SYSTEMS MANUAL for CORVEC DOMESTIC BOILERS

Chaffoteaux et Maury

1. INTRODUCTION

Chaffoteaux et Maury is one of the largest producers of gas water heaters and boilers in Europe and one of the oldest established manufacturers of these appliances. Chaffoteaux et Maury have been designing and making water heaters since 1919 and low water content boilers since 1952.

The principle of the well known instantaneous water heater is not so different from that of the central heating boiler — THEY BOTH HEAT WATER — the former for direct use, the latter as the medium for transmitting heat.

Comparing the functions of the two appliances it is apparent that the water heater operates in less favourable conditions than the central heating bc

The boilers made by Chaffoteaux et Maury use a low water content finned copper heat exchanger.

Why copper? — Why low water content?

Copper is universally known and used as the best material for conveying water, in addition it is both easily worked and durable. Most important, it is one of the best conductors of heat.

In the conventional boiler of cast iron or steel, the boiler probably weighs 80 — 100 lbs. with a water content of probably 20 — 40 lbs. and it is evident that there will be a delay whilst all this mass is heated before the system responds. At the end of a cycle the boiler dissipates the heat of this mass some of it to atmosphere, through the flue, before the thermostat responds and starts the cycle once ag

Low water content coupled with light weight means that we have a low mass resulting in a flexible and responsive appliance, having efficiencies of 78% — 80%.

Since a boiler providing central heating is designed to maintain room temperatures at an adequate level when the outside temperature is -1°C — (30°F) it follows that the boiler will only be working under its design conditions for a few days in the year, for the rest of the time it will cycle due to its output being greater than the demand. With a high mass boiler it is necessary on each cycle to heat not only the water content, but the whole surrounding mass of metal. High mass boilers show a marked drop in efficiency when working under part load conditions. Low mass boilers, like the Chaffoteaux boiler, show only a very small drop in efficiency between full load and half load, between 3% and 4%. In a high mass boiler the drop in efficiency is more usually about 20%. It has been suggested that a domestic boiler works 80% of the time at about 30% of load, part load efficiency is therefore vitally important.

Today with the continual raising of fuel prices and the depletion of natural resources, it makes sense to use low water content boilers.

Our boilers are suitable for either open or sealed systems but because of their construction must be used on fully pumped systems. All commonly used external system controls can be used.

This Guide is not a substitute for Installation and Servicing Instructions which accompany each boiler. Before going ahead with your first installations please study that booklet.

This publication is not intended to be a text book on central heating but, it is hoped that the information it contains will help the reader understand our appliances and that the tables and data will be of daily use.

2 PRINCIPLES OF OPERATION OF CHAFFOTEAUX ET MAURY APPLIANCES

2. PRINCIPLES OF OPERATION OF CHAFFOTEAUX ET MAURY APPLIANCES

The operation of all Chaffoteaux domestic range boilers is the same, the units depend on water flow through the appliance for their operation. It is a safety feature of the boiler that it will not fire unless there is a sufficient flow of water.

The minimum flow rates for all models are such that the boilers can only be used on fully pumped systems and not with gravity systems.

Water enters the boiler via the return pipe and flows through the heat exchanger. It then enters the venturi (1), across the thermostat (2) and out of the flow pipe (3). When the boiler is firing the thermostat capsule (2) closes a by pass (5) and the venturi creates a pressure difference in the water section which lifts the diaphragm (6) against the gas valve spring (7) pressure. When the temperature of the water reaches the pre-set value of the thermostat capsule the capsule lifts off its seat (2a) and allows the by pass (5) to open. The pressure difference across the diaphragm is equalised and the gas valve spring closes the gas valve. The shapes of the gas valve and thermostat capsule ensure a modulation of the burner flame.

The thermostat capsule operates at a pre-set temperature of 82°C and no adjustment is necessary. The range of boilers utilise a non-electric multi-functional control that provides all the necessary interlock features required by current Standards. With the consumer's control in the 'off' position (A) no gas can reach the pilot or main burner irrespective of the operation of the water section. When the consumer's gas control is turned to pilot position (B) gas is allowed to flow to the pilot head and simultaneously a spark is produced to ignite the pilot flame. The pilot flame heats the thermocouple (8) which energises the electromagnet (9) holding open the thermoelectric valve. When the pilot is established the consumer's gas control can be turned from the pilot to the main gas position (C) allowing gas to flow to the underside of the main gas valve (10). The operation of the water section will now determine when gas is allowed to flow to the burner.

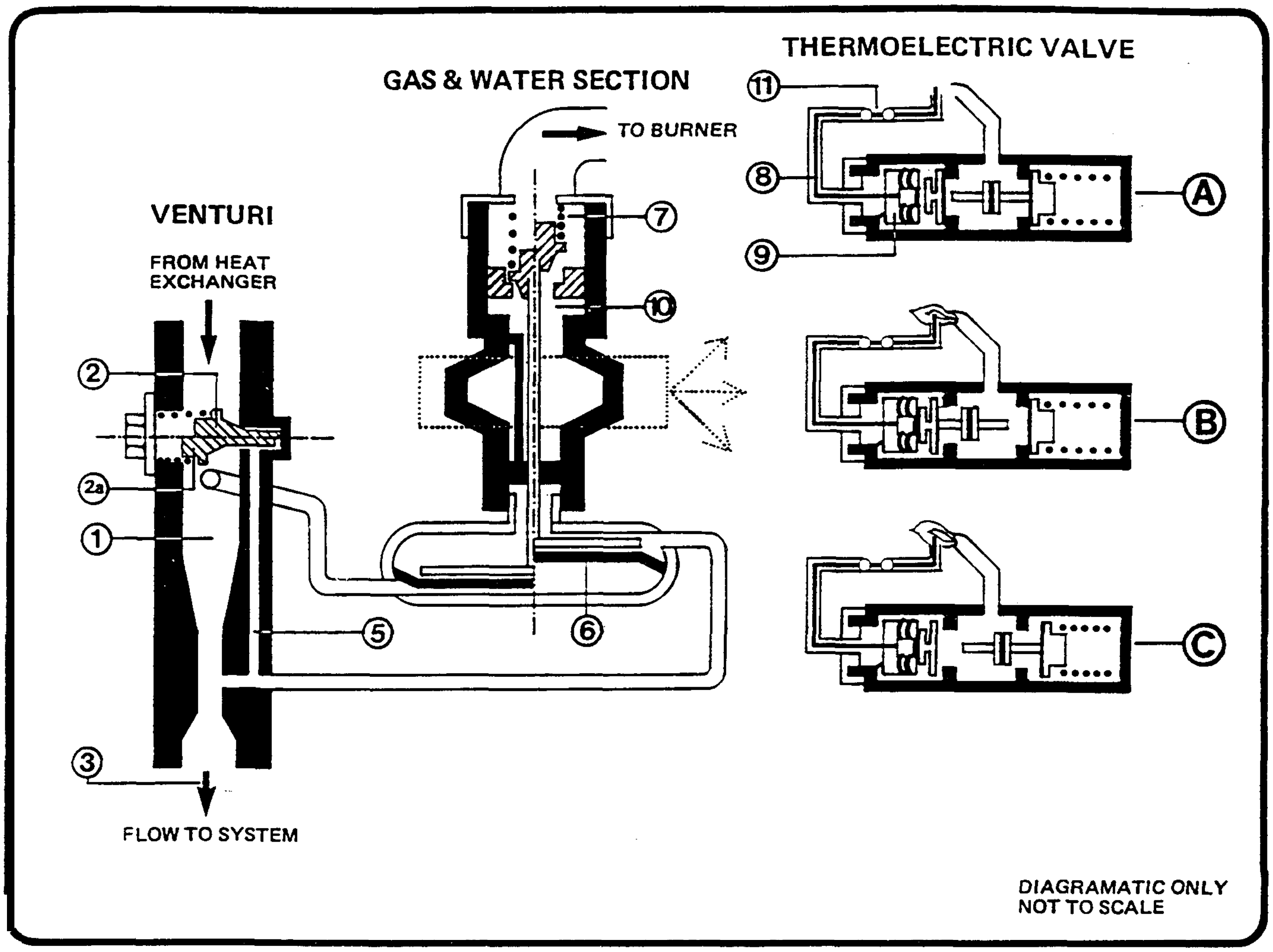
The boilers incorporate standard safety features throughout the range:-

i) The water section only allows the gas valve to operate when the correct flow of water is passing through the appliance.
NO WATER FLOW MEANS NO GAS.

ii) The thermocouple and thermoelectric valve ensure that no gas can pass to either the pilot or main burner in the event of pilot failure.

iii) A high limit temperature overheat is provided in the form of a fusible link (11) which, if ruptured, interrupts the circuit to the thermoelectric valve and isolates gas from the pilot and main burner.

iv) An interlock is provided so that, if the pilot is extinguished for any reason, the boiler can only be refired by repeating the lighting sequence. The relighting sequence can only be attempted after a delay of about one minute.



THERMOELECTRIC VALVE
GAS & WATER SECTION
TO BURNER
VENTURI
FROM HEAT EXCHANGER
FLOW TO SYSTEM
2
2a
1
3
5
6
7
10
11
8
9
A
B
C
DIAGRAMATIC ONLY
NOT TO SCALE

HEAT LOSSES

3. HEAT LOSSES

Before a central heating system can be designed it is necessary to define the parameters on which the design is to be based.

The consumer should be made aware that once installed it will not be possible to increase the internal temperatures without the installation of additional heating media.

Generally, in the UK, domestic heating provides agreed internal temperatures at an external temperature of -1°C (30° F).

It may be necessary to consider a lower design temperature in Northern England and Scotland, or if the property is on the coast or exposed to high v ls.

The current recommended internal temperatures and air change rates are given in Table 2. Where bedrooms are likely to be used as a study or playroom it is as well to provide a higher temperature of, say, 18°C (65°F).

TABLE 1.
(BS 5449 Pt. 1: 1977)
Temperatures and rates of air changes on which heat loss calculations should be based.

Room	Room temp.* °C	°F	Air change/ hour †
Living Room	21	70	1
Dining Room	21	70	2
Bedsitting Room	21	70	1
Bedroom ††	16	60	½
Hall	18	65	1½
Bathroom ∮	22	70	2
Kitchen ∮	18	65	2
Toilet ∮	18	65	1½

* These temperatures will only apply for whole house central heating and for heated rooms with part house central heating.

