow, is delivered to each radiator from an independent circuit, thus overcoming some of the problems of the single pipe system.

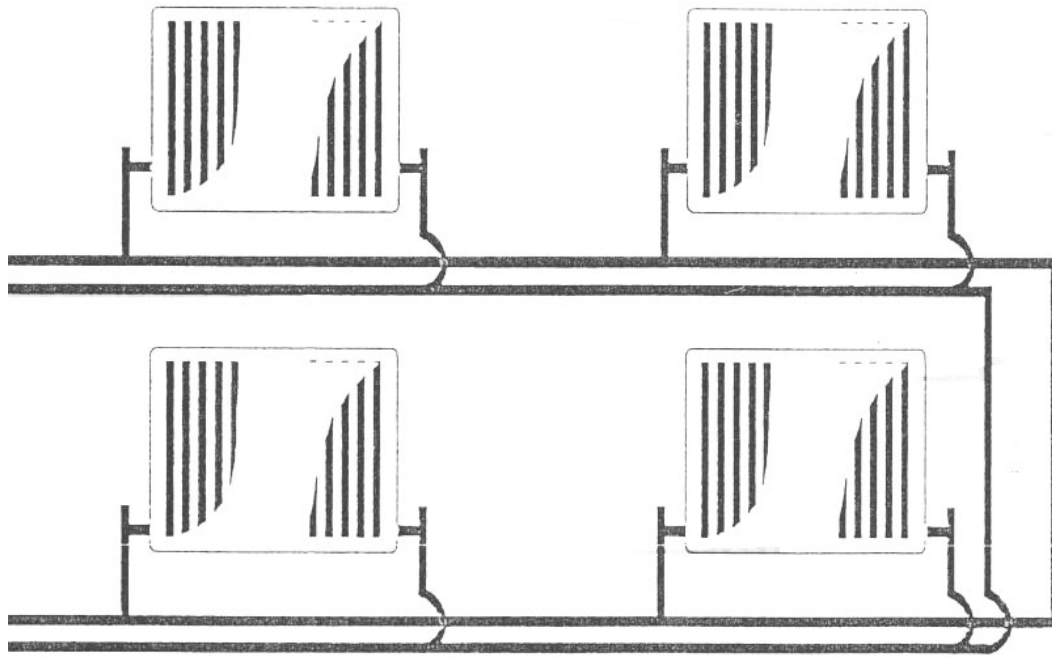


Figure 19. Two Pipe System

As you can see heated water is distributed to each radiator through separate branches of the flow and return pipes from the boiler in the two pipe system.

The heated water from the boiler is distributed more evenly throughout the system and in practice without a significant loss of temperature from the boiler to each radiator. With the single pipe system this is not the case as heat is lost as the water progresses around the circuit, which can make sizing the radiators a more complicated process.

In addition to single pipe and two pipe small bore systems the installer may encounter a further variation - the minibore or microbore system, as shown in the diagram below.

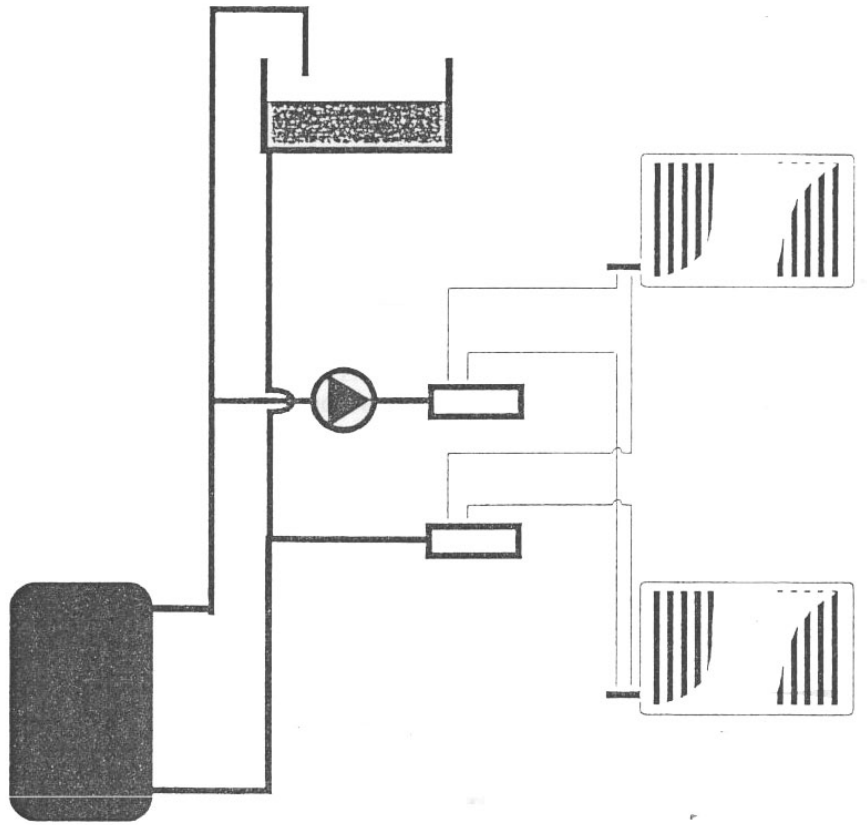


Figure 20. Minibore or Microbore System

In this type of system manifolds for both the flow and return pipes from the boiler are utilised, from which small diameter pipes, normally 6 or 8 mm, are run to each radiator. The diameter of the pipework for the manifolds is normally sized as for a small bore system and is dependant on the number of radiators and length of run.

The smaller diameter flow and return pipes from the manifold to the radiators are easier to install, for example in areas of restricted space, but care must be taken to prevent pipe damage and subsequent restriction of the water flow.

Although both the single and two pipe systems can be used for both gravity and pumped circuits, it is the two pipe system which gives greater flexibility in pipework layout, heating distribution, radiator sizing and system control, which is more commonly used nowadays.

Heat Emitters

There are basically two types of heat emitters which may normally be found on a central heating system.

- Radiators
- Convectors

However, in larger premises, for example schools and churches you may also find large pipework which has been used to provide the heat source for the area to be heated. For the purposes of this domestic unit we will concentrate on radiators and convectors.

Radiators

Radiators found on older gravity systems were normally constructed of cast iron columns. This type of radiator gives off the majority of its heat by the passage of air passing over the heated columns (convection).

Modern radiators, however, are now normally manufactured from pressed steel, although copper and aluminum may also be found. With this type of radiator heat is transferred by low temperature radiation in addition to convection.

To provide flexibility in matching design temperatures with available locations, panel radiators may be supplied with either single, double or treble panels. Because of their construction they may also be customised to fit bay windows or other irregular shapes.

Convectors

A variation on the radiator is the wall convector which consists simply of a heat exchanger constructed from fins surrounding hot water circulating pipes, within a pressed steel case,

Heat is transmitted by the airflow passing over the fins by natural convection and is controlled by a simple damper. In many cases the convector may be supplied to fit along the bottom of the wall to replace the skirting board.

A variation is the addition of a fan that can be automatically controlled to provide both time and temperature control for the customer.

Radiator Controls

Radiators will normally be installed with three types of control as listed below:

- **Lockshield**

Valve Fitted to the return connection of the radiator, the lockshield valve may be used by the installer to balance the system and as such is normally fitted with a protective plastic cover to discourage accidental adjustment.

In addition the valve may also be used to isolate the radiator from the system without draining down. Where this is the case the valve must be readjusted to ensure the correct operation of the radiator and system.

- **Customer Control**

Valve Fitted to the flow connection to the radiator, this valve provides manual control for the customer to turn the radiator off or on.

Used in conjunction with the lockshield valve to isolate the radiator from the system.

Normally the two radiator valves will use the same valve body, with the appropriate head, either the lockshield or customer control, fitted to the valve, as shown in the diagram below.

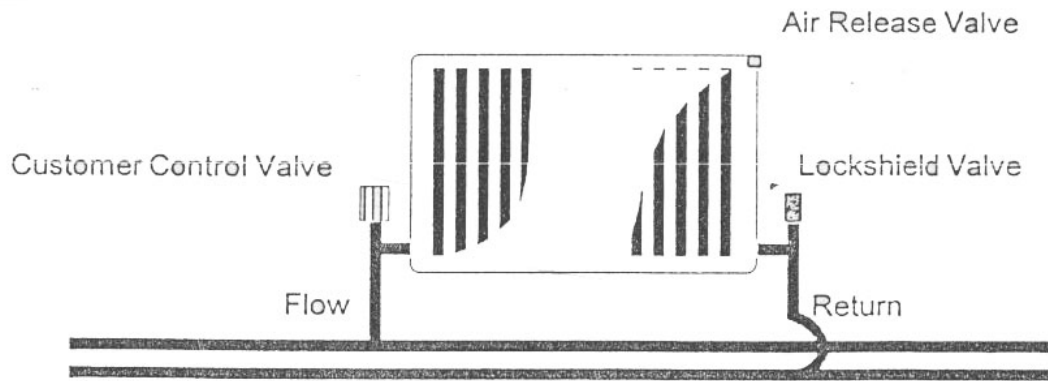


Figure 21. Radiator Valve

- **Thermostatic Radiator Valve (TRV)**

Installed in place of the manual control valve, the TRV provides automatic control of the radiator. The valve is normally supplied as a complete unit including valve body and head. Sensors located either within the valve, or in some cases remote from the valve, close down the valve at the selected temperature.

The head of the valve can be rotated to a selected number by the customer, which corresponds to a temperature setting, show in Figure 22 on page 32.

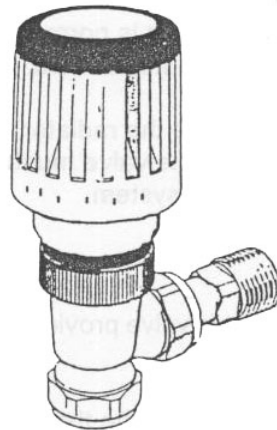


Figure 22. Control head in place

In most cases when the head is removed the valve spindle will be allowed to move upwards allowing the valve to close on its seating, show in Figure 23 on page 32.

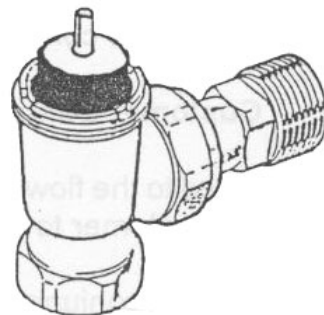


Figure 23. Head removed

Possible Radiator Problems

Corrosion within the radiator can be a problem which could ultimately cause the erosion of the radiator surface or partially restrict the flow of water around the circuit or through the radiator.

Apart from the normal problems associated with water controls all of the above controls must be correctly located and adjusted where necessary to maintain satisfactory operation of the system.

In many cases poor circulation through one particular radiator may be attributed to the lockshield valve being closed down by the customer and either being left closed or reset to a position that does allow the correct circulation of water through the radiator.

On some systems alteration of a lockshield valve on one particular radiator may also effect the operation of other radiators on the system.

Further guidance on balancing systems is given in the Commissioning and Balancing section of this workbook.

Reverse Circulation through Radiators

To prevent any possible circulation of heated water around the heating circuit when not required it is important to ensure that the return pipework from the radiators and domestic hot water cylinder are correctly installed.

A typical example where reverse circulation could take place is shown in the diagram below, where the DHW return pipework has been connected between the heating returns.

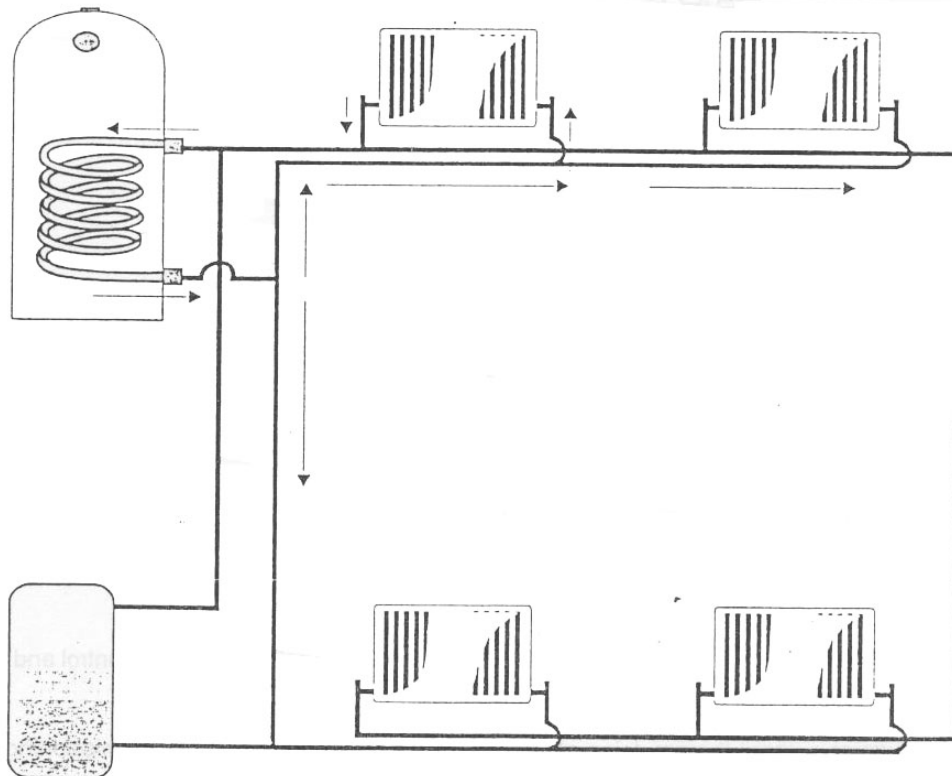


Figure 24. Reverse Circulation

In this configuration when heated water is circulating around the DHW circuit the water returning to the boiler could circulate through the upstairs radiators when they should be off.