† Local building regulations may require a specific rate of air change for particular rooms.

†† When used part time as bedsitting rooms or for study purposes additional means should be provided for maintaining a higher room temperature.

∮ Where continuous mechanical ventilation is provided due allowance for the greater change should be made.

Perhaps at this stage it is as well to remember that many of the mechanical aids available and the 'rule of ib' methods are less than accurate and could result in user dissatisfaction and in the final analysis there is no substitute for proper heat loss calculation. This has the added advantage of highlighting the areas of greatest heat loss and gives the designer the opportunity to consider additional insulation. It also brings to the designer's attention, by highlighting areas of greatest loss, the positions for radiators.

The heat loss of a room is based on three criteria:-

1) Area of components of the structure — walls, windows, floor, ceiling.
2) The conductivity of the component (expressed as a 'U' value).
3) The temperature difference between the two faces of the structure.

Common 'U' values are set out in Table 5. and worked example is shown.

An alternative to using a lower external temperature for properties in exposed positions is to use a percentage addition as set out in Table 2.

TABLE 2.

Orientation	Normal	Exposed
NORTH	10%	20%
EAST	10%	15%
WEST	5%	10%
SOUTH	–	5%

Before commencing the calculation carefully note:-

1) Orientation N. S. E. W. facing.
2) The construction of the building component.
3) The measurements of the component.
4) The temperature of adjacent areas.

In semi-detached and terraced houses the prudent designer cannot assume that the adjoining building will be heated to a certain standard and it is customary, in these circumstances, to assume a temperature in adjoining areas of 4° (40°F).

As well as the losses through the structure, heat is lost through the air changes in the room. Air change rates are given in Table 1.

To obtain the heat loss by ventilalation multiply:-

Volume of room in m^3 or ft^3
by
number of air changes/hour (from Table 1)
by
factor given in Table against the temperature difference Δ T external to internal air.

TABLE 3.

Temp difference Δ t in °C	Factor
12	0.0036
14	0.0042
17	0.0051
19	0.0057
22	0.0066

EXAMPLE
(based on Table 3.)

Room 3 m x 4 m x 2.4 m = 28.8m^3
2 Air changes — 22°C t
28.8 x 2 x 0.0066 = 0.380 kW

TABLE 4.

Temp. difference Δ t in °F	Factor
20	0.386
25	0.460
30	0.552
35	0.644
40	0.736

EXAMPLE
(based on Table 4.)

Room 9.84 ft x 13.12 ft x 7.87 ft = 1016 ft
2 Air changes — 40° F t
1016 x 2 x 0.736 = 1495 btu/h

TABLE 5. **Building Heat Losses**
HVCA/IHVE Guide to Good Practice

Usi = The number of watts that will flow through each square metre for each degree C. difference between the internal and external temperatures in the case of external walls, or in the case of partition walls between the temperatures on either side of the wall.

Uimp = The number of btu/h that will flow through each square foot for each degree F.

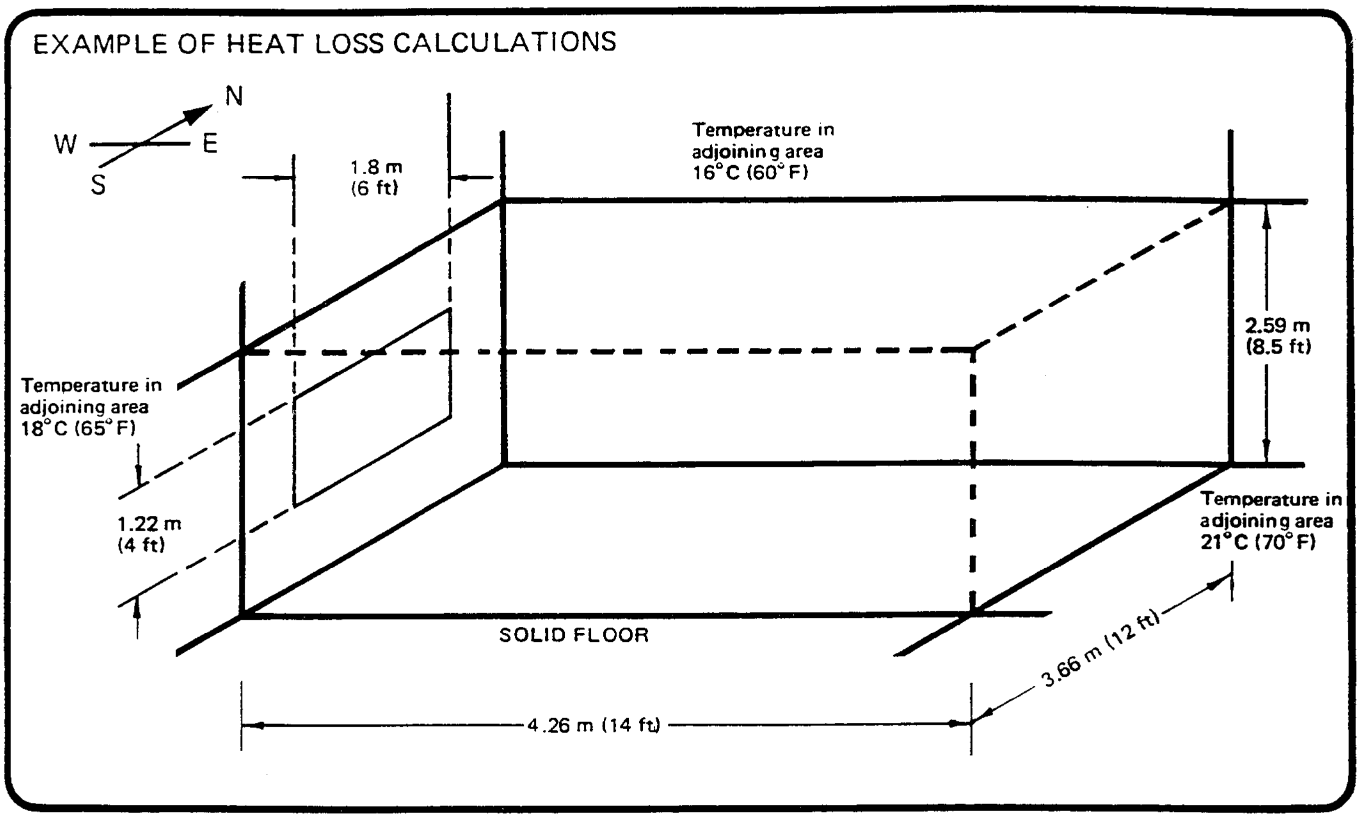
Item	CONSTRUCTION	Usi	Uimp	Remarks
	EXTERNAL WALLS			
	Brick, plastered 16 mm.			
1	Solid 121 mm. (4½" nominal)	3.00	0.53	
2	" 236 " (9" ")	2.10	0.37	
3	" 351 " (13½ ")	1.70	0.30	
	Cavity (two leaves brick, air space and 16 mm. plaster)			These U values are average figures and apply to most suburban and country dwellings. For North and North-East exposures on hill sites, at the coast or at riversides, however, See Table 2.
4	Both leaves brick (11" nominal)	1.50	0.26	
5	As 4, inner leaf 100 mm. (4") cinder aggregate	1.37	0.24	
6	As 5, outer leaf 220 mm. (9" nominal) brick	1.16	0.20	
7	Cavity as 5, inner leaf 100 mm. (4") insulating concrete	0.96	0.17	
8	As 7, outer leaf 220 mm. (9" nominal) brick	0.84	0.15	
	WINDOWS			
9	Single glazed, wood frames	4.30	0.79	
10	" " metal "	5.60	0.99	
11	Double glazed, wood frames	2.50	0.44	
12	" " metal "	3.20	0.56	
	PARTITION WALLS			
13	105 mm. brick, plastered 16 + 16 mm. (4½" nominal)	2.30	0.40	
14	220 mm. brick (9" nominal)	1.75	0.31	
15	75 mm. (3") breeze	2.25	0.40	
16	25 mm. (1") softwood	2.24	0.39	
	ROOFS (flat)			
17	Plasterboard ceiling, 3 layers of felt on boards on joists	1.59	0.28	
18	On 50 mm. (2") strawboard or chipboard on joists	1.05	0.18	

Item	CONSTRUCTION	Usi	Uimp	Remarks
19	Plaster ceiling, asphalte on 100 mm. (4") concrete	3.41	0.60	
	ROOFS (pitched)			
20	Tiles on boards and felt	2.75	0.48	
	Plaster ceiling, roof space above,			
21	tiles on battens	2.98	0.52	The full difference between internal and external temperature should be taken. Allowance has been made for the fact that the underside temperature will be higher than the external temperature.
22	tiles on boards and felt	1.92	0.34	
	Plasterboard ceiling, roof space above tiles on battens and felt			
23	No insulation between joists	2.50	0.44	
24	25 mm. (1") glass fibre between joists	0.90	0.16	
25	50 mm. (2") glass fibre between joists	0.55	0.10	
26	75 mm. (3") glass fibre between joists	0.39	0.07	
27	50 mm. (2") vermiculite between joists	0.88	0.15	
	GROUND FLOORS			These heat losses are for a medium 15 x 7.5 metre (1000 ft.^{2}) plan detached house. Decrease by 50% for a terraced house. Increase by up to 25% for a small house of 5 x 10 m. (500 ft.^{2}) plan.
	Ventilated wood floor on joists, air brick on one side			
28	bare boards	0.61	0.11	
29	parquet, lino or rubber	0.59	0.10	
	Air brick on more than one side			
30	bare boards	0.82	0.14	
31	parquet, lino or rubber	0.68	0.12	
32	Solid floors in contact with earth	0.36	0.06	
	INTERMEDIATE FLOORS			
	Wood floor on joists, plaster ceiling			
33	downward transmission	1.50	0.26	
34	upward transmission	1.70	0.30	
	Concrete 150 mm. (6") with 100 mm. (2") screed			
35	downward transmission	2.20	0.39	
36	upward transmission	2.70	0.48	
	Concrete 150 mm. (6") with wood flooring			
37	downward transmission	1.70	0.30	
38	upward transmission	2.00	0.35	

Effect of Fabric Insulation

The following table shows examples of the approximate reduction in heat flow resulting from insulation:-

Fabric	Type of Insulation	Reduction of heat flow
Ceilings	3" glass fibre	80%
Cavity walls	foam insulation	75%
Suspended floor	2" polystyrene	80%
Solid floor	1" solid insulation	50%
Windows	double glasing	40%



SEE TABLE 5	'U' value S.I. w/m²/°C	'U' value Imp. btu/ft²/°F
External walls 11" cavity (un-ventilated)	1.50	0.26
Internal walls 3" breeze plastered both sides	2.25	0.40
Window — single glazed, wood frame	4.30	0.79
Ceiling — wood floor above ceiling, plastered	1.70	0.30
Floor — solid	0.36	0.06

Exposure — Normal. Internal temperatures 21°C (70°F) @ −1°C (30°F) external.