In most cases the flow of water will follow the circuit with the least resistance and so only a selection of the radiators may get hot.

To prevent this happening all the radiator returns should be ‘commoned together before the final connection to the boiler and the DHW return should be closer to the boiler than the heating return, show in the diagram below.

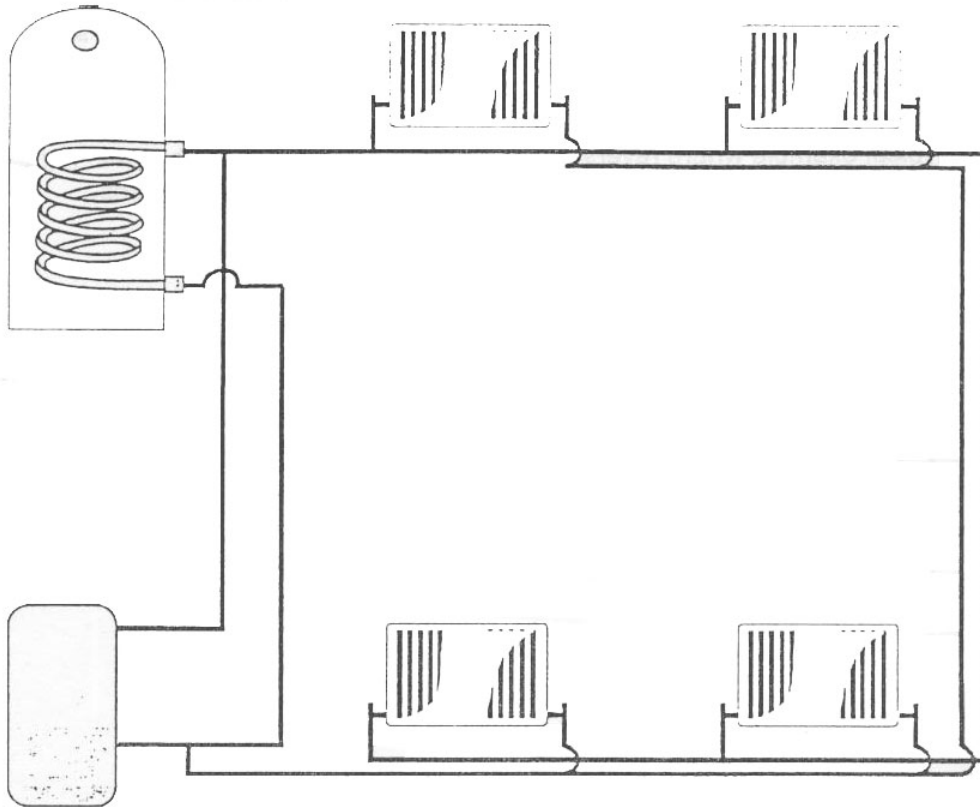


Figure 25. Commoned Returns

Draining the System

The final ‘control’ we shall consider is the drain cock. Arguably, it is not a control and is very often overlooked when discussing central heating.

However, without the provision of suitable drain cocks on the system commissioning of the system, and remedial repair work cannot be achieved.

I.S. 813 1996 Part 7.1.3 requires provision to be made for the drainage of the whole system. Care should be taken to ensure that enough drain cocks, suitably located will effectively drain all of the system, and not just a part of it.

This completes the section on basic pipework layouts. The following self assessment questions may be used to check your understanding before proceeding with your studies.

Self Assessment

Place a tick in the appropriate box. If you consider any of the statements to be incorrect enter your alternative answer. When you are ready check your answers with those on the following pages and refer back to the relevant text for confirmation of your answer, where necessary.

	True	False
1. Gravity central heating circuits use smaller diameter pipework than a fully pumped system.		
2. The cold feed pipe should always be connected to the flow pipe as close as possible to the boiler.		
3. The open vent pipe should be connected to the flow pipe as close as possible to the boiler. No valves or components should be fitted to the open vent.		
4. Excessive entrainment of air within a system may be cured by installing an air separator.		
5. Water circulating through radiators when the heating is switched off may be caused by incorrectly sited return pipes to the boiler.		
6. Pumps should always be located on the return pipework to the boiler to prevent water being pumped out of the open vent.		
7. A central heating system operating at a negative pressure may result air being drawn into the system.		

Self Assessment Answers

	True	False
1. Gravity central heating circuits use smaller diameter pipework than a fully pumped system.		✓
2. The cold feed pipe should always be connected to the flow pipe as close as possible to the boiler.		✓
3. The open vent pipe should be connected to the flow pipe as close as possible to the boiler. No valves or components should be fitted to the open vent.	✓	
4. Excessive entrainment of air within a system may be cured by installing an air separator.	✓	
5. Water circulating through radiators when the heating is switched off may be caused by incorrectly sited return pipes to the boiler.		
6. Pumps should always be located on the return pipework to the boiler to prevent water being pumped out of the open vent.		✓
7. A central heating system operating at a negative pressure may result air being drawn into the system.	✓	

So far we have examined general pipework layouts with the inclusion of a cold feed and open vent pipe. This type of system, which is open to atmosphere, is generally referred to as an Open System. Before proceeding we need to be aware of another type of system which is not open to the atmosphere - the Sealed or Pressurised System.

Sealed Or Pressurised Systems

With a sealed or pressurised system the feed and expansion cistern is not used to supply cold water to the system and as the name suggests the pipework is not open to the atmosphere as in the open system, in the diagram below.

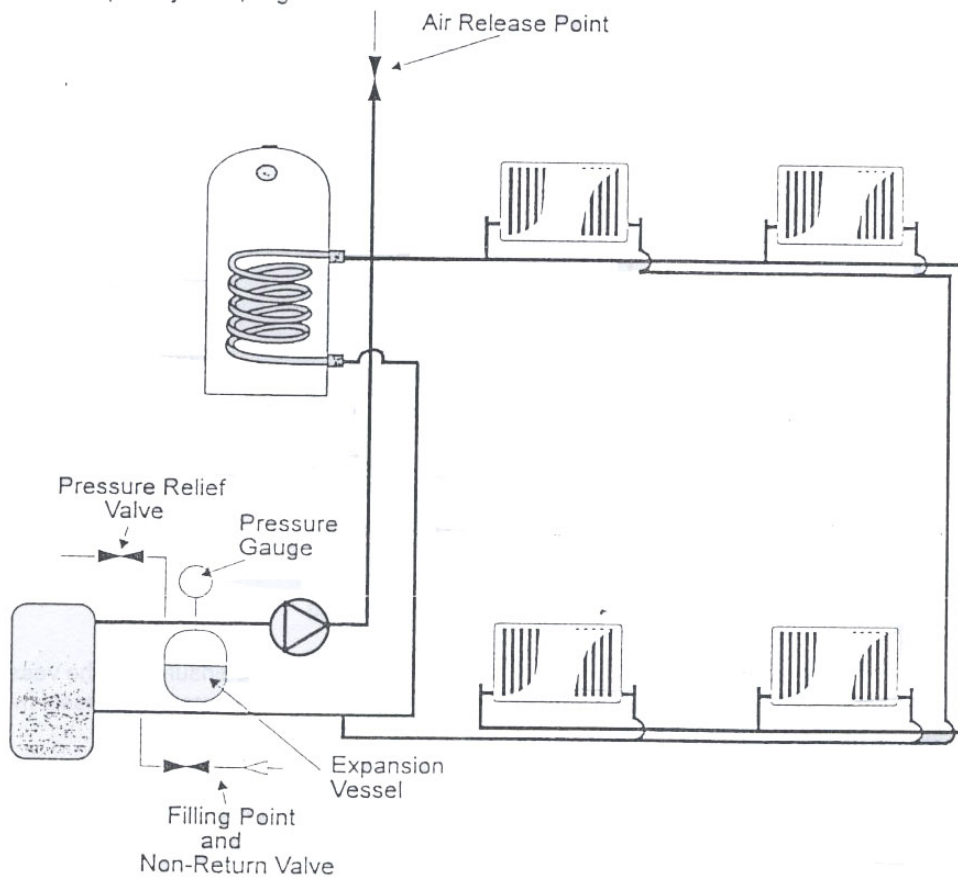


Figure 26. Fig 25 Typical Sealed System

On a sealed system the open vent pipe and F& E cistern are replaced by alternative methods for supplying cold water to the system, venting the system and providing a vessel to allow the expansion of water when heated.

Two advantages of sealing the system are that the operating temperature of the heated water may be increased, giving the opportunity to reduce radiator sizes and corrosion of the system may be reduced as the circulating water is not in contact with the atmosphere. A further advantage is that because the sealed system does not require a F&E cistern within for example a loft space, they may be installed in dwellings which were deemed unsuitable for more conventional open systems.

Expansion of Heated Water

An expansion vessel in the diagram below fitted with a diaphragm and charged on one side with either nitrogen or air is fitted to the system. As the water is heated within the system and expands it pushes against the diaphragm which moves to accommodate the increase in volume of water. As the water cools and reduces the diaphragm is allowed to move back to its original position.

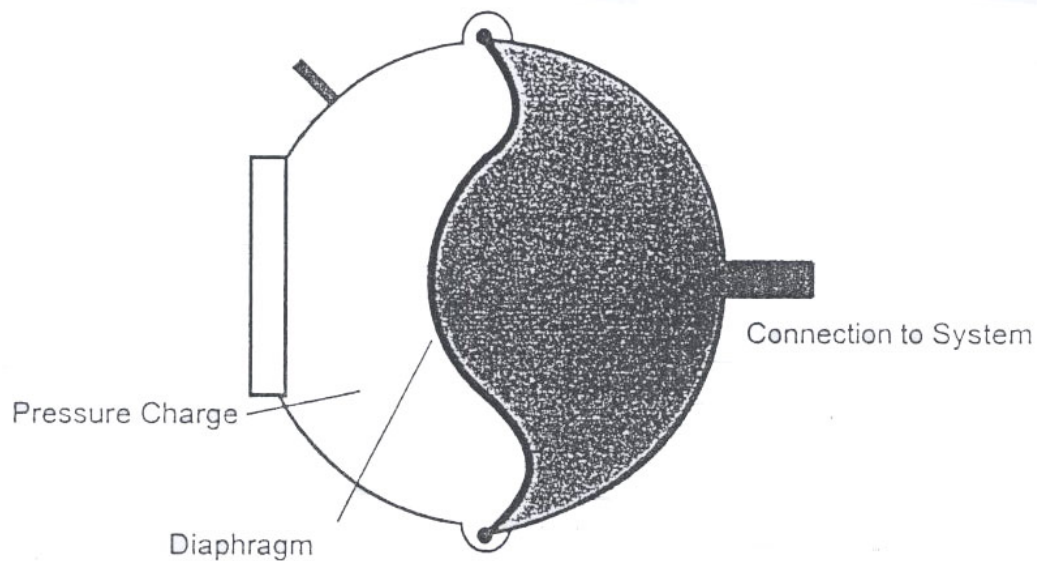


Figure 27. Expansion Vessel

The size of the vessel is in proportion to the size of the system to ensure that the vessel will accommodate the volume of water when heated. The charge pressure of the vessel must be such to balance the static water pressure of the system when full of water.

The majority of expansion vessels have a valve from which the charge pressure can be checked and if necessary adjusted. Untrained installers, or customers, have been known to confuse this valve as means of venting the system of air. A decision that is incorrectly reinforced when air or nitrogen is released from the valve.

The effects on the system of such an action can be such that it may never operate correctly and could possibly require constant attention until such time as the charge is reinstated.

Interlinking of Solid Fuel to Automatic Boiler

Note: Finger tip guide on operation to be explained and given to the customer.