EXAMPLE

Heat loss — SI units

Component	Area		Δ t	Construction from Table	'U'	Loss
Wall N	4.26 m x 2.59 m	11.03m²	22	4	(1.5 + 10%) 1.65	400
Wall W	(3.66 m x 2.59 m) — (window) (2.19 m²)	7.29m²	22	4	(1.5 + 5%) 1.575	252
Wall E	3.66 m x 2.59 m	9.48m²	Nil	—	—	—
Wall S	4.26 m x 2.59 m	11.03m²	3	15	2.25	74
Glass	1.8 m x 1.22m	2.19m²	22	9	4.30	207
Floor	4.26m x 3.66 m	15.59m²	22	32	0.36	123
Ceiling	4.26 m x 3.66 m	15.59m²	5	34	1.70	132
Air change 1 x	4.26 m x 3.66 m x 2.59 m	40.38m³	22	—	Factor from Table 3 .0066	266
						1454 watts/h

Heat Loss — IMP. units

Component	Area		Δ t	Construction from Table	'U'	Loss
Wall N	14' x 8.5'	119 ft^2	40	4	(0.26 + 10%) 0.28	1333
Wall W	(12' x 8.5') — (window) (6' x 4')	78 ft^2	40	4	(0.26 + 5%) 0.27	842
Wall E	12' x 8.5'	102 ft^2	Nil	—	—	—
Wall S	14' x 8.5'	119 ft^2	5	15	0.40	238
Glass	6' x 4'	24 ft^2	40	9	0.79	758
Floor	14' x 12'	168 ft^2	40	32	0.06	403
Ceiling	14' x 12'	168 ft^2	10	34	0.30	504
Air change 1x	14' x 12' x 8.5'	1428 ft^3	40	—	Factor from Table 4 0.736	1052
						5129 btu/h

NB The very small discrepancy is due to 'U' values & dimensions being worked to 2 places only.

4. 1 RADIATOR SELECTION

Having determined, by calculation, the heat losses it is the time to select a radiator/heat emitter to satisfy the heat loss.
Radiator manufacturers, in their catalogues, generally show an emission based on mean water temperature 170°F.
On full load the temperature difference across a Chaffoteaux boiler is 20°C (36°F) i.e. a flow temperature of 82°C (180°F) and a return temperature of 62°C (144°F). The mean water temperature is therefore

$$\frac{82 + 62}{2} = 72°C\ (162°F)$$

It is, therefore, necessary to adjust the radiator size in order to achieve the required output and the multiplying factors are shown in Table 6 and a worked example is also given.

TABLE 6.

Design Room temp.	Correction Factor
16°C	1.04
18°C	1.06
21°C	1.08

EXAMPLE

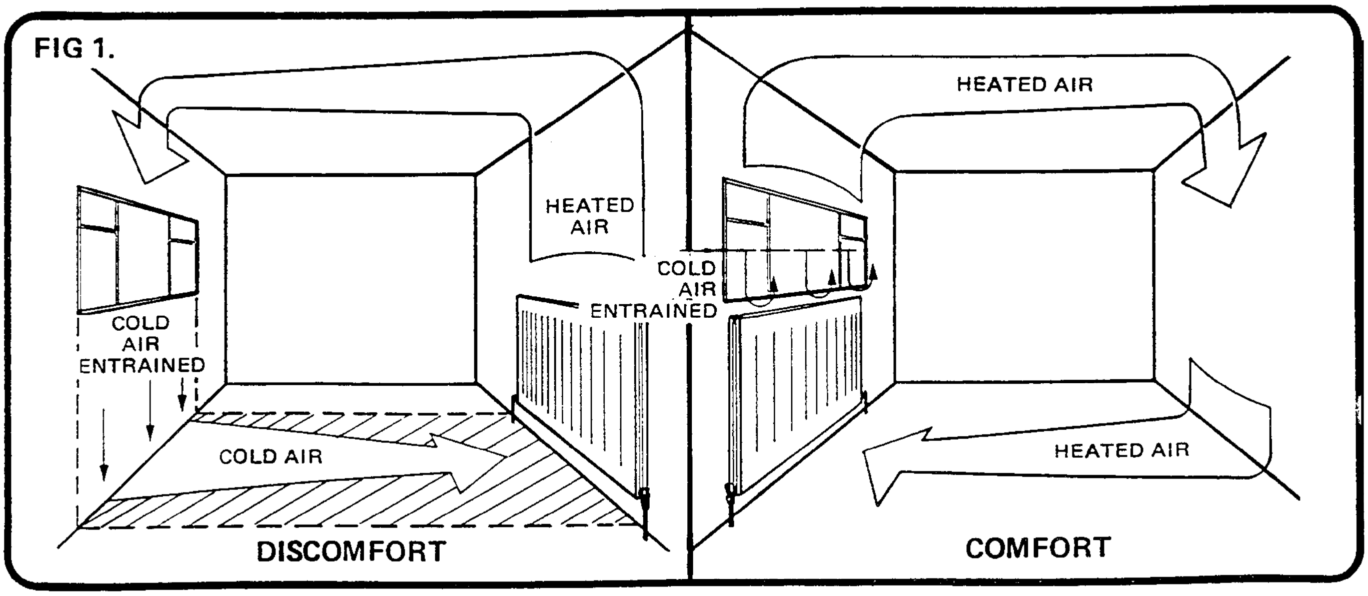
Room Heat loss for 21°C/70°F		7018 btu/h
7018 x 1.08	=	7579

Select radiator with output of 7579 btu/h. @ 55°C (100°F) ΔT.

Radiator Positioning

The best air 'entrainment' is achieved if the radiators are taken to the source of the greatest heat loss. See Fig. 1. By so doing one can avoid cold draughts at low level. The word 'radiator' is a misnomer, for a radiator is, in the main, a convector, approximately 70% of the output is in convected heat and only 30% in radiant heat.
Radiators should be placed on walls with a minimum distance beneath them of 4 in. No shelf, sill or other obstruction should be closer than 2 in. above and should not protrude more than half the width of the radiator. If it does an additional 10% should be added to the output to allow for this. Ensure there is no obstruction to the passage of air over the rear surface of the radiator, i.e. protruding skirting board, mouldings etc.
Where full length curtains are likely to be closed in front of a radiator it must be remembered that a space of 4 in. should be left in front of the radiator to allow passage of air across the front surface. Likewise there should be a 4 in. space between the bottom of the curtain and the floor and a similar space at the top. See Fig. 2.
To obtain the best entrainment it usually, but not invariably, means that radiators are placed under, or adjacent to, windows.
When a shelf is used because a radiator is on an inside wall and it is necessary to make a provision to prevent 'pattern staining' (dust entrained in the rising air stream which is deposited on and discolours walls above radiators) recommendations are shown in Fig. 3.
We have also shown various types of radiator enclosure and the suggested additional output for which allowance should be made. See Fig. 4.
In large or irregular shaped rooms two or more radiators should be considered to provide the best comfort conditions.

FIG 1.



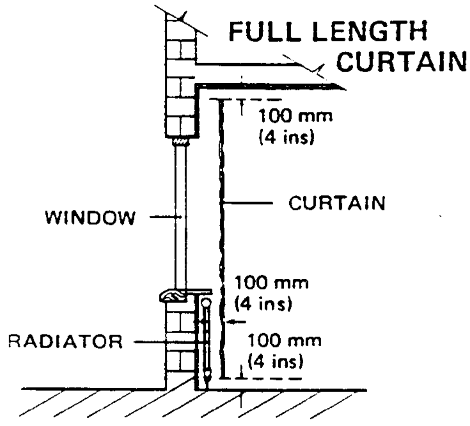


FIG. 2.

RADIATOR SHELF + 5% to 10%

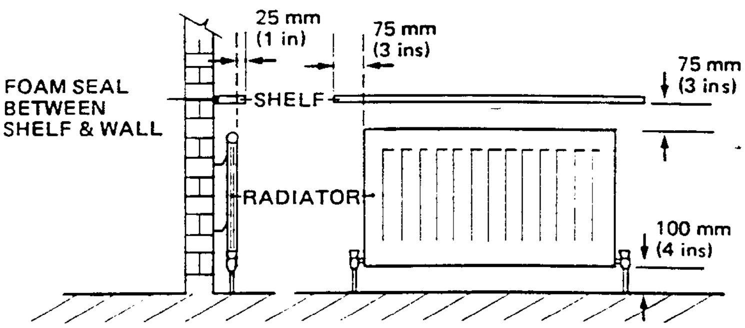


FIG. 3.

ENCLOSED RADIATOR + 20% to 30%

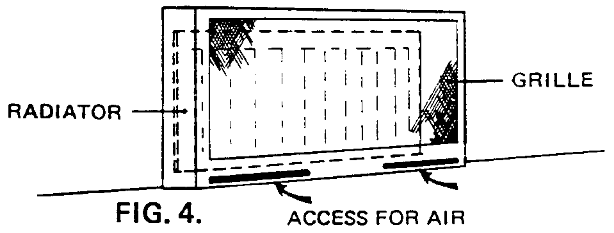


FIG. 4.

NB. Make provision for access to valves. Provide access for venting radiator.

4. 2 PIPE SIZING

Chaffoteaux boilers are suitable for either one pipe or two pipe systems but, in each case, the pipework must be correctly sized.

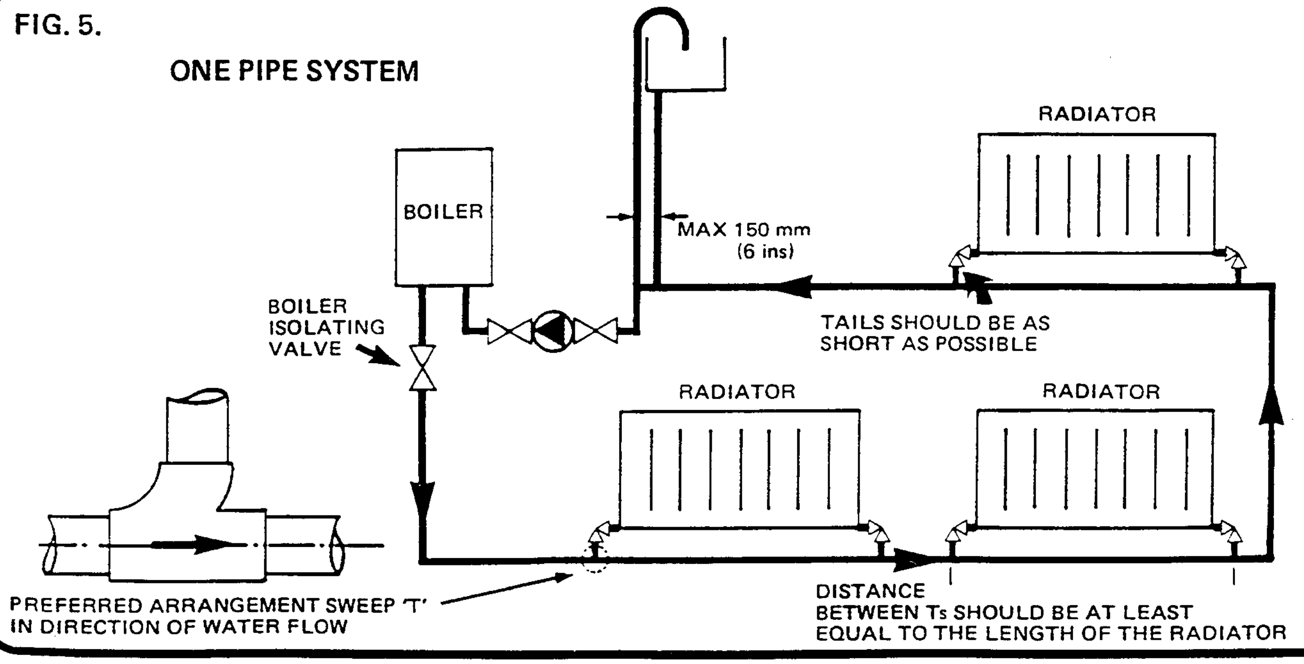
1) So that there is sufficient volume of water passing through the radiators compatible with their output.
2) So that there is a sufficient flow of water through the boiler so that the boiler achieves full flame.
3) So that the total system resistance falls within the range of the domestic circulators (pumps) available.
4) So that the water velocity in any part of the system does not exceed 1m/sec, (3ft/sec) for small bore and 1.2m/sec, (4ft/sec), for micro-bore.

The deficiency with a one pipe system is that there is a temperature drop as the circuit progresses. The last radiators on the loop will receive cooler water than the first and, therefore, the mean water temperature will be lower so it will be necessary to increase the radiator size to achieve output. Generally a one pipe loop in 15 mm should not be designed to carry more than approximately 20,000 btu/h. A one pipe circuit is illustrated in Fig. 5.

There are available single entry radiators which are suitable for one pipe systems when used in conjunction with a special radiator valve which incorporates a by-pass.

FIG. 5.

ONE PIPE SYSTEM



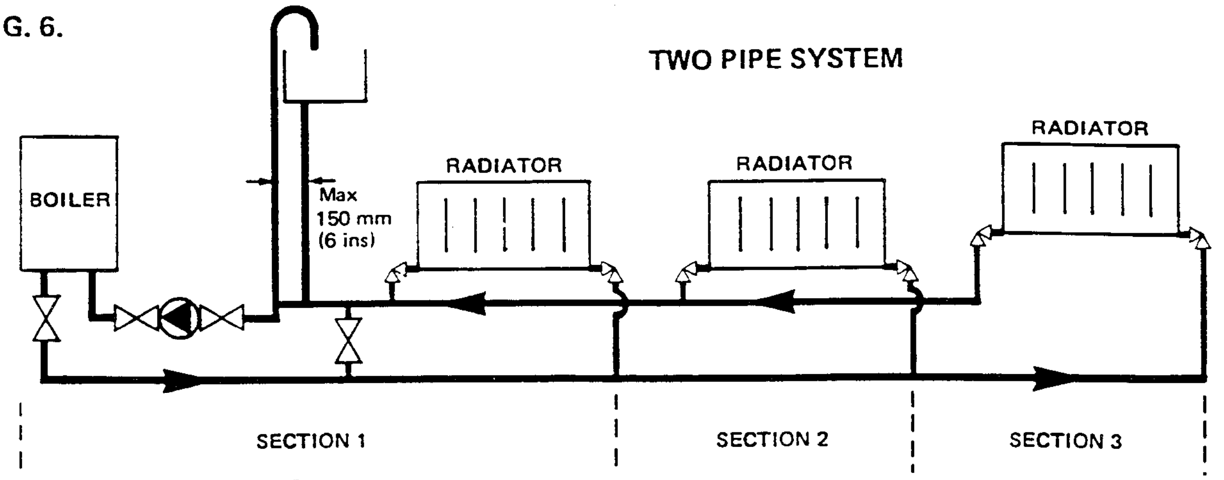


FIG. 6.

TWO PIPE SYSTEM

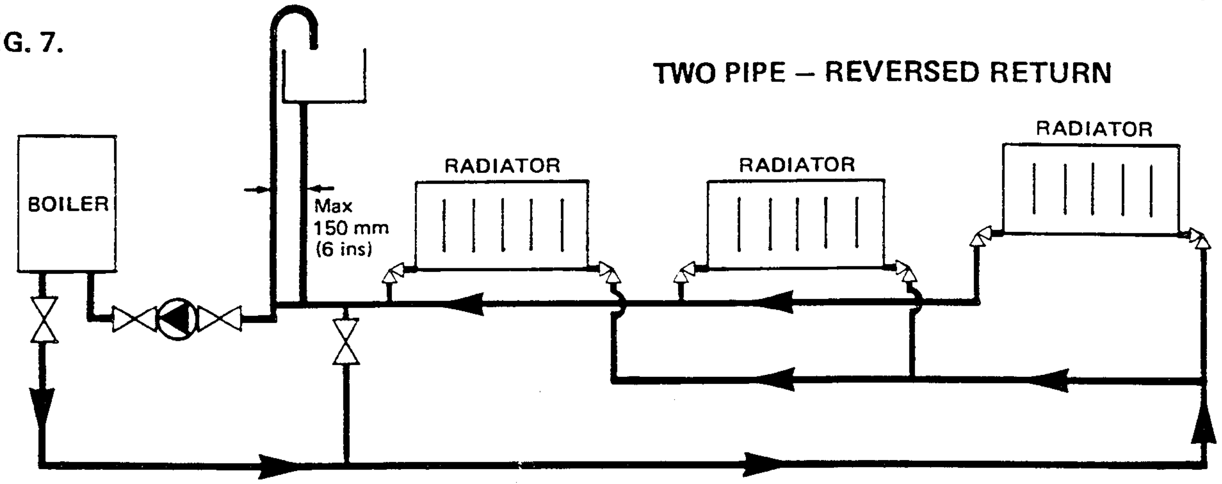


FIG. 7.

TWO PIPE – REVERSED RETURN

NB. In a reversed return system the pipe resistance to each radiator is the same. No balancing is usually required.

The preferred layout is a two pipe system. It will be seen that the volume of water which flows in Section 1 is greater than that in Section 2 which itself is greater than in Section 3. The size of the pipes should take this into account. Two pipe systems are illustrated in Figs. 6 & 7.

This would seem an appropriate time to remind ourselves that pipework should be graded towards the radiators and the open vent. Any inverted loops, which should be avoided are provided with an air vent and provision is made at any low point to drain the system.

Where practicable pipes should be fitted clear of timber joists. If a joist is notched it should not exceed 15% of the depth of the joist. (10" joist maximum depth of notch 1½").

Notches in the same joist shall be at least 4" apart horizontally. Notches should be lined with pads of felt to minimise noise. Consideration should be given to the inclusion of protective saddles to prevent damage by nails.

Pipe fixings and supports should be fitted at intervals not exceeding 1.8 m (6 ft.), in exposed or vulnerable positions the interval between pipe fixings should not exceed 1.2 m. (4 ft.).

Pipework passing through structure should not be built in but should be provided with a sleeve.

All pipes not emitting useful heat should be insulated.

Before the pressure drop (resistance) of the system can be calculated it is necessary to establish the volume of water required in the various circuits.

The flow in lbs/h is derived from the following formula:-

$$\frac{\text{Circuit heat output (btu/h)}}{\text{Temperature difference (36°F)}} = \text{Water flow in lbs/h.}$$

When working in S.I. units the flow rate is expressed in kg/sec and is derived from the following:-

$$\frac{\text{Circuit heat output in kW} \times 0.238}{\text{Temperature difference (20°C)}} = \text{kg/sec.}$$

The velocity in small bore copper pipes should not exceed 1 m. sec (3 ft. sec).

The resistances for straight pipes are given in Tables 9 & 10. It is also necessary to know the resistance for fittings. The best way of calculating this is in terms of equivalent length of straight pipe.

Some of the more usual fittings are shown in Tables 11 & 12.

The equivalent length for reduced 'T's motorised valves, radiators etc. can be obtained from the manufacturer's literature.

There are two worked examples, one for a one pipe system and one for a two pipe system.

HEAT EMISSION FROM COPPER PIPES

BLE 7.

Heat emission in btu/h/ft for uncovered copper pipes.

Nominal pipe Size	Temperature difference deg. F. (water to air)								
	72	81	90	99	108	117	126	144	162
15	29	32	36	41	46	53	60	79	101
22	40	41	45	58	65	73	83	114	135
28	50	58	66	75	84	94	114	135	176

TABLE 8.

Heat emission in W/m (watts per meter) for uncovered copper pipes.