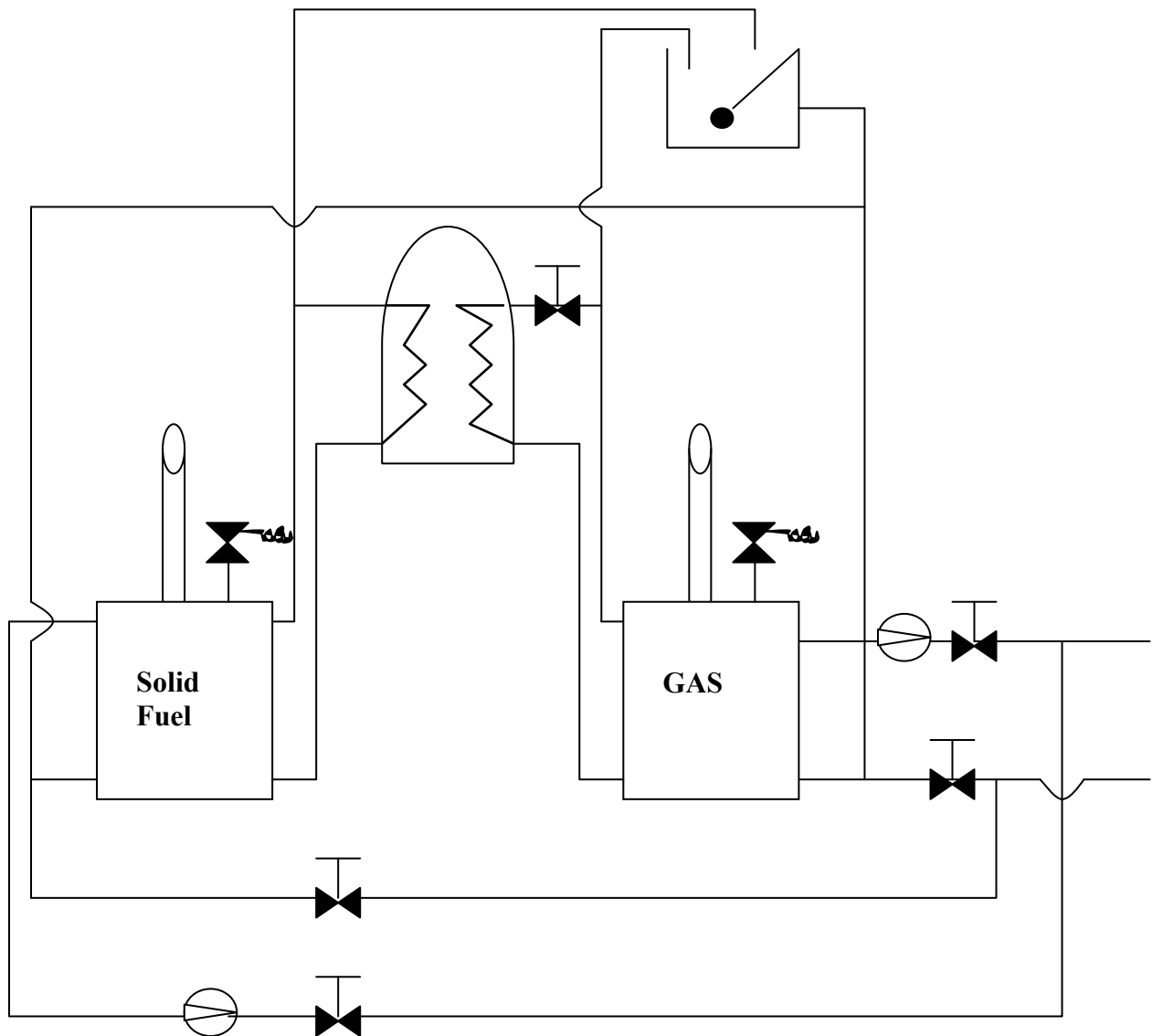


Figure 28. Interlinking solid fuel to auto boiler

Twin Coil Cylinder.

- 1" unrestricted gravity flow and return on solid fuel
- Thermostatic control on hot water for gas boiler.
- Separate vents.
- Separate safety valves.
- Separate valves isolating heating circuits.
- Separate pumps – both pumps on the same pipe, (flow/return) so they pump in the same direction.

Provision must be made, as with the open system, to not only prevent an excessive build up of pressure, but also provide a further means of safeguarding the system against malfunction of the thermostat on the boiler.

Pressure and Temperature Safeguards

To safeguard the system a pressure relief valve, preset by the manufacturer, 3Bar and boils at 140° is fitted to the sealed system, shown in the diagram below. A discharge pipe, of a diameter recommended by the manufacturer, from the pressure relief valve must terminate in a safe and visible position where it cannot be a danger to any person should the valve discharge.

Remember, because the water within the system is under pressure it could be higher than the actual boiling point of water under normal atmospheric pressure. If the valve lifts the hot water will come into contact with the atmosphere and be turned into a mixture of steam and water, which will be emitted from the discharge point under pressure.

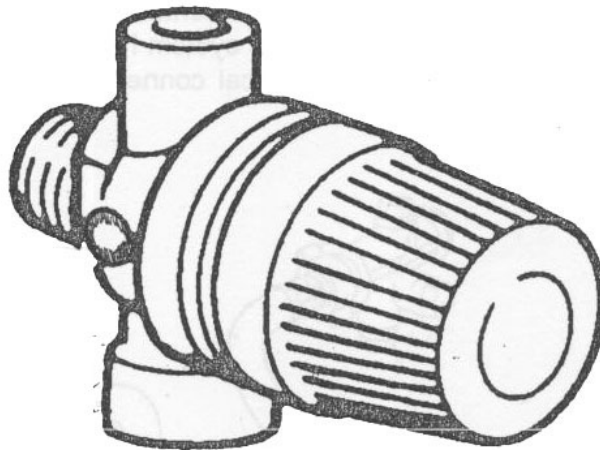


Figure 29. Pressure Release Valve & Discharge Pipe

B.S 759.

Pre-set to 3 Bar.

Valve material and seating must be of non-stick type.

Location;

- a). On the boiler
- b). On the flow pipe near boiler with no valve.

Filling and Maintaining the System Water

With the open system filling and maintaining the water level is a simple operation of turning on the water supply and venting the air out of the system and the water level is automatically controlled by the ball valve in the F&E cistern.

With the sealed system, as there is no ball valve, water has to be introduced in the majority of systems from the mains water supply by manually opening a stop valve and turning it off when enough water has entered the system in accordance the manufacturer's instructions. To prevent possible contamination of the mains water supply the connection between the mains water and the system should incorporate the following components:

- a double check valve (non-return valve).
- a test point.
- a stop valve fitted to the system return pipework.
- a stop valve fitted to the mains water take-off point.

As a further precaution against possible contamination, a temporary filling loop is normally used, which can be removed after the system has been filled (Fig 28). Once the loop has been disconnected there is no physical connection between the system and the mains water supply.

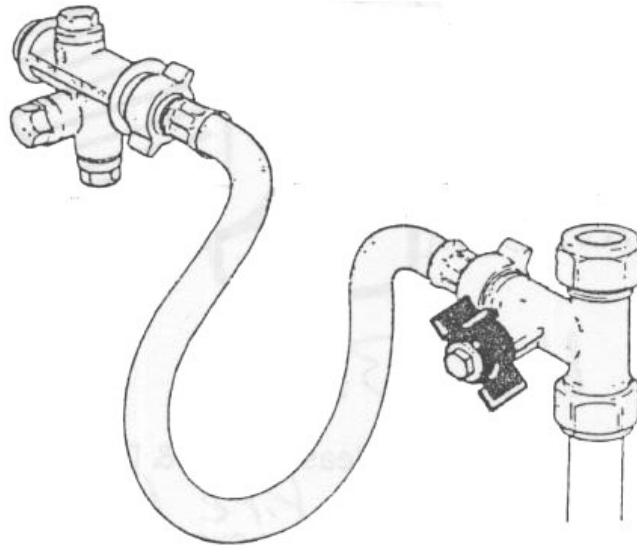


Figure 30. Temporary Filling Loop

As there is no ball valve to shut off the water when the system is full of water an alternative method must be used which estimates the amount of water required to fill the system.

Using the principle that a column of water exerts a given pressure, a pressure gauge permanently connected to the system, with a range of 0-4 bar, can be used to determine the amount of water contained within the system.

Although it is possible to calculate the approximate pressure required for each system, dependant on the amount of pipework and radiators etc. it is common practice for manufacturers to state the fill pressure of their boilers for a typical system.

Maintaining the Water Level

There are two basic methods that can be used to maintain the water level within the system. Either provision is made for an automatic top-up bottle to be used as shown in the diagram below or an allowance is made for additional water to be forced into the system.

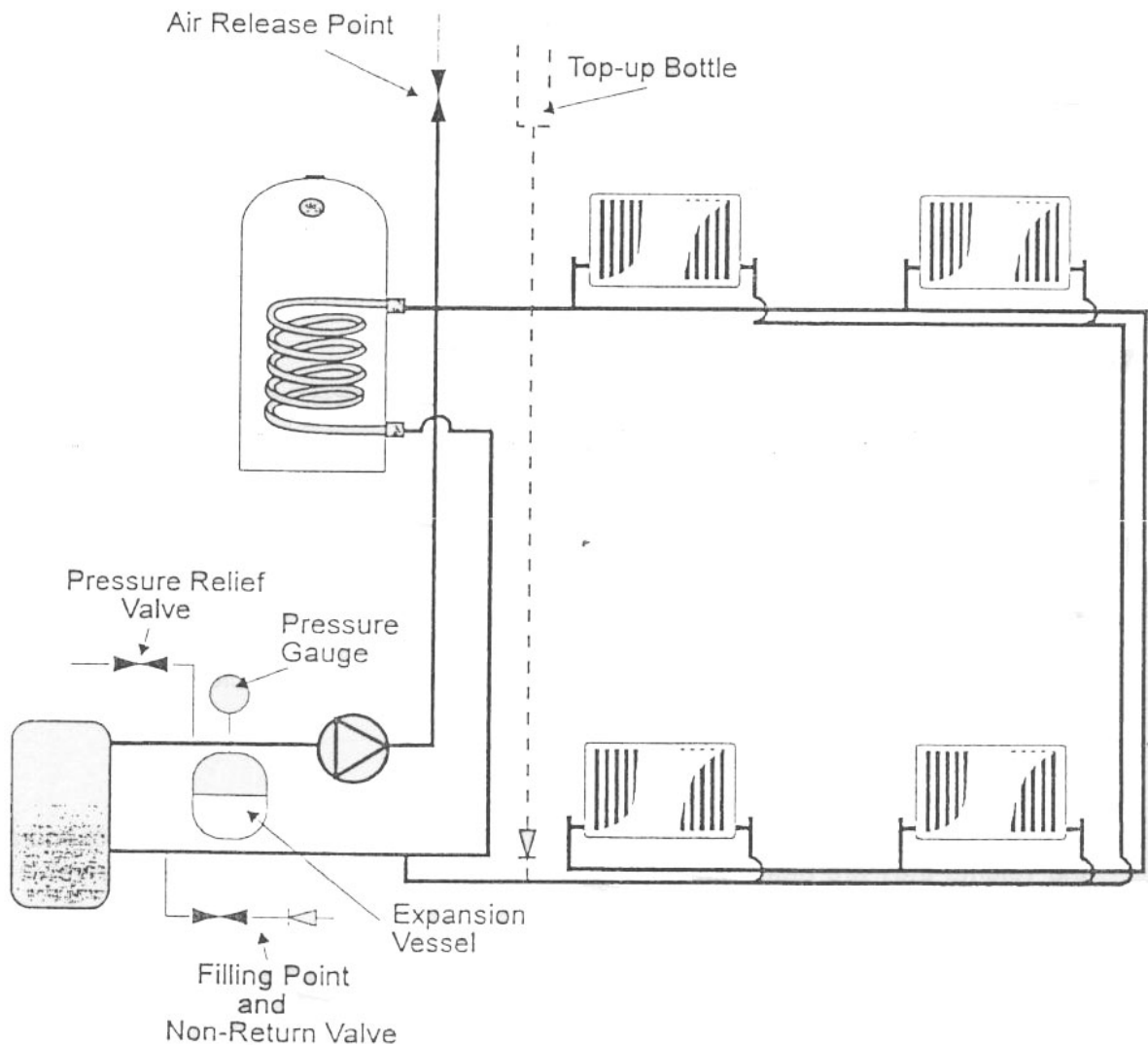


Figure 31. Automatic Top Up Bottle

Where an automatic top up bottle is used this must incorporate a non-return valve. When the system is full the valve is closed, if the water level drops the valve opens and allows water to enter the system.

The disadvantage of such a system is that the customer must periodically check the water level in the top up bottle and manually replace any water in the bottle that has been lost.

An alternative method relies on over pressurising the system on initial filling to force more water into the system than is actually required.

Systems which rely on over pressurisation must be designed to ensure the size and charge pressure of the expansion vessel can cope with the additional pressure within the system. The manufacturer's instructions should be referred to in all cases when filling or exchanging essential components on the pressurised system.

Common Problems

Water discharging from the safety valve indicates that the system operating pressure has been exceeded. This may be caused by the water being heated over and above the maximum operating temperature. However for this to occur it would require both the boiler stat and overheat control to have failed.

A more likely explanation is that the system has either been overfilled or the expansion vessel is defective. The reliability and accuracy of the safety valve should also not be overlooked.

Checking and Recharging Expansion Vessels

The charge pressure within most expansion vessels can be checked by using a car tyre pressure gauge attached to a schraeder type valve fitted to the expansion vessel and where required recharged using a pump.

The manufacturer's instructions must be followed to ensure the vessel is recharged correctly. In most cases this will entail draining the system and ensuring any water trapped within the expansion vessel can be discharged from the system via an available open point.

Overfilling a System

Although the majority of sealed systems will accept a small amount of water over and above the volume they are designed for, excessive overfilling will cause the safety valve to lift either in the cold or hot state.

If water is continually introduced into the system from the mains water connection it will slowly raise the pressure in the system. If the mains water pressure is above the manufacturer setting of the safety valve it will lift and discharge cold water.

If the ingress of water is stopped prior to the valve lifting, the possibility still exists of exceeding the operating pressure when the system heats up. A correctly filled system will have the provision for the expansion of water and the increase of pressure between the fill pressure and safety valve pressure.

Defective Expansion Vessel

As we have mentioned the expansion vessel is designed to accommodate the increase in the volume of water as it expands. However, this can only take place if the vessel is large enough to accept the volume of water, the charge pressure on the underside of the diaphragm is correct and the diaphragm within the vessel is intact.

If the charge is lost, water will fill the expansion vessel and expansion of the water will not be able to take place. The same effect will happen if the diaphragm is split and water is allowed to occupy both compartments either side of the diaphragm, shown in the diagram below.

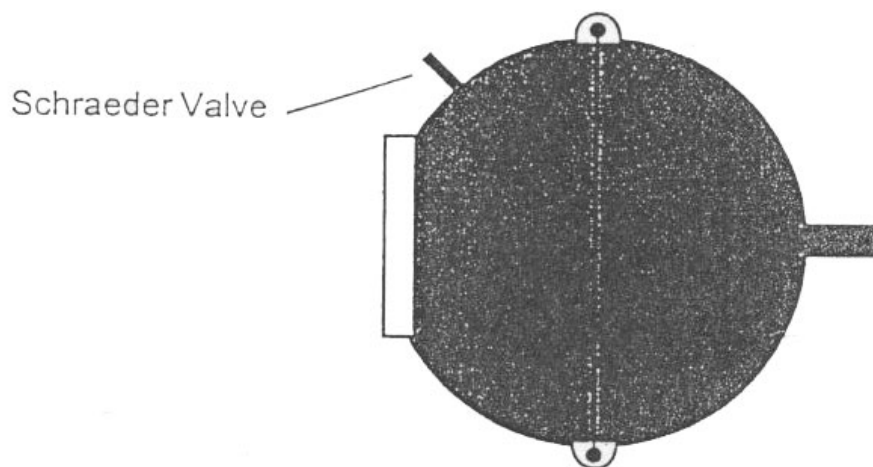


Figure 32. Fig Defective Expansion Vessel

Checking for Split Diaphragms

In cases where the diaphragm has split or been punctured this can easily be confirmed. Where the installer suspects that this is the cause of the problem the schraeder type valve may be cracked open.

If the diaphragm has split, water will be present within this chamber and will subsequently be issued from this bleed point. Care should be taken with this course of action because if the diaphragm is intact only the charge pressure will be present and this will require recharging.

Too high a charge pressure under the diaphragm may prevent the diaphragm from moving when the water is heated and begins to expand.

The sealed system may provide the answer in providing central heating where an open system was not possible. However, the most popular application is now the combination boiler, which uses the principle of the sealed system with the expansion vessel and ancillary controls fitted within the case of the boiler.

Self Assessment

1. What is the main difference between a sealed system and a conventional open system?
2. What must the boiler incorporate to protect against overheating?
3. What could be the effect if a sealed system was overfilled with system?
4. List two methods that can be used to maintain the' water level within a sealed system.
5. What is the purpose of the expansion vessel on a sealed system?
6. What could happen if the expansion charge pressure was too high?

When you are ready check your answers with those on the following pages and refer back to the relevant text for assistance with your answer, where necessary.

Self Assessment Answers

1. What is the main difference between a sealed system and a conventional open system?

The sealed system is not open to the atmosphere as with the conventional system which has an open vent.

2. What must the boiler incorporate to protect against overheating?

An overheat device that will interrupt the main gas supply to the burner and a suitable discharge pipe installed in accordance with the manufacturers instructions.

3. What could be the effect if a sealed system was overfilled with system?

Although the majority of systems will operate correctly if they are overfilled, if too much water is 'forced into the system the safety valve may lift when the water expands and discharge the system water.

4. List two methods that can be used to maintain the ' water level within a sealed system.

a) A top-up bottle with a non return valve.

b) Pre-pressurising the system on initial filling to force additional water into the system.

5. What is the purpose of the expansion vessel on a sealed system?

To allow the expansion of the water to take place within the system when it is heated.

6. What could happen if the expansion charge pressure was too high?

Expansion of the water may not be able to take place with the result that system water may be discharged via the safety valve.

Domestic Central Heating Main Equipment

Some form of central heating has become a prerequisite for modern houses and it is part of the plumbers work to install and maintain these systems.

Domestic central heating systems are simply an extension of the indirect system of hot water supply.

Generally the main equipment required is as follows:

- A Boiler.
- An Indirect Cylinder.
- A Feed & Expansion Cistern or Expansion Vessel.
- A Circulating Pump.
- Radiators.

The pipes used in domestic central heating systems are generally copper or plastic in various sizes. In industrial installations it is more likely that steel pipes would be used.

There are two types of systems most commonly used:

- The Open Vent System;
This system incorporates a feed and expansion cistern, vent pipe and cold feed.
- The Sealed System;
In this system the expansion of water is taken up by an expansion vessel.

The Open Vent System

Consider a basic system comprised of a Boiler, indirect cylinder, feed and expansion cistern. Radiators will be added later.

The drawing shows the position of the equipment.

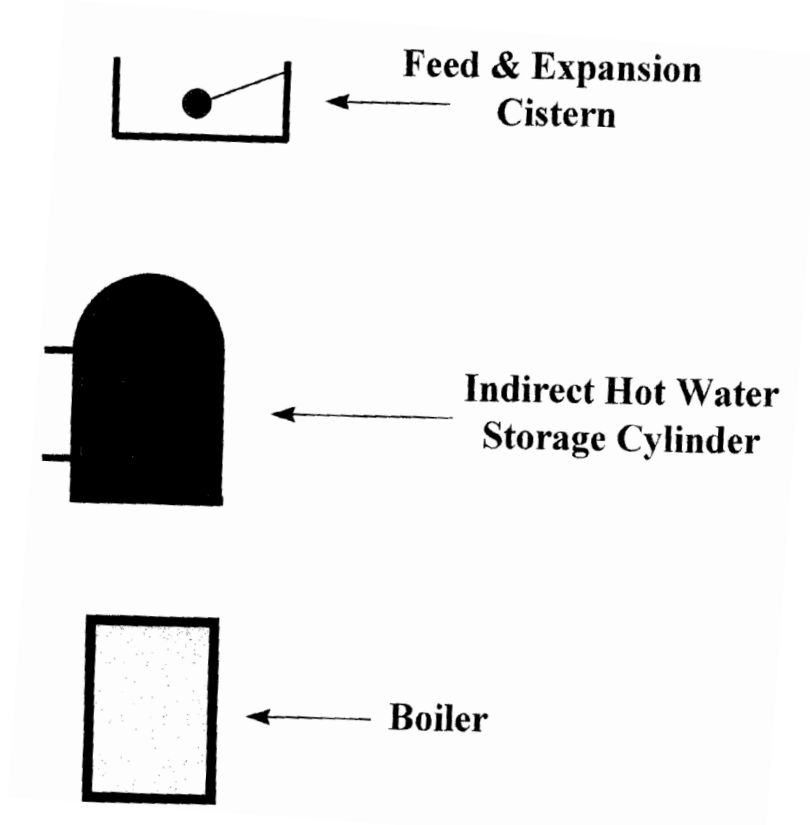


Figure 33. Basic Open Vent System

A 15mm connection is taken from the feed and expansion cistern and should enter the system at a low level and if possible close to the boiler.

A standard gate valve is fitted on this pipe.

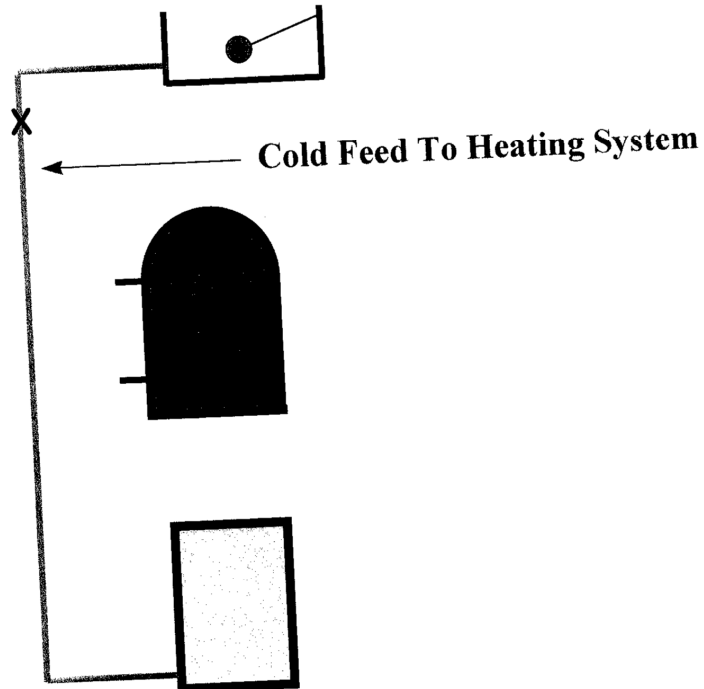


Figure 34. Cold Feed to Heating System

A 25mm flow is run from the top of the boiler and connects to the upper coil connection on the indirect cylinder.

This pipe is referred to as the primary flow.

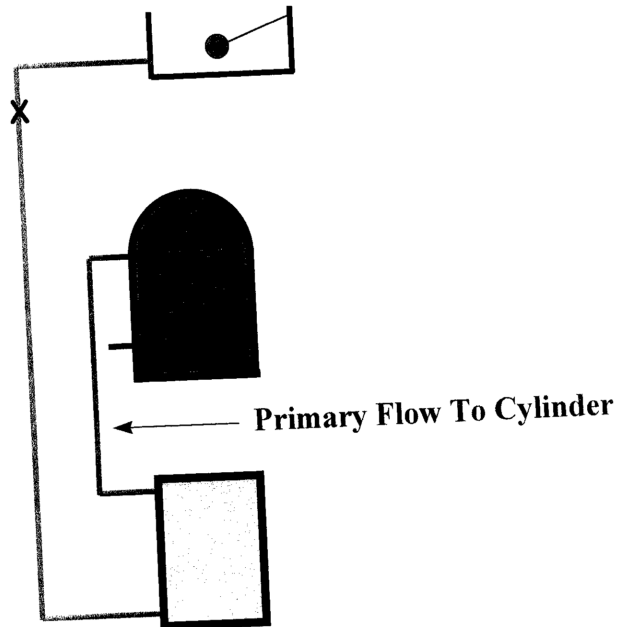


Figure 35. Primary Flow to Cylinder

This pipe reduces to 20mm diameter and continues to rise and terminate above the F&E cistern.

This pipe is now known as the open vent or expansion pipe.

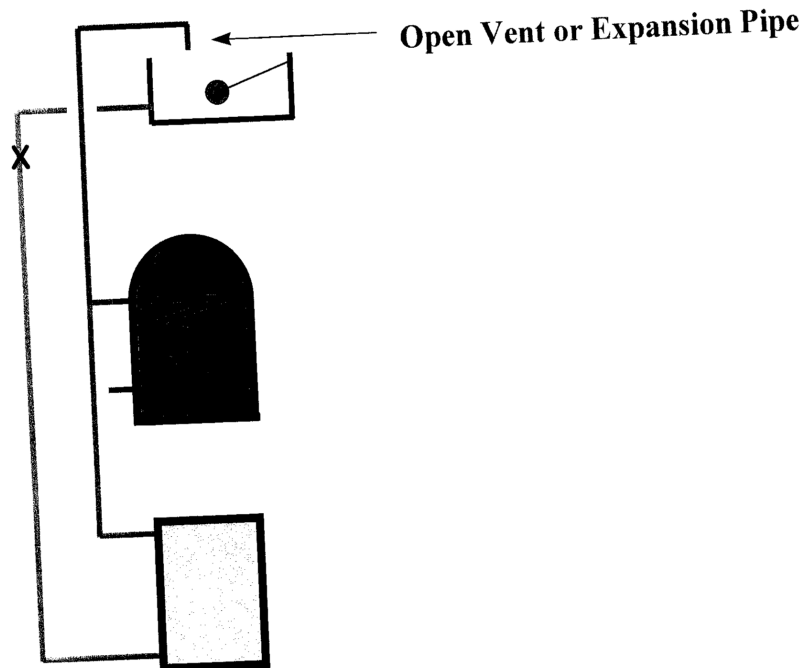


Figure 36. Open Vent or Expansion Pipe

A 25mm return pipe is taken from the lower connection on the coil of the indirect cylinder and run back to the lower connection on the boiler.

This pipe is referred to as the primary return.

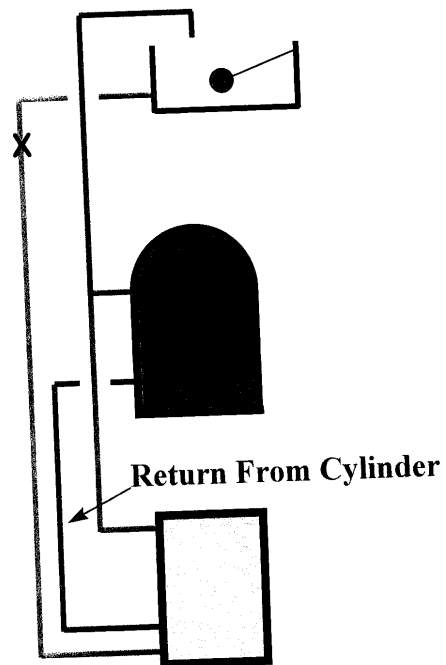


Figure 37. Primary Return

Four radiators are now added to the system.