Nominal pipe Size	Temperature difference deg. C. (Water to air)								
	40	45	50	55	60	65	70	80	90
15	28	31	35	40	45	51	58	76	98
22	39	40	44	56	63	71	80	110	130
28	48	56	64	72	81	91	110	130	170

TABLE 9 Small bore pressure loss inches w.g. per ft. run

Flow rate lb/hr	Nominal pipe size		
	15 mm	22 mm	28 mm
100	0.016		
150	0.031	0.0049	
200	0.049	0.0073	
250	0.07	0.011	
300	0.10	0.015	
350	0.13	0.019	0.0058
400	0.16	0.025	0.0073
450	0.20	0.031	0.0092
500	0.24	0.034	0.011
600	0.33	0.051	0.015
700	0.44	0.066	0.019
800	0.55	0.083	0.024
900	0.68	0.10	0.030
1000	0.82	0.12	0.036
1100	0.97	0.15	0.042
1200	Velocity in excess of 3 m secretary	0.17	0.050
1300		0.20	0.057
1400		0.22	0.065
1500		0.25	0.073
1600		0.29	0.082
1800		0.35	0.10
2000		0.42	0.12
2400		0.59	0.17
2800			0.22
3400			0.31

TABLE 10 Small bore pressure loss N/m^2 per metre (Newton metres)

Flow rate kg/s	Nominal pipe size		
	15 mm	22 mm	28 mm
0.0126	13		
0.0189	25	4	
0.0252	40	6	
0.0315	57	9	
0.0378	82	12	
0.0441	106	15	4
0.0504	130	20	6
0.0567	163	25	7
0.063	196	28	9
0.0756	269	41	12
0.0882	359	54	15
0.1008	449	68	19
0.1134	555	81	24
0.126	670	98	29
0.138	792	122	34
0.151	Velocity in excess of 1 m secretary	138	41
0.163		163	46
0.176		179	53
0.189		204	59
0.201		236	67
0.226		285	81
0.252		343	98
0.302		482	138
0.352			179
0.428			253

RESISTANCE OF PIPE FITTINGS

TABLE 11

Expressed in equivalent length of straight pipe in metres

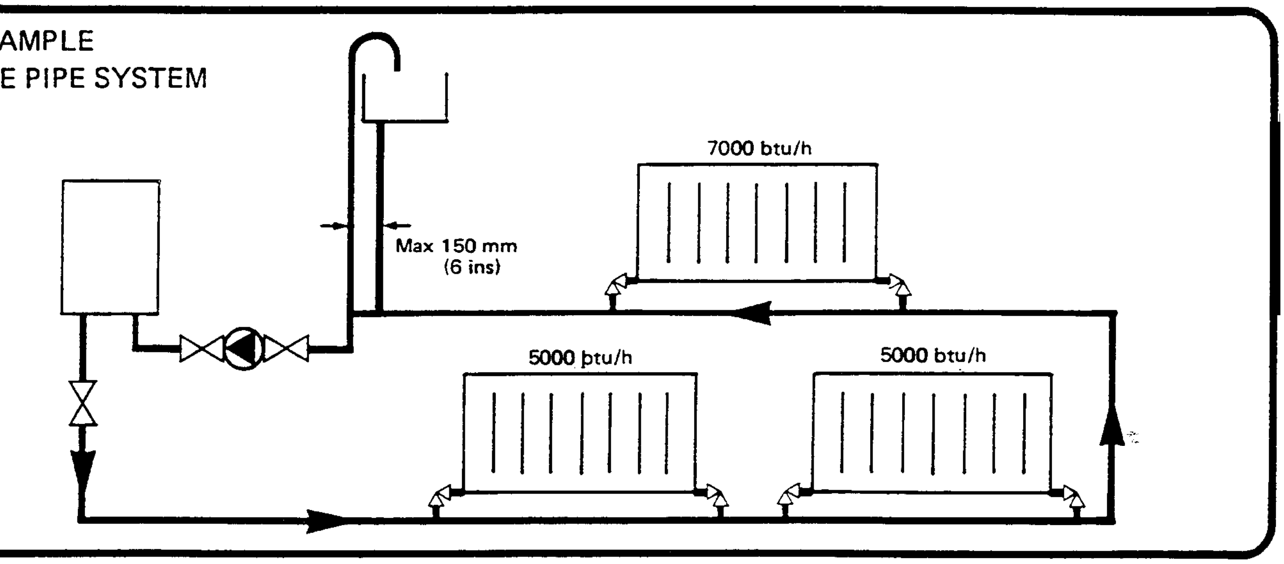
Type of fitting		Equivalent length in feet		
		15	22	28
Valves	Straight	1	1	2
	Angle	5	13	18
Copper elbow	Capillary	2	3	4
	Compression	1	1	2
Tee branch	Square	3	5	6
	Sweep	2	3	3

TABLE 12

Expressed in equivalent length of straight pipe in metres

Type of fitting		Equivalent length in metres		
		15	22	28
Valves	Straight	0.30	0.30	0.60
	Angle	1.6	4.3	6.00
Copper elbow	Capillary	0.60	1.00	1.30
	Compression	0.30	0.30	0.60
Tee branch	Square	1.00	1.60	2.00
	Sweep	0.60	1.00	1.00

EXAMPLE
ONE PIPE SYSTEM



A one pipe system has load of 17,000 btu/h.
Temperature difference is 36°F.
System has 80' of 15 mm pipe.
Heat emission from 15 mm pipe assuming 90°F above room temperature is 36 btu/h per ft. – Table 7.
Therefore heat load = 17,000 btu/h + (80 x 36 (pipes)) = 19,880

Water flow = $\frac{19,880}{36}$ = 552 lbs/h

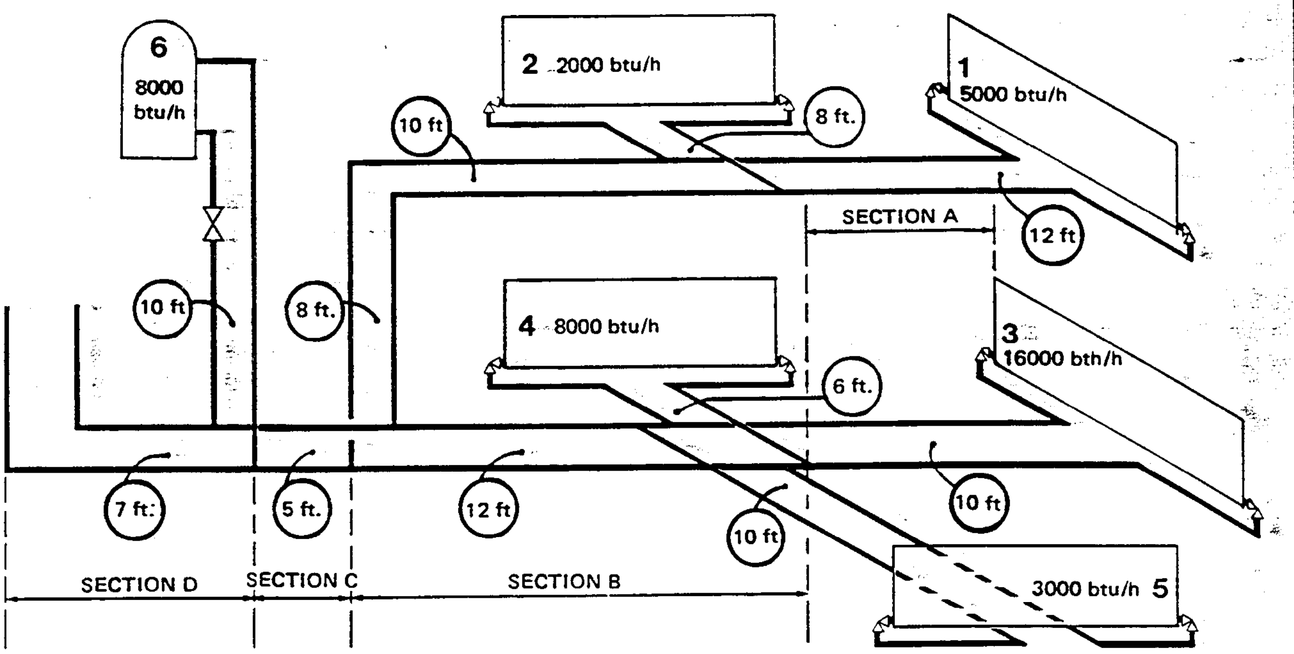
From table by interpolation resistance at 552 lb/h = 0.29 in p.ft.

Fittings	6 sweep Ts	Eq. L	12 ft of pipe
	12 elbows	"	24 ft of pipe
	6 angled valves	"	30 ft of pipe
	3 straight valves	"	3 ft of pipe
Equivalent length of fittings			69 ft of pipe
Actual length of pipe			80 ft.
Total pipe & Fittings			149 ft

Resistance = 149 x 0.29
= 43.5 in or 35 ft 7.5 in head.

EXAMPLE

TWO PIPE SYSTEM



Consider layout and determine the index circuit. The index circuit is the circuit with the highest resistance which often means the circuit with the highest load.

Index circuit is ground floor circuit to rad. 3.

Section A – (Rad. 3 to junction Rads. 4/5)

Load for rad .... 16,000 btu/h

d for pipes 30 ft of unpainted 15 mm pipe
Room 70°F – mean water 162°F
Therefore temp. difference Δ t = 92°F
Emission from pipes from Table 7.
(90°F Δ t = 36 btu/h/ft)
(99°F Δ t = 41 btu/h/ft)
By interpolation
92°F Δ t = 37 btu/h/ft

30 ft x 37 btu/h/ft .... 1,110 btu/h

Total Load for section .... 17,110 btu/h

Convert to lbs/h $\frac{17{,}110 \text{ btu/h}}{36°\text{F } \Delta \text{ t}}$ = 475 lbs/h

From Table 9. resistance of 15 mm pipe=0.22 in.w.g. per ft.

Length of pipe = 30 ft
(Equivalent length of fittings)
4 elbows = 8 ft
2 ∠ valves = 2 ft
valent length of pipe
section = 40 ft

Resistance in section = 40 x 0.22 in = 8.8 in.w.g.

Section B

Load – Previous Section .... 17,110 btu/h
Rads 4 & 5 .... 11,000 btu/h
Pipes 46 ft. x 37 btu/h .... 1,702 btu/h

29,812 btu/h

Convert to lbs:- $\frac{29812 \text{ btu/h}}{36 \Delta \text{ t}}$ = 828 lbs

15 mm pipe resistance 0.58" per ft.
Length of pipe = 24 ft. (No fittings).
Resistance = 24 x 0.58 = 13.92 in.w.g.

Section C

Load – Previous sections .... 29,812 btu/h
Load for 1st floor:-
Rads .... 7,000 btu/h
Pipes – 76 ft. x 43°F per ft. .... 3,268 btu/h

Since room temperature is lower
Δ t is higher.
Therefore pipe emission higher.
Room 60°F – Mean water 162°F
Δ t = 102°F

Load for section .... 40,080 btu/h

Convert to lbs:- $\frac{40080 \text{ btu/h}}{36 \Delta \text{ t}}$ = 1113 lbs

(Max. load in 15 mm 1100 lbs use 22 mm pipe)
22 mm pipe resistance at 1113 lbs/h = 0.17 in.w.g./ft.
Length of pipe 10 ft x 0.17 = 1.7 in.w.g.

Section D

Load – previous sections	40.080 btu/h
Hot Water	8,000 btu/h
Pipes 15 mm 20 ft x 37 btu/ft.	740 btu/h
Pipes 22 mm 14 ft. x 34 btu/h/ft.	630 btu/h
	49,450 btu/h

Convert to lbs $\frac{49{,}450 \text{ btu/h}}{36 \Delta t} = 1{,}373$ lbs

Length of pipe 14 ft. x 0.21 in.w.g./ft. = 2.9 in.

SUMMARY

Total flow 1373 lbs/h.
1 gal. weighs 10 lbs.

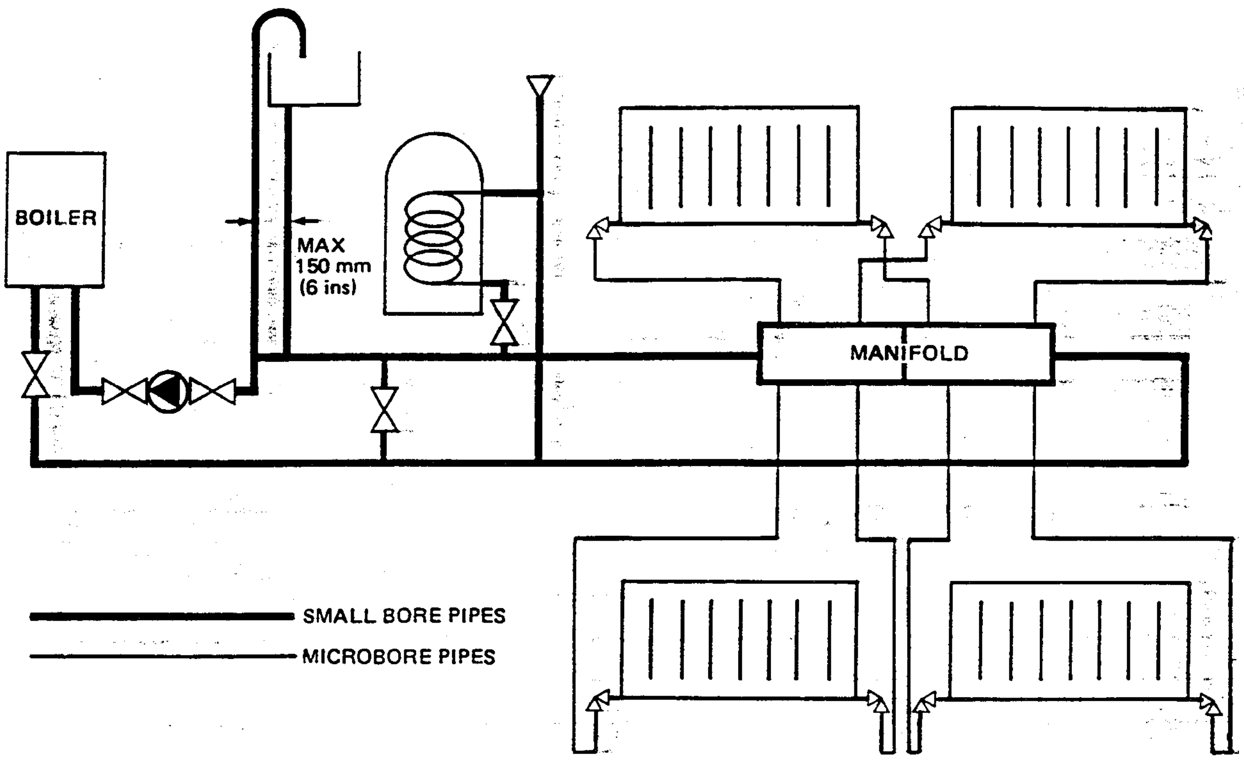
Flow in system	=	137.3 gph
	=	2.28 gpm
Resistance	=	8.8 in.
		13.92 in.
		1.7 in.
		2.9 in.
		17.32 in. = 2.27 ft.

Minimum required flow through Maxiflame boiler is 2.6 gpm at which the head loss = 5.5 ft.

Required pump duty = 2.6 gpm against head loss of 7.77 ft.

FIG. 8.

MICROBORE SYSTEM



Chaffoteaux boilers are suitable for use with microbore systems. The essential feature of a microbore system is that each radiator is connected in parallel back to a central manifold using 6 mm, 8 mm, or 10 mm soft copper pipes.
The velocity in the pipes should not exceed 4 ft/sec. – 1.2 m/sec.
The advantage of microbore systems is more evident in new housing with solid floors than in older type housing. The pipework can be laid in the screed, with proper provision for insulation, lateral and linear expansion and of course draining. The advantages are that lengths can be laid without there being joints in the screed.
A typical system is illustrated in Fig. 8. Pipe losses and resistances are given in tables 13, 14 & 15. A worked example is also provided.

TABLE 13

Microbore

Flow Rate kg/s	Nominal pipe size OD 6 mm	8 mm	10 mm	12 mm
0.007	810	182	46	21
0.008	975	210	55	28
0.009	1165	245	68	34
0.010	1395	285	81	40
0.011	1625	325	94	47
0.012	1885	360	107	53
0.013	2165	405	120	60
0.014	2475	460	133	66
0.015	2800	525	145	73
0.016	3155	595	164	79
0.017	3535	665	180	88
0.018	3930	740	195	97
0.019	4350	815	215	107
0.020	4800	903	234	113
0.021	5330	990	253	120
0.022	5780	1075	273	126
0.023	6210	1165	293	133
0.024		1260	313	139
0.025		1350	338	146
0.031		2010	520	223
0.037		2755	754	313
0.043		3585	1030	413
0.049		4485	1325	536
0.055			1670	665
0.061			2030	795
0.067			2410	925
0.073			2830	1080
0.079			3280	1235
0.085			3780	1408
0.090				1547
0.095				1710
0.100				1860
0.105				2030
0.110				2220
0.115				2365
0.120				2540
0.126				2785
				Velocity 1.5 m/s

TABLE 14

Flow of water at 150°F through copper pipes.
Microbore

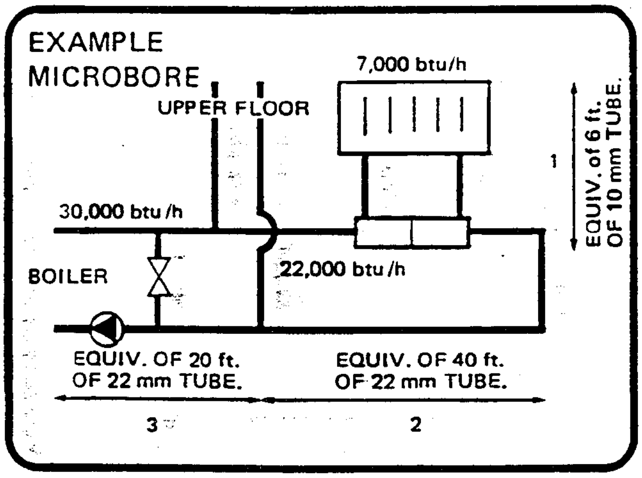
Flow Rate lb/h	Loss of head per 1 foot run in inches WG (62°F) Pipe size 6mm o.d.	8mm o.d.	10mm o.d.
50	0.86	0.20	0.05
60	1.10	0.24	0.06
70	1.38	0.29	0.08
80	1.71	0.35	0.10
90	2.08	0.41	0.12
100	2.51	0.47	0.14
110	2.98	0.55	0.16
120	3.48	0.65	0.18
130	4.02	0.76	0.21
140	4.62	0.87	0.23
150	5.26	0.99	0.26
160	5.96	1.12	0.29
170	6.79	1.25	0.32
180		1.39	0.35
190		1.53	0.38
200		1.67	0.42
250		2.52	0.66
300		3.49	0.96
350		4.57	1.32
400		5.75	1.72
450			2.16
500			2.63
			4'/sec Velocity
550			3.14
600			3.67
650			4.24
700			4.83
750			5.43
800			6.04
850			6.70

In the absence of data this table can be used for light gauge steel pipes
If an approximation, based on velocity, is made for a preliminary assessment of pipe sizes, care should be taken in using the higher velocities otherwise the final calculated pressure drop may be excessive.

TABLE 15

Microbore

Type of fitting	Equivalent length 6 mm	8 mm	10 mm
Two angle valves or one twin angle vaive	5.00	6.00	9.00
Minimum radius smooth bend	0.25	0.25	0.50
Manifold connection	2.00	2.00	3.00



Section 1

Load — Rad & pipe losses 7,000 btu/h

Flow in Section = $\frac{7{,}000}{36°F\ \Delta T}$ = 194 lbs/hr

Resist. 0.4 in.w.g. per ft.

60 x 0.4 = 24 in.

Section 2

Load — Rads & pipework 22,000 btu/h

Flow in section $\frac{22{,}000}{36°F\ \Delta T}$ = 611 lbs/h

Resist. 0.034 in.w.g. per ft.

40 x 0.034 = 1.36 in.

Section 3

Load — Rads & pipework 30,000 btu/h

Flow in section $\frac{30{,}000}{36°F\ \Delta T}$ = 833 lbs/h

Resist. 0.09 in.w.g. per ft.

20 x 0.09 = 1.8 in.

System requirement 1.38 g.p.m. against 27.16 in.

4.3 PUMP SELECTION

Having designed your circuits and selected the pump by reference to the pump manufacturer's graphs, the pump position relative to the cold feed and open vent must be decided.

It is essential that the designer ensures that:-

1) Water is not expelled over the open vent.
2) No part of the system is under sub-atmospheric pressure.