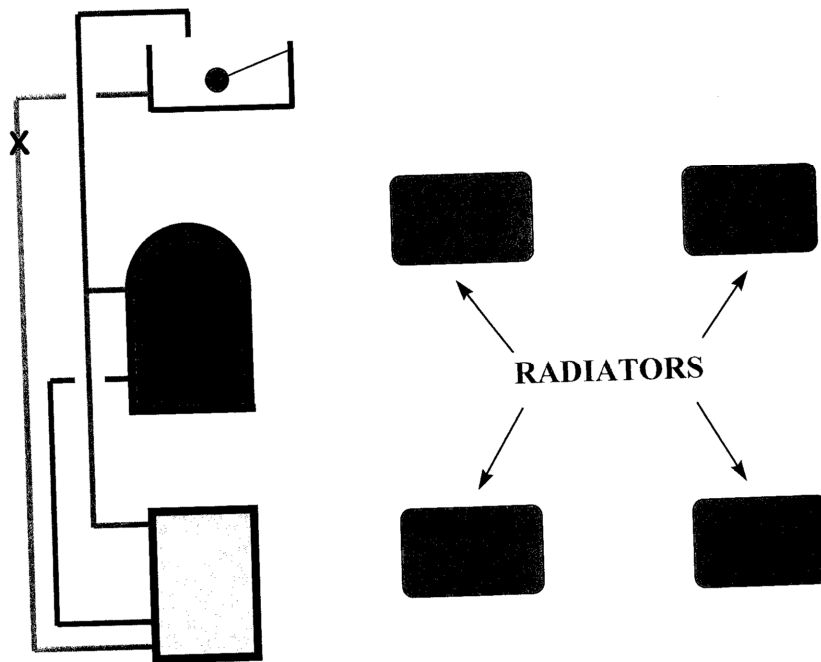


Figure 38. Radiators

Each radiator is fitted with two valves:

- A Handwheel valve on the flow.
- A Lockshield valve on the return.

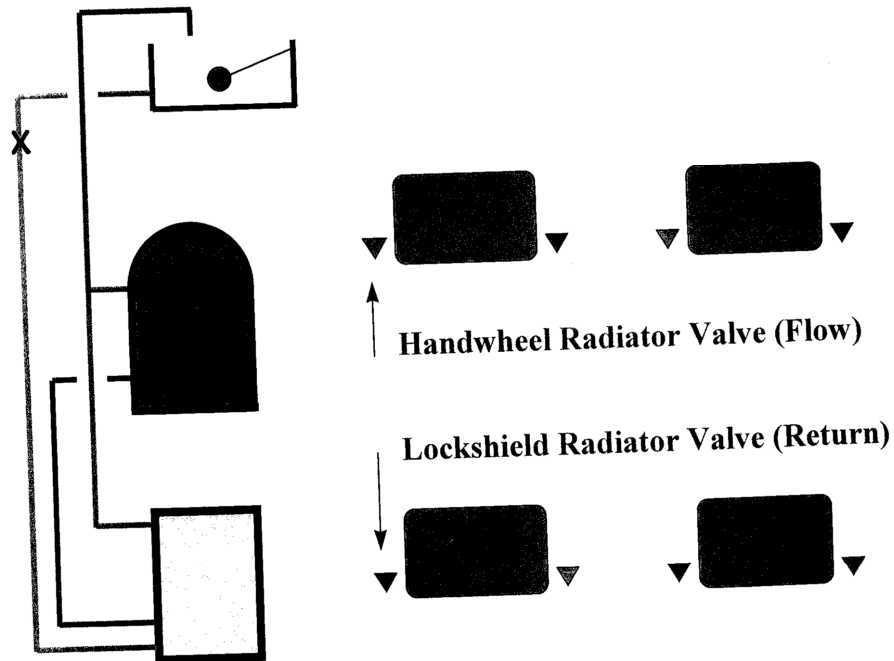


Figure 39. Radiator Valves

The One Pipe System of Central Heating

This consists of single pipe or ring main into which both connections the radiator are made.

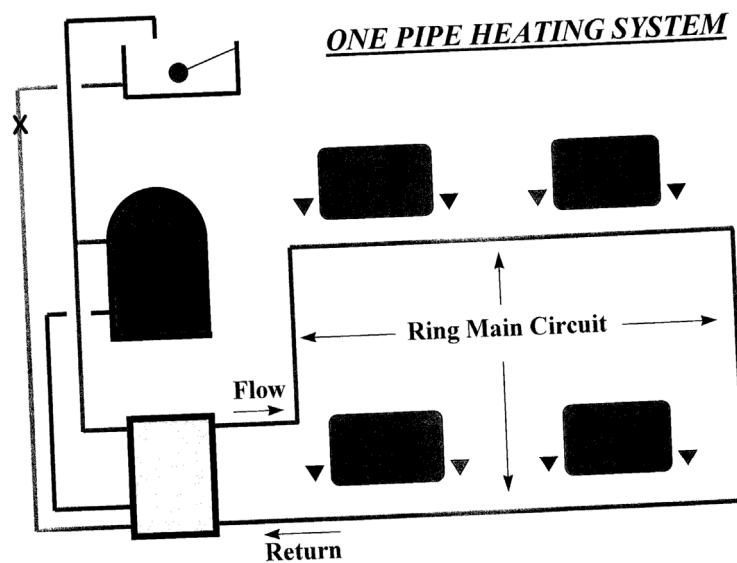


Figure 40. One Pipe Heating System

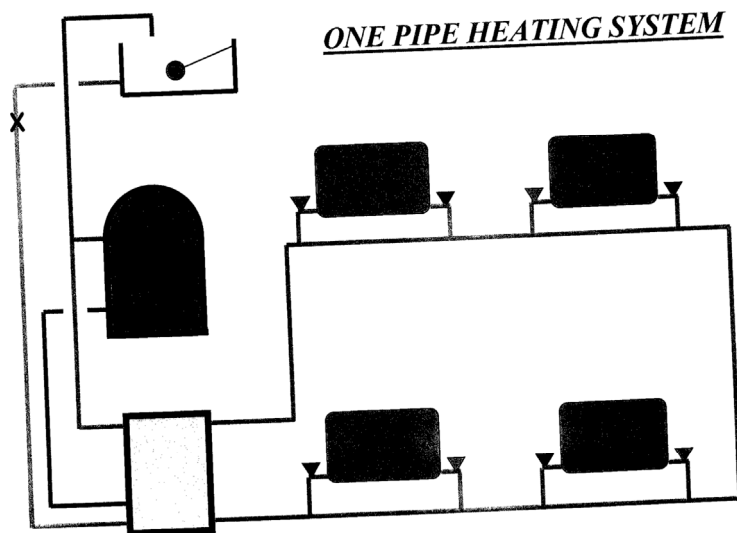


Figure 41. One Pipe Heating System

A pump, safety valve and drain cock are now fitted to complete the system.

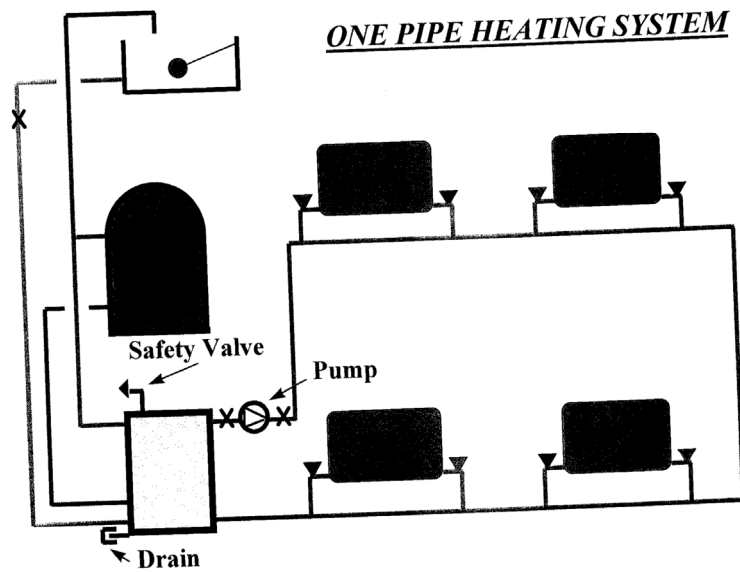


Figure 42. Pump, Safety Valve and Drain Cock

The Two Pipe Heating System of Central Heating

In this system the hot water from the boiler is pumped through each radiator through the flow pipe.

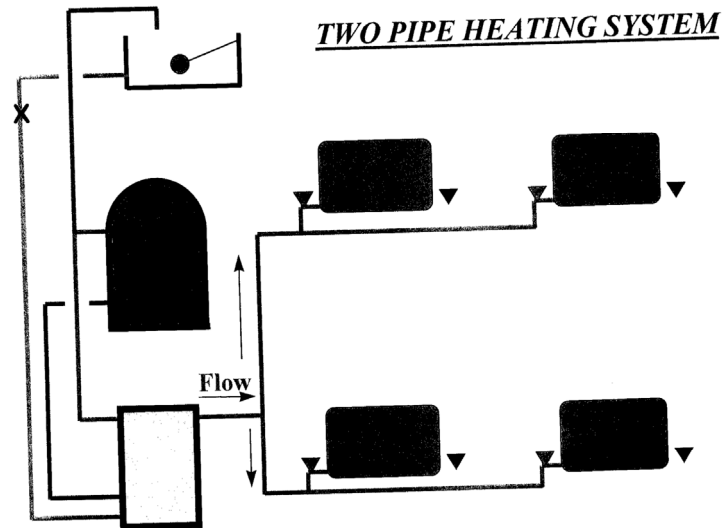


Figure 43. Two Pipe Heating System

The water from each radiator goes back to the boiler through the return pipe.

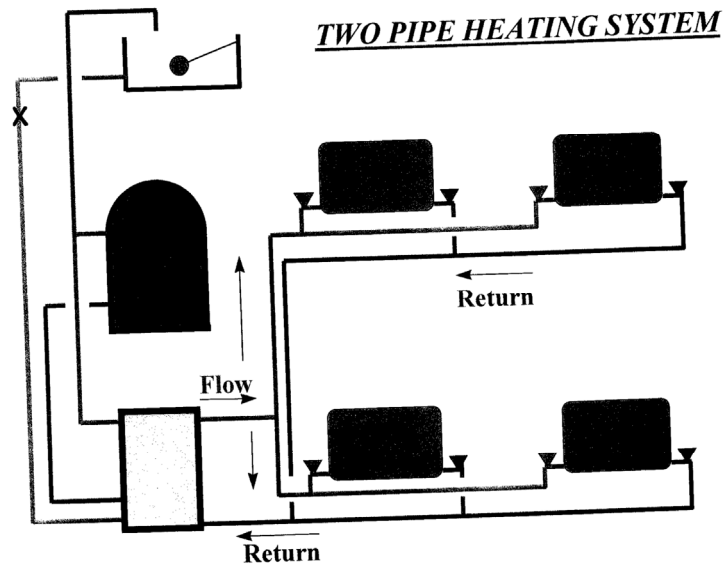


Figure 44. Return Pipe

To understand the system, consider it being filled for the very first time.

Cold water from the F&E cistern passes down the cold feed pipe to the boiler. Note that the system fills the flow and return pipework to the cylinder coil is self venting. The radiator in the system are not self venting and some means of removing the air has to be provided. This is achieved by the fitting of an air vent in each individual radiator. As the system fills the air in each radiator is compressed in the upper portion. A vent key is used to open the vents to allow this air to escape and the radiator to fill with water. The system is now full of water and ready for firing.

As the boiler heats (with the pump switched off), gravity circulation by **convection** currents will heat both the coil in the cylinder and the higher level radiators in the system – i.e. any radiators fitted higher than the boiler. Because water rises when heated the lower radiators will **not** heat by gravity. To enable these lower radiators to heat the water must be forced through the pipework by switching on the pump.

The water circulated by the pump will be forced through **all** the radiators and pipework on the heating side of the system, but will **not** affect the gravity circulation to the indirect hot water cylinder.

The One Pipe System of Central Heating (Advantages and Disadvantages)

The main advantage of this system is that only one pipe is necessary to convey hot water to the radiators.

This system is cheap to install because there are less pipes than the two pipe system and there is also a saving on materials.

The disadvantage of the one pipe system is that hot water passing through the first radiator is cooled and returns to the main flow pipe.

This water then supplies the next radiator and has the effect of producing a lower temperature.

As this process is repeated at each radiator the water becomes progressively cooler, and the temperature of the last radiator on the circuit is noticeably lower than that of the first.

This can be overcome to some extent by careful regulation of the lockshield valves on each radiator, and by limiting the number of radiators on each single pipe circuit to three or at most four.

There is a further factor to be taken into account with the one pipe system. Hot water is pumped round the circuit pipework only and **not through the radiators**. The radiators are heated by convection currents which occur between the cool water in the radiator and the hot water in the flow pipe beneath it.

As most modern radiators have only 15mm BSP tappings, these may not be large enough to convey sufficient water to the radiators at the low-flow rates produced by gravity circulation. This may result in an unacceptable Temperature difference between the top and bottom of the radiators.

In the one pipe system radiator connections should be at least 20mm BSPT and if possible top and bottom opposite ends.