The point at which the cold feed enters is called the neutral point.

At this point the pressure is constant and is not affected by the flow of water round the system. At all other parts of the system the pressure is a combination of the pump head plus the static head. By reference to the pump manufacturer's graph against the flow rate for the system, the available head will be indicated. This is the head available on the outlet to the pump. This head is gradually reduced by the resistance of the system until one arrives at the inlet side of the pump. Most pump manufacturers require a minimum of 6 ft. static head at the pump inlet.

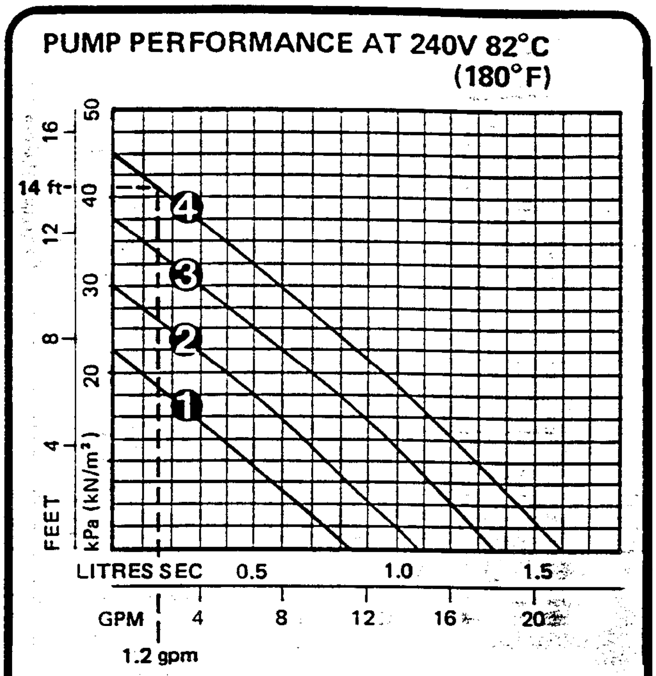


FIG 9.

Fig. 9 shows the graph for a typical domestic pump. Let us assume that the heating load is 26,000 btu/h. The volume of water we will require the pump to pass will be:-

Flow rate: $\frac{26{,}000 \text{ btu/h}}{36°F \text{ temp. diff.}} = 722$ lbs/h

$\frac{72 \text{ lbs/h}}{10 \text{ (lbs in gal) x } 60 \text{ (minutes)}}$ = 1.2 gals per min. (GPM).

At 1.2 GPM available head on setting 4 is approx. 14 ft.

At 1.2 GPM the head loss through the boiler is 4 ft. of head.

Let us also assume that the system resistance is 5 ft. of head.

Figs. 10 to 13 show the pump in various positions relative to the cold feed and open vent.

Since the temperature at which water boils is directly dependent upon pressure — the higher the pressure the higher the boiling point. See Table 16. If the water in the heat exchanger approaches boiling point or actually boils the results are boiler noise (kettling) or possible damage to the heat exchanger. It is, therefore, important to obtain the highest possible pressure in the boiler.

System 1 The pressure at the open vent is always higher than the static head so the system will always pump over.

System 2 Pressure in boiler is always less than the static head. The open vent will suck in air when the static head is 4 ft. or less.

System 3 Open vent pressure is always the same as the static head so no pumping over or air sucked in.

System 4 Preferred position — Highest pressure in boiler. Open vent pressure always the same as the static head — no pumping over or air sucked in.

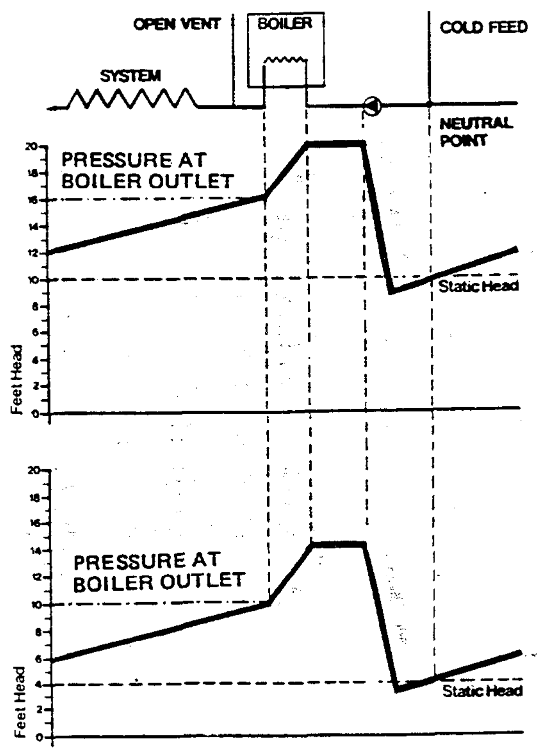


FIG. 10.

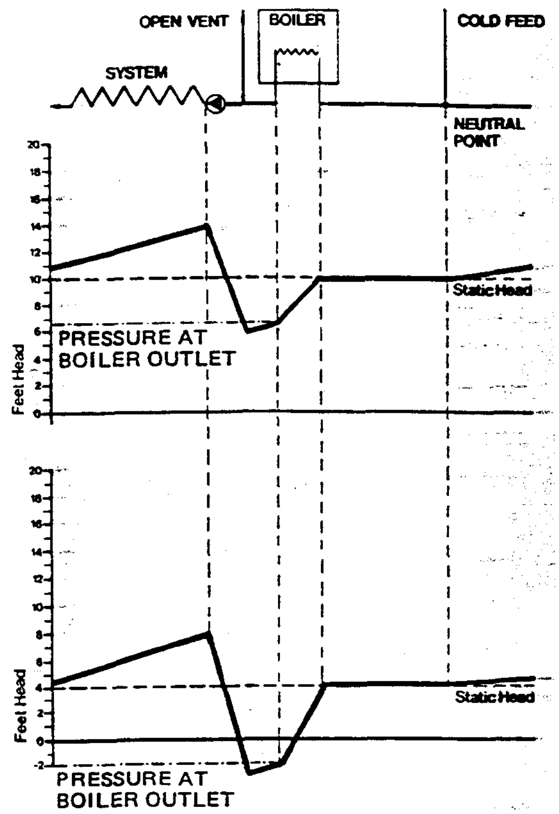


FIG. 11.

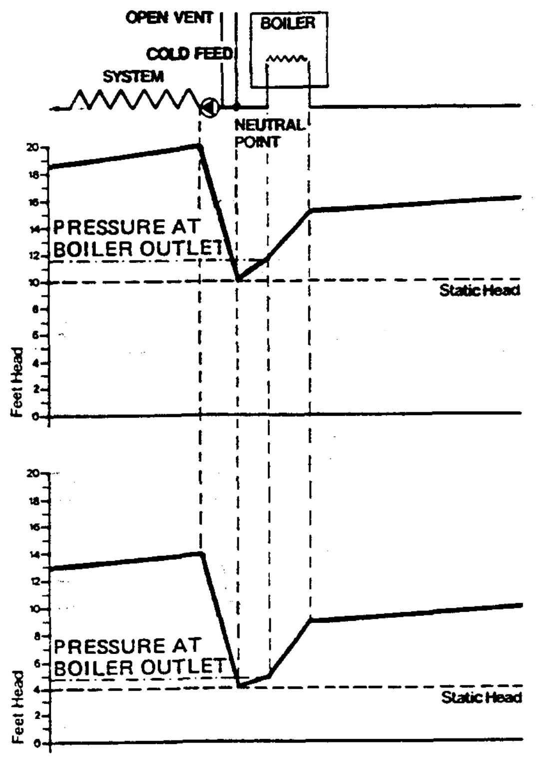


FIG. 12.

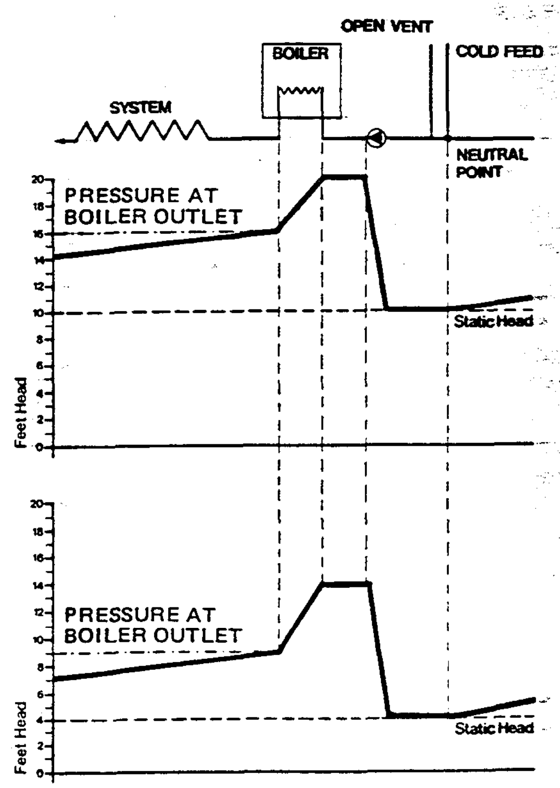


FIG. 13.

TABLE 16

Head in feet	Head in metres	PSI increase over atmosphere	Bar	Boiling °F	Boiling °C
0		atmospheric		212.0	100
1	0.304	0.43	0.029	213.0	100.5
2	0.609	0.86	0.058	214.9	101.6
3	0.914	1.30	0.088	216.3	102.3
4	1.219	1.73	0.117	217.6	103.1
5	1.524	2.16	0.147	219.0	103.8
6	1.829	2.60	0.176	220.3	104.6
7	2.134	3.30	0.205	221.6	105.3
8	2.439	3.46	0.235	222.8	106.0
9	2.743	3.89	0.264	224.1	106.7
10	3.048	4.33	0.294	225.3	107.3
15	4.573	6.50	0.441	231.0	110.5
20	6.097	8.66	0.588	236.2	113.4
25	7.621	10.83	0.735	241.2	116.2
30	9.146	12.99	0.882	245.7	118.7
35	10.670	15.66	1.029	249.9	121.0
40	12.195	17.32	1.176	253.8	123.2
45	13.719	19.49	1.323	257.7	125.3
50	15.243	21.65	1.470	261.3	127.3
60	18.292	25.98	1.764		

Atmospheric pressure 14.7 psi.