The one pipe system is only suitable for small single storey buildings and is often used in halls and schools.

The Two Pipe System of Central Heating (Advantages)

The two pipe system has a number of advantages over the one pipe system and should be used in preference to it. Its main advantage is that hot water from the boiler supplies each radiator and then returns via the return pipe without passing through any more heat exchanges. This ensures a quick heat up time and a more positive flow to the radiators. It is for this reason that when convector radiators are used, this system of pipework is essential.

Radiators

There are three main types of radiators

- Panel radiators.
- Column radiators.
- Hospital radiators.

Panel radiators are manufactured from thin sheets of mild steel, which are pressed into shape with the seams welded together.

Radiators can be manufactured from any of the following materials:

- Mild Steel.
- Aluminium.
- Cast Iron.
- Copper.

Radiator Connections

All radiators are threaded with female B.S.P.T. (British Standard Pipe Thread) connections.

The location of the connections are as follows:

- B.O.E. Bottom Opposite End
- T.B.O.E. Top and Bottom Opposite End
- T.B.S.E. Top and Bottom Same End

An air release valve or vent is fitted at one of the top corners of the radiator.

BOTTOM OPPOSITE END	TOP & BOTTOM SAME END	TOP & BOTTOM OPPOSITE END
------------------------	--------------------------	------------------------------

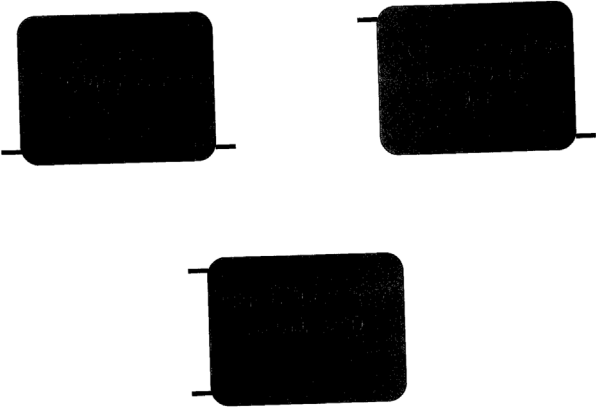


Figure 45. Locations of Radiator Connections

Radiator Valves

The flow connection to a radiator should be fitted with a manually operated **HAND WHEEL** control valve. The return connection should be fitted with a **LOCKSHIELD** radiator valve. This valve enables the water flow through the radiator to be controlled or balanced, and once set should not be altered. When the central heating system is first operated, radiators that are close to the boiler will tend to have an excessive flow of hot water through them. This will result in reduced flow through radiators which are located farther away.

By closing down the lockshield valves on radiators near the boiler, and progressively opening the lockshield valve on the farther radiators, a more balanced and even heat is achieved.

THIS OPERATION IS KNOWN AS BALANCING THE CENTRAL HEATING SYSTEM.

To control the temperature of a radiator a **THERMOSTATIC RADIATOR VALVE (TRV)** can be used. These may be fitted on either the flow or return side of the radiator depending on the type used.

Thermostatic radiator valves enable the user to turn the radiator on and off and are useful for regulating the temperature of bedrooms or rooms which are not in general use but still require some heating.

When a TRV is fitted on the return connection of a radiator the lockshield valve must be positioned at the flow connection.

Positioning of Radiators

Whenever possible, the radiator should be installed under a window. This is the best position because the hot convection currents will counteract the cold down flow of air from the glass.

If the radiator cannot be fitted under the window it should be on an adjacent wall. The worst position is opposite the window as the convection currents will encourage the cold down flow of air.

Circulating Pumps

These devices, sometimes known as accelerators, are fitted to the pipework to assist water circulation. Basically pumps utilise a circular veined wheel (impeller) which draws water in through its centre and throws it out by centrifugal force.

The pump is a very important part of the modern central heating system. It enables the use of smaller diameter pipes and boilers than would be the case if a conventional gravity system was used.

The function of the pump is to provide pressure inside the system which in turn will force water to circulate throughout the whole system of pipework and heat emitters.

The location of the pump within the system can be on the **FLOW PIPE** (now generally accepted as the best position) or on the **RETURN PIPE**. In some instances it is located adjacent to the boiler inside the boiler casing.

One popular location is in a horizontal pipe close to the boiler with isolating valves on either side to facilitate removal or repair.

Positioning of the pump is very important. Figs. A – B – C show three different combinations of pump placement in relation to the cold feed and expansion pipe or open vent.

In case 'A' the tendency will be for the pump to draw water down the cold feed while at the same time forcing a similar amount out through the expansion pipe. This occurrence is known as "PUMPING OVER" or "PITCHING" and will result in extensive oxygen entering the water which will cause corrosion within the system. In diagram 'B' both the vent pipe and the cold feed are subject to the same pressure and therefore no pitching will occur. However, as the rest of the system is operating under negative pressure because the pump is on the return, there will be a tendency for air to be drawn in through the packing glands of radiator valves.

In case 'C' the pump is fitted on the flow pipe and the whole system is under positive pressure. There is no tendency for air to be drawn into the system and pitching will not occur.

Safety Valves

In all heating installations it is essential that a safety valve should be fitted.

SAFETY VALVES SHOULD BE FITTED DIRECTLY ON TOP OF THE BOILER IN THE HOTTEST PART OF THE SYSTEM

WITH NO INTERVENING VALVE OR RESTRICTION.

Some boiler manufacturers provide extra tapping for this purpose.

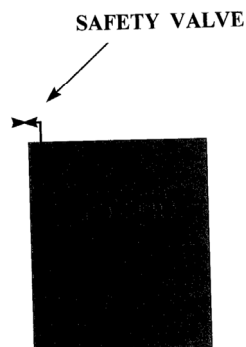


Figure 46. Safety Valve

In the case of solid fuel wrap around boilers this arrangement may not be possible and the usual practise is to fit the safety valve on the

FLOW PIPE as near as is practical to the boiler. The safety valve should always be accessible for testing.

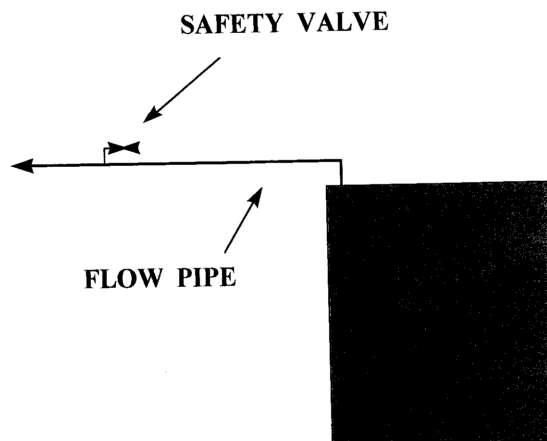


Figure 47. Safety Valve and Flow Pipe

The purpose of a safety valve is to release any excess pressure which may build up in the system due to a fault. For domestic purposes safety valves should be non-adjustable with a pre-set lift pressure of **3 BAR**.

It should be spring loaded and have valve and valve seating of materials which will not cause the valve to stick in the closed position.

The valve should be positioned in such a way that should it discharge water or steam, it will not cause injury or create a hazard to the occupants of a building or damage to electrical components or wiring.

To prevent this happening a means of connecting a discharge pipe is provided. The discharge pipe must terminate in such a manner as to allow visual identification of valve operation.

OFTEC (Oil Firing Technical Association For The Petroleum Industry) recommend that the discharge pipe from safety valves terminate 100mm above floor level.

The Sealed System of Central Heating

Central heating systems which have a vent or expansion pipe open to the atmosphere via a feed and expansion cistern, are commonly known as “LOW PRESSURE HOT WATER HEATING SYSTEMS”.

In every wet central heating system provision must be made for the expansion of the hot water. In low pressure hot water heating systems this expansion of water is accommodated in the feed and expansion cistern. These systems are also known as ‘open’ or ‘vented’ central heating systems.

The alternative to the “OPEN SYSTEM” is the “SEALED SYSTEM” of central heating. In the sealed system the water is supplied from either:

- The Incoming Water Main
- A Top Up Bottle

When filling the system from the incoming water main a “FILLER LOOP” may be used. This is a device which incorporates:

- A Check Valve (Non-Return Valve)
- An Isolating Valve
- A Flexible Pipe For Disconnecting

When this method of filling the system is used the ‘filler loop’ must be disconnected from the mains supply in order to prevent the BACK-SIPHONAGE of water from the heating system into the local authority water main.

A ‘TOP UP BOTTLE’ is a 45 litre cistern used to fill the heating system. A standard BS 1212 Portsmouth ball valve fills the cistern. A 15mm connection is taken from the outside side and is fitted with a non-return valve before connecting into the system pipework.

In the sealed system, when the boiler is fired the water heats up and expands. Because this expanding water cannot be taken up in an F&E cistern, it generates a pressure on the pipework. This pressure must be catered for by the fitting of an “EXPANSION VESSEL”.

Expansion Vessel

An expansion vessel is a gas/air filled vessel used to take up the expansion of water in sealed central heating systems.

The gas or air is separated from the system water by a rubber diaphragm or washer.

The vessel is charged with gas or air equal to the static head of the system. This is approximately 0.11 Bar for every metre high. In the average house the pressure should be 0.5 Bar when the system is cold.

IN A DOMESTIC SITUATION THIS PRESSURE SHOULD NEVER EXCEED 1 BAR.

IN DOMESTIC CENTRAL HEATING SYSTEM THE WATER TEMPERATURE SHOULD NEVER EXCEED 80°C.

The expansion vessel should be pressurised with air/nitrogen prior to filling the system with water. This will ensure that when the system is cold there will be no water in the vessel. This means that the full capacity of the vessel can be used to take up the expansion of water in the system.

The expansion vessel should be connected to the system at a point close to the pump inlet which is also referred to as the suction side of the pump. Although the vessel can be located anywhere in the building, you must ensure that no valve is fitted on the pipe between the point of connection and the vessel itself.

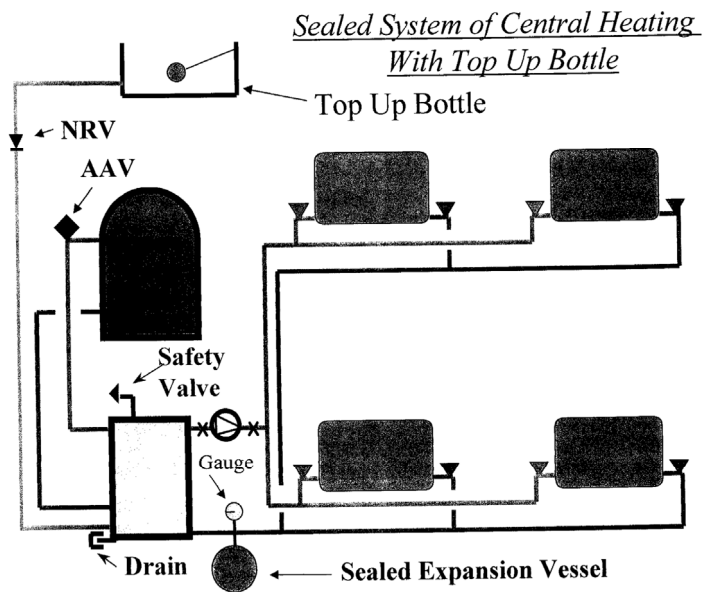


Figure 48. Sealed System of Central Heating with Top Up Bottle

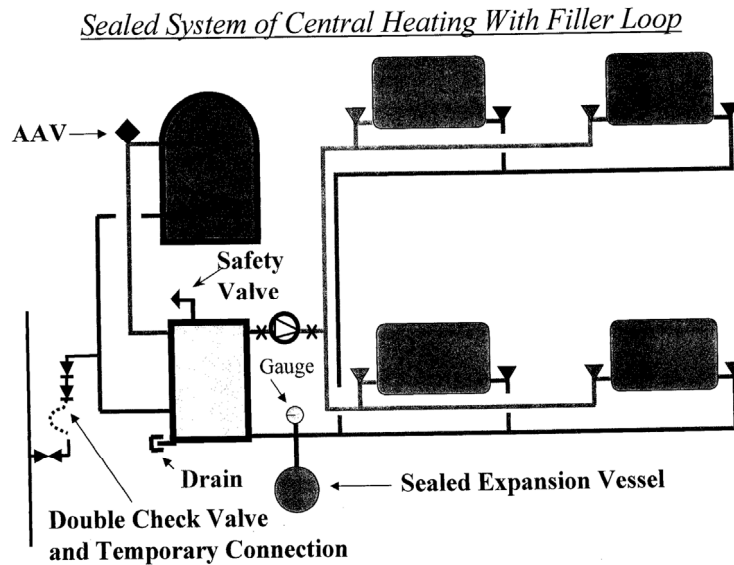


Figure 49. Sealed System of Central Heating with Filler Loop

Sizing of Expansion Vessels

Expansion vessels are available in various sizes depending on the water capacity of the system i.e. the bigger the installation the larger the expansion vessel. The following table shows some examples of the vessel sizes to be found in domestic central heating systems.

System Load (KW)	Size of Vessel (Litres)	Internal Gas Pressure (Bar)	Safety Valve Pressure (Bar)
3	4	0.5 – 1.0	3
6	4	0.5 – 1.0	3
12	8	0.5 – 1.0	3
18	12	0.5 – 1.0	3
24	18	0.5 – 1.0	3

The above table is only a guide and detailed information on expansion vessels is available from the manufacturers.

Sealed central heating systems are only suitable for use with automatically fired boilers such as those run on gas or oil.

THE SEALED SYSTEM SHOULD NOT BE USED WHERE BOILERS ARE HEATED BY SOLID FUEL.

Advantages of the Sealed System

1. Because there are no F&E cistern there is no loss of water through evaporation and therefore less risk of oxygen entering the system.
2. The vessel can be located close to the boiler and therefore monitored on a regular basis.

3. Pumping over or pitching into the F&E cistern is eliminated.
4. The boiler can be located anywhere in the installation.
5. In industrial situations the system can be operated at high temperatures.
6. There is a cost saving in time and material due to the elimination of pipework to the F&E cistern.
7. Because there may be no pipes in the attic the danger of frozen pipework is greatly reduced.

The Sealed System in Industrial Installations

Under normal atmospheric pressure water boils at 100°C. This means that regardless of the amount of heat used the water temperature cannot be increased.

The evaporated water, which is steam, also has a temperature of 100°C.

However, if the pressure of the water is increased a higher water temperature can be achieved.

In systems which need to be designed to operate at or over 100°C, the pressures must be higher than 1 bar. In large installations where excessively long pipe runs are common, and the criteria for domestic situations were applied (i.e. max. water temperature of 80°C), the temperature drop over the long run could be such as to make it impossible to achieve the required heat output.

To overcome this difficulty a “**PRESSURISED**” sealed system is used. This means that the water in the system is pressurised above 1 atmosphere (1 Bar) thereby allowing the temperature to be raised above 100°C without the water turning to steam.

Therefore the higher the internal pressure of the system the higher the temperature of the circulating water.

If a “**PRESSURISED**” sealed heating system was used in a domestic installation, and the above principle applied, the surface temperature of the radiators would be extremely high and therefore would be dangerous to touch.

Another situation where an automatic air vent could be used would be on the primary flow pipe to an indirect cylinder.

If the primary flow does not continue up as the vent/expansion pipe some method of removing air is required

This would have disastrous consequences in a domestic situation and that is why in industrial installations this pipework is usually run at a high level, or in locations where no injuries can occur to any person due to faults in the system.

Automatic Air Vents

This is a valve designed to release air automatically from the high point of a central heating system.

If, for example, a boiler was located on the roof of a building the flow and return pipes would have to drop to supply radiators fitted on the floors below.

In such a situation air would naturally rise to the highest point of the system and some means of releasing this air is required. An automatic air vent could be used in such an installation.

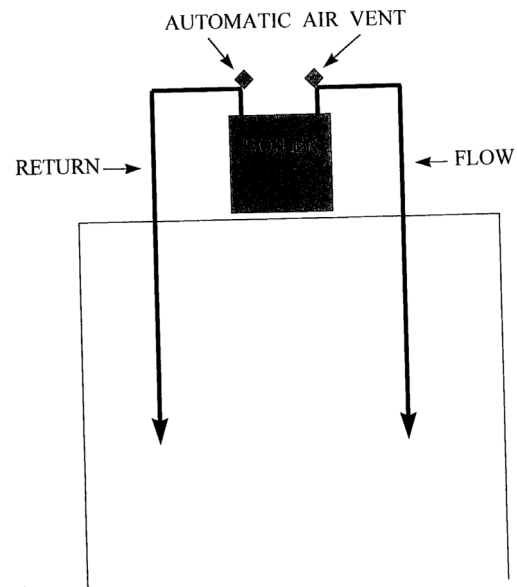


Figure 50. Automatic Air Vent

Another consequence of the “PRESSURISED” sealed system is that although the water inside the system is above 100°C it is still a liquid.

However, should a leak occur this water will then instantly turn to steam – same temperature as the water in the system and also under high pressure.

Commissioning of Wet Central Heating Systems

On completion of a central heating installation the system should be commissioned as follows:

1. The pump should be removed and replaced with a suitable piece of pipe to bridge the gap. The system is now filled with water, any air being vented out as necessary from all high points and checked for leaks.

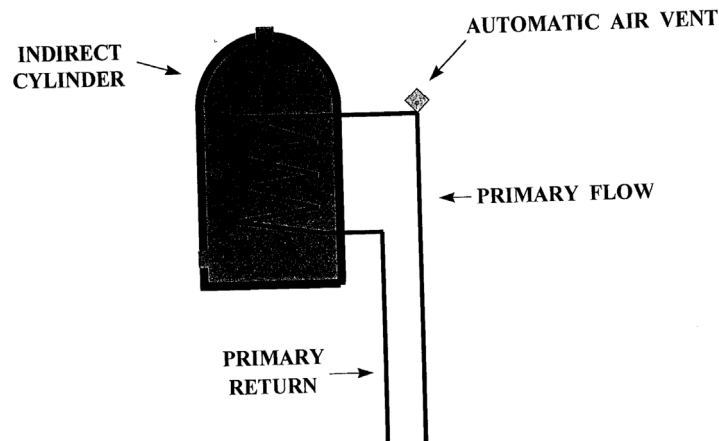


Figure 51. Wet Central Heating System

2. The system should then be drained down and receive a flush through to remove any wire wool, flax, PTFE tape, flux, solder etc. The pump is now replaced and the system refilled as in step 1 above. The boiler is now ignited and the system brought into operation by turning up any thermostats etc. A check should be made of the boiler thermostat to confirm that it is working.
3. At this stage the boiler can be commissioned for correct operation.
4. Close all lockshield valves and go round the system balancing the heat emitters to each room. This involves slowly reopening the lockshield valve to give a mean water temperature to each heater. Ensure that the design temperature drop across the system is maintained at the boiler. This should be carried out using clamp-on thermostats at the flow and return pipes to achieve approximately 82 °C flow and 71 °C return temperatures. This will ensure maximum efficiency and give a longer life to the boiler.
5. Check the operation of the programmer, room thermostat and cylinder thermostats etc. and any motorised valve fitted to the system and ensure the pump switches off as required.
6. Recheck for leaks. Turn off the boiler and drain the system while it is still hot. This assists the removal of flux residuals.
7. Refill and vent the system, adding an inhibitor, if applicable. Having cured any problems and secured cistern lids and insulation material, the installer should attach to the boiler a card identifying the date of installation and the name of the installer. Labels should also be fixed to any valves etc. for identification purposes. The job should now be tidied up in readiness for hand over to the owner.

Handing Over

The working of the system should be demonstrated to the user and the best methods of economic and efficient usage explained. All documentation supplied with equipment should be left with the owner/occupier who should be made aware of the need for a regular service contract to ensure the equipment is maintained in an efficient and safe operating condition.

Column radiators are manufactured from cast iron. They have a large surface area, which enables them to emit heat efficiently.

Hospital radiators are similar in appearance to column radiators but do not have any dust traps or crevices and are easier to keep clean.

Because water rises when heated the lower radiator will **not** heat by gravity. To enable these lower radiators to heat the water must be forced through the pipework by switching on the pump.

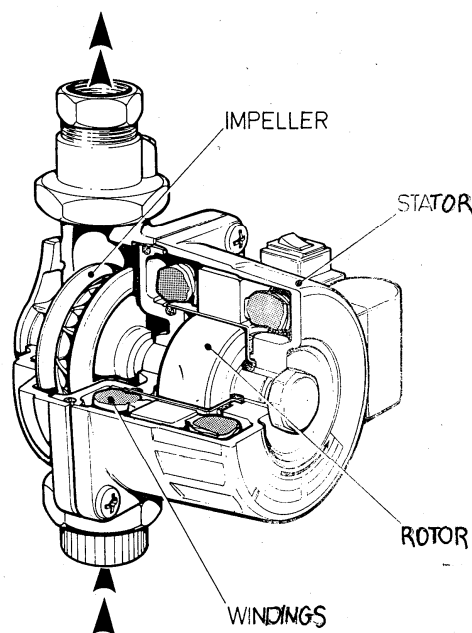
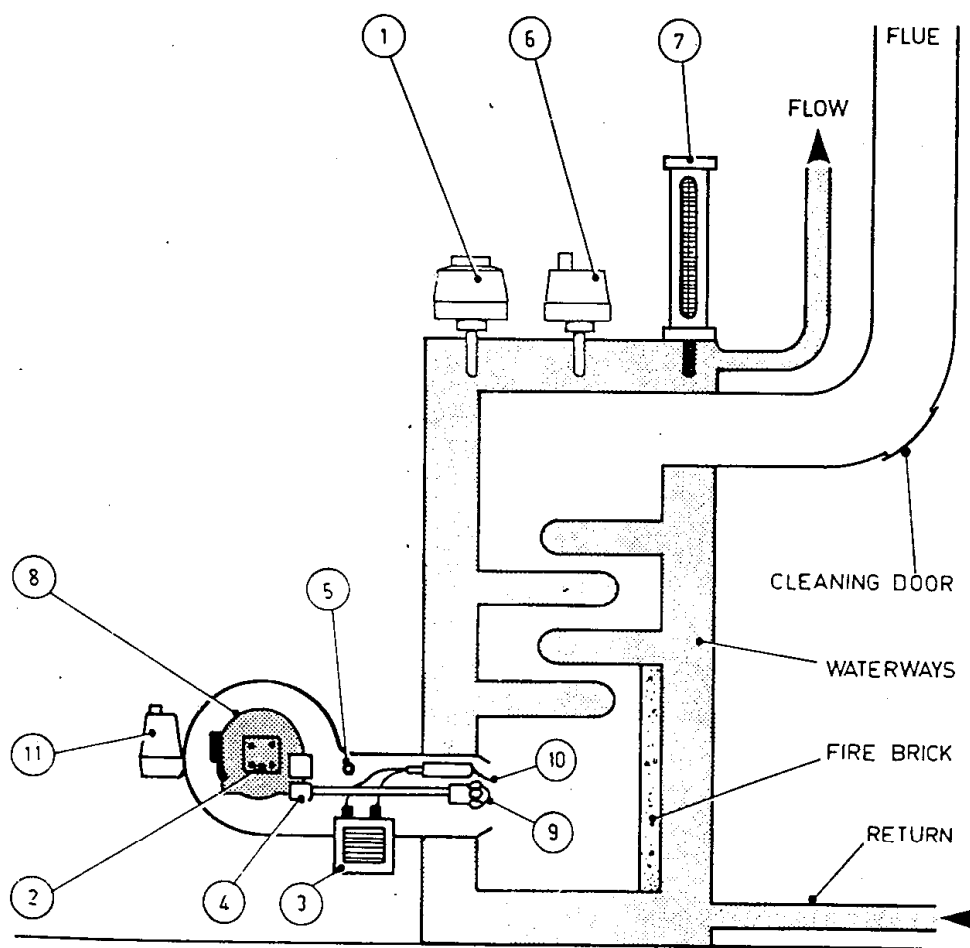
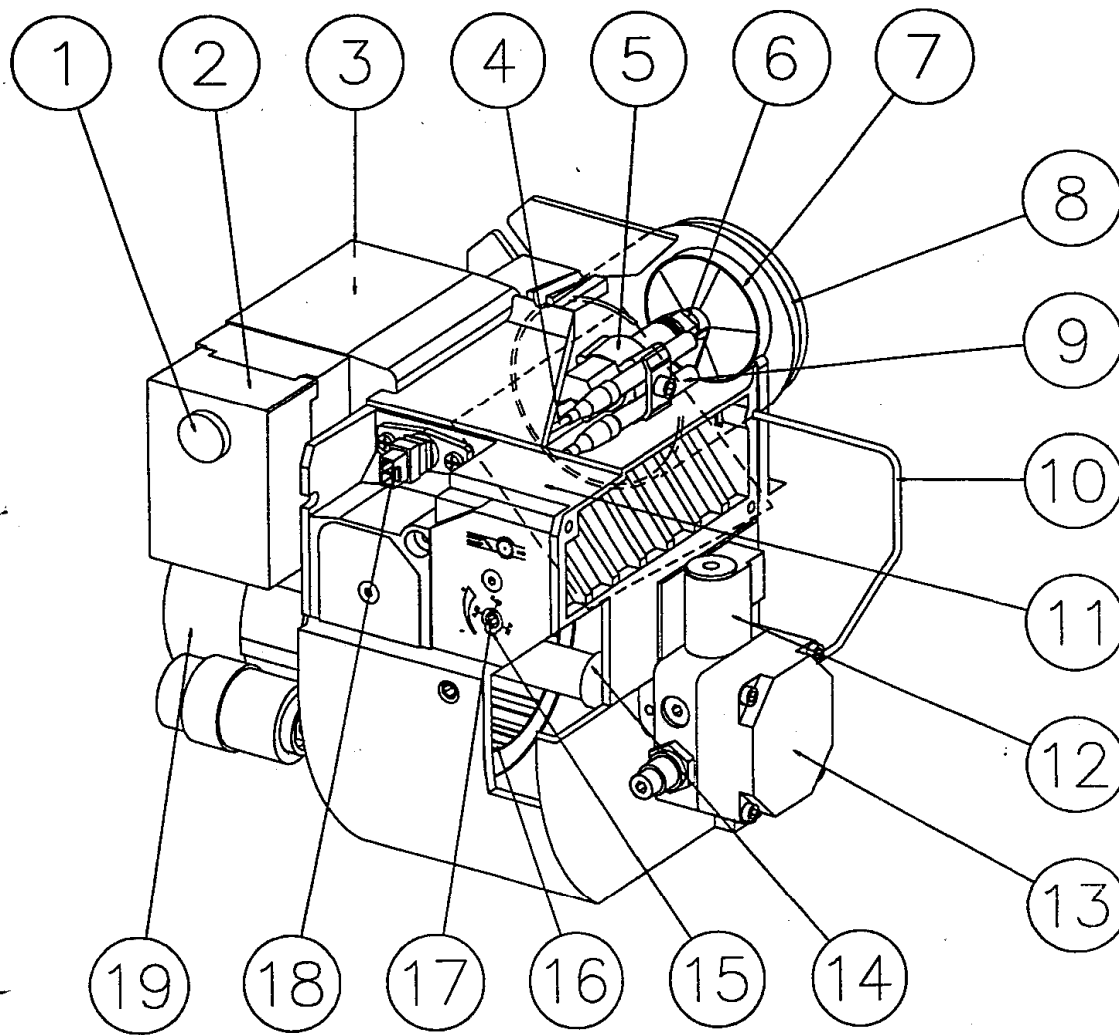


Figure 52. Identification of Circulating Pumps



- | | |
|---------------------------------|-------------------------|
| 1. Adjustable boiler thermostat | 7. Temperature gauge |
| 2. Oil pump | 8. Burner motor and fan |
| 3. Ignition transformer | 9. Nozzle |
| 4. Solenoid valve | 10. Ignition electrodes |
| 5. Photo electric cell | 11. Burner control box |
| 6. Boiler limit thermostat | |

Figure 53. Assembling Oil Fired Boilers

DESCRIPTION**COMPONENTS**

- | | | |
|-------------------------|------------------------|----------------------------|
| 1. Reset button | 8. Blast tube | 14. Drive coupling |
| 2. Control box | 9. Ignition electrodes | 15. Indication, air damper |
| 3. Ignition transformer | 10. Connecting pipe | 16. Fan wheel |
| 4. Ignition cables | 11. Air damper | 17. Adjustment, air damper |
| 5. Nozzle assembly | 12. Solenoid valve | 18. Photoresistor |
| 6. Nozzle | 13. Pump | 19. Motor |
| 7. Brake plate | | |

Figure 54. Assembling Oil Fired Boilers

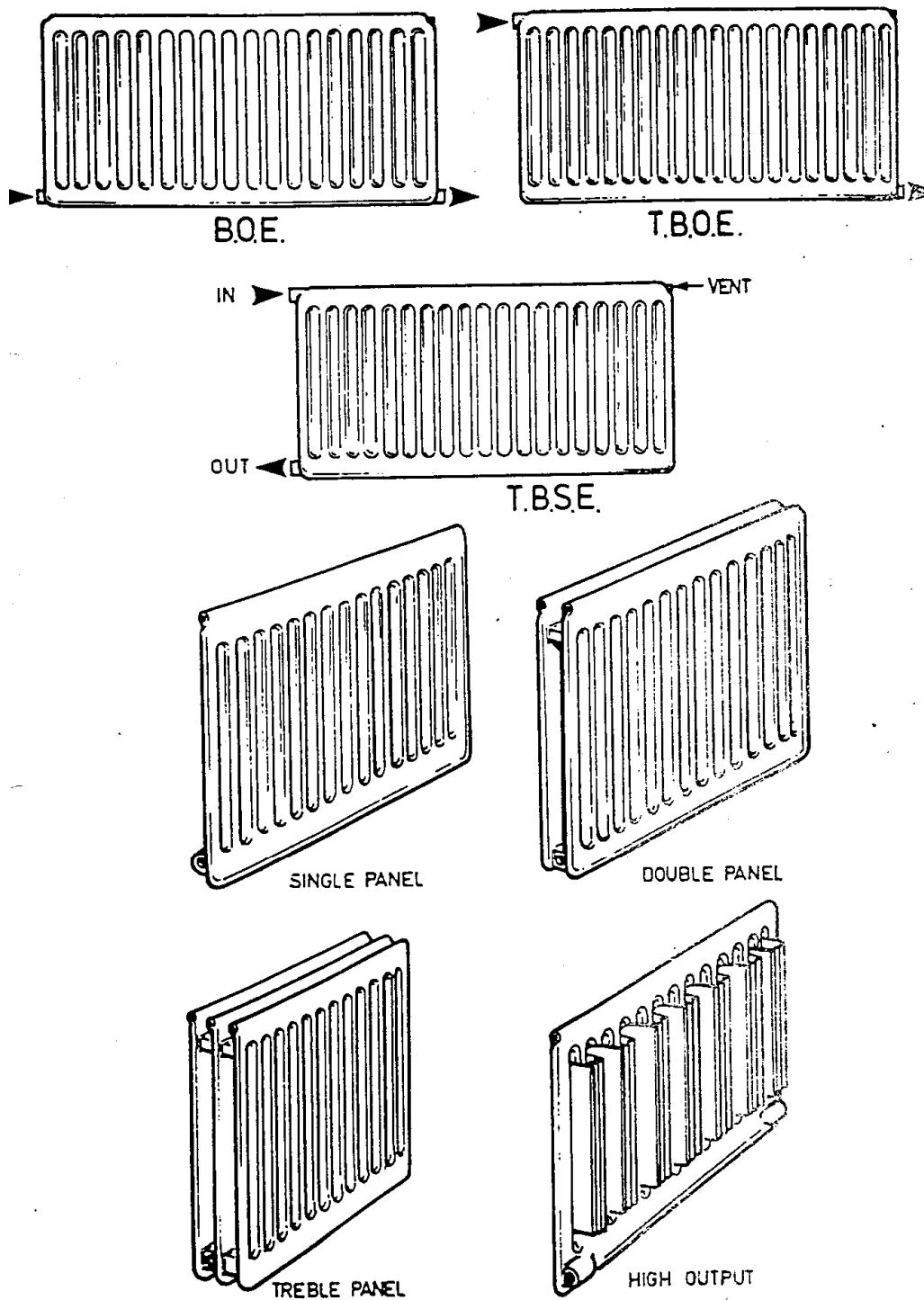


Figure 55. Radiator Identification

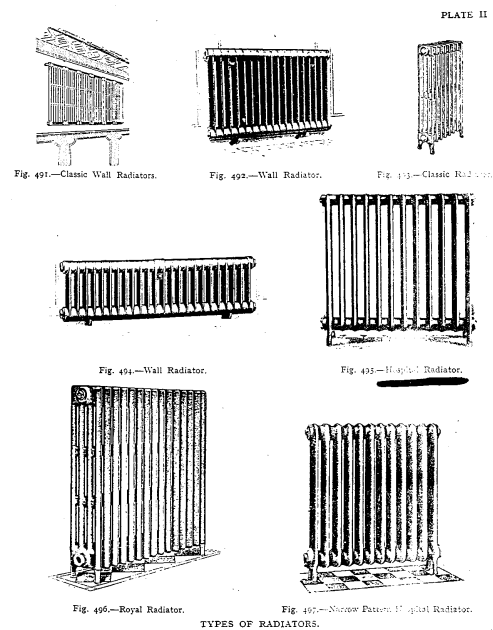
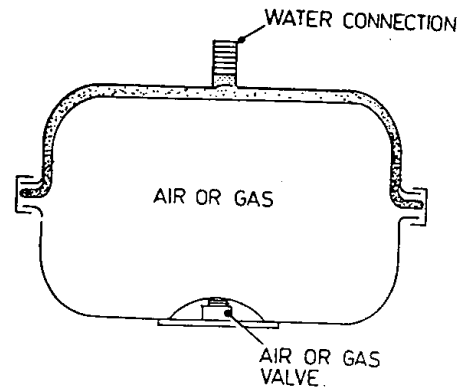
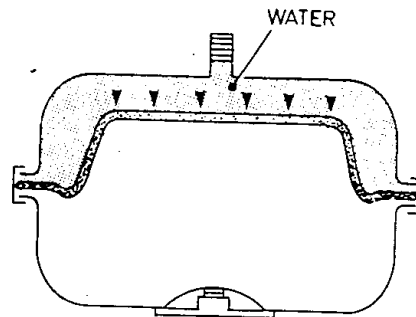


Figure 56. Convector Heater Identification

When the heating system is cold ,
the air or gas charge
completely fills the vessel.



When the system starts to heat
up the expanding water begins to
compress the air or gas
charge.



When the system is at full
temperature the water has
reached its maximum expansion
and the air or gas charge
is fully compressed.

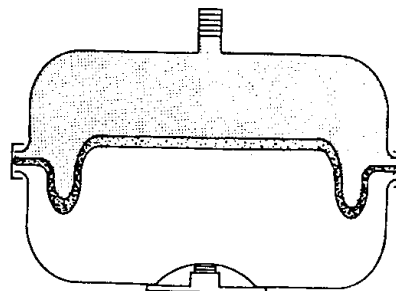


Figure 57. Fitting of Expansion Vessels

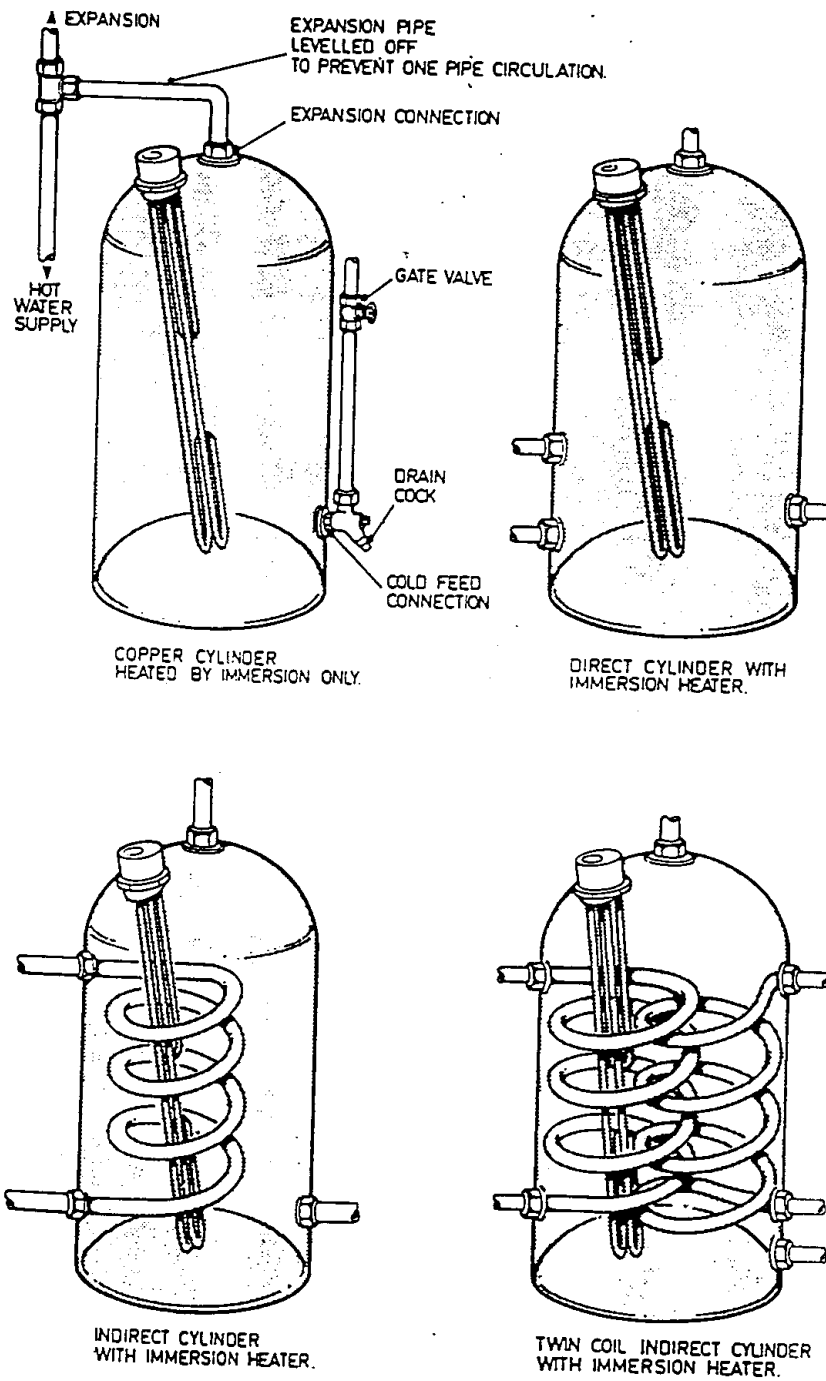


Figure 58. Copper Cylinder Identification

Self Assessment

Exercises

1. Using a sketch describe the open vented system of domestic heating.
2. Name the two pipes that connect the boiler to the cylinder.
3. List three types of radiator.
4. Give two advantages of the two-pipe system over the one pipe.
5. Give examples of where the following types of heat transfer occur in a heating system:
 - a). Convection
 - b). Radiation
6. State the purpose of the following heating components:
 - a). Expansion vessel
 - b). Feed and expansion tank
7. Identify the working parts of a domestic heating pump in drawing No. 2.3.2a in the curriculum document.

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