4.4 COLD FEEDS AND OPEN VENTS

The movement of water in the open vent is relative to the circuit resistance between the cold feed and open vent — the lower the resistance the lower the risk of introducing aerated water into the system when the pump starts and stops. For this reason Chaffoteaux recommend that the cold feed and open vent are placed within 6 in. of each other on the inlet side of the pump. The order in which connections are made is not critical but the preferred order is cold feed, open vent, pump.

Preferred layouts are shown in Figs. 14 to 16.

Since one of the functions of the open vent pipe is to vent to atmosphere air circulating with the water, it is recommended that a low velocity point is formed. It should be appreciated that, if the open vent connection is made horizontally into the side of a pipe, then it is unlikely that the air will be vented. See Fig 18. The open vent pipe MUST rise throughout its entire length from its junction with the system to atmosphere over the expansion tank.

It is strongly recommended that an air separator is used. Their efficiency is due to the reduction in the water velocity and to the special movement given to the water. They are most efficient in reducing commissioning time and pump failures and adding to the life of the boiler.

As a minimum an expanded 'T' should be used as Fig. 17.

Chaffoteaux recommend that the pump is placed in the return. In this position, with the cold feed and open vent entering on the low pressure side of the pump as illustrated, one achieves the following:-

1) Avoids pumping over and air entrainment.
2) Pump in coolest water—for better performance.
3) All the system will be under positive pressure.
4) Highest pressure in the boiler.

The effect of high pressure in the boiler is to in crease the boiling point of the water and aviod kettling.

COLD FEED AND OPEN VENT CONNECTIONS

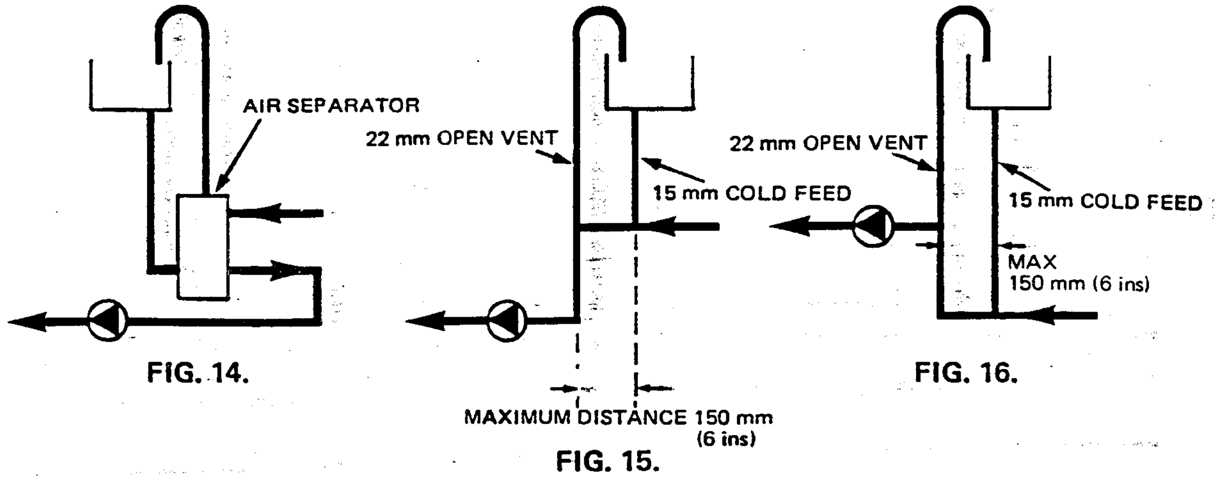


FIG. 14. FIG. 15. FIG. 16.

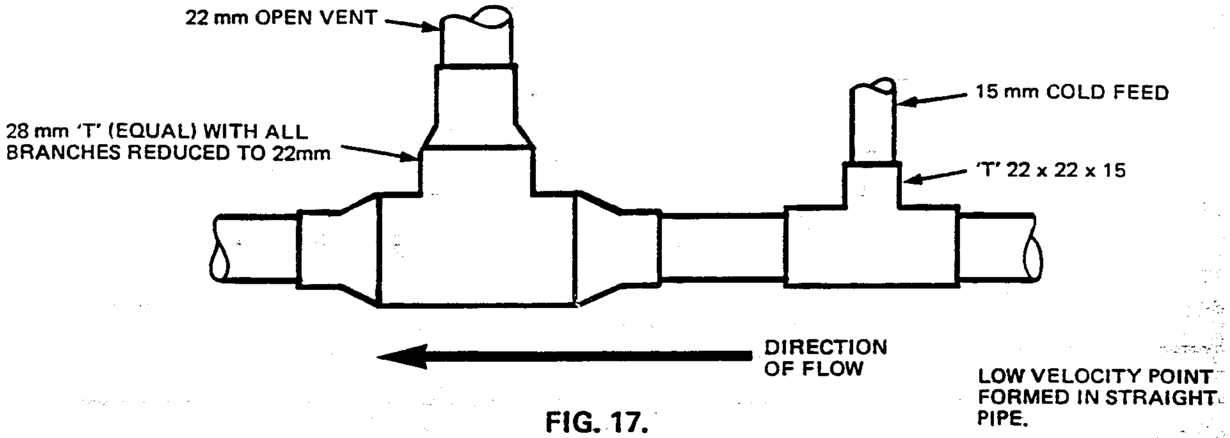


FIG. 17.

COLD FEED AND OPEN VENT CONNECTIONS

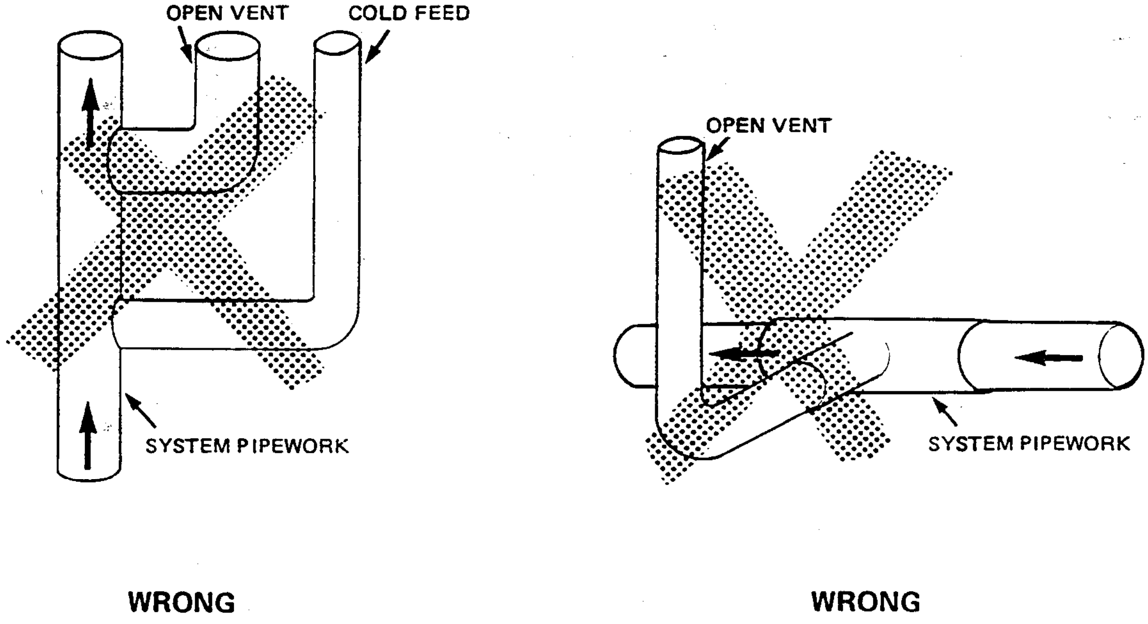
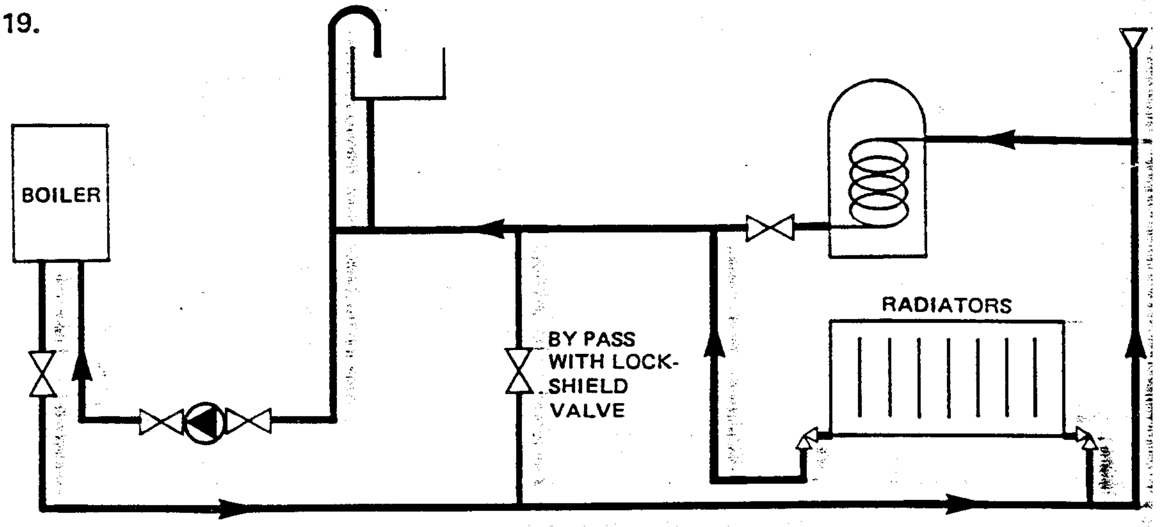


FIG. 18.

FIG. 19.



4. 5 BY PASSES

It is recommended that an adjustable by pass is fitted with Chaffoteaux boilers and this is illustrated in Fig. 19. This is also a British Gas requirement with all low water content boilers.

The purpose of the by pass is to ensure that there is under all conditions a sufficient volume of water circulating through the boiler to enable it to function. This is particularly important in a system utilising thermostatic valves or where hot water control is via a mechanical valve which closes progressively.

The method of adjusting the by pass is set out in the installation instructions for all our appliances and is reproduced below.

"To set the system by-pass, close the by-pass valve and turn off the required number of radiators to suit the customer's minimum needs then open the by-pass until the boiler lights."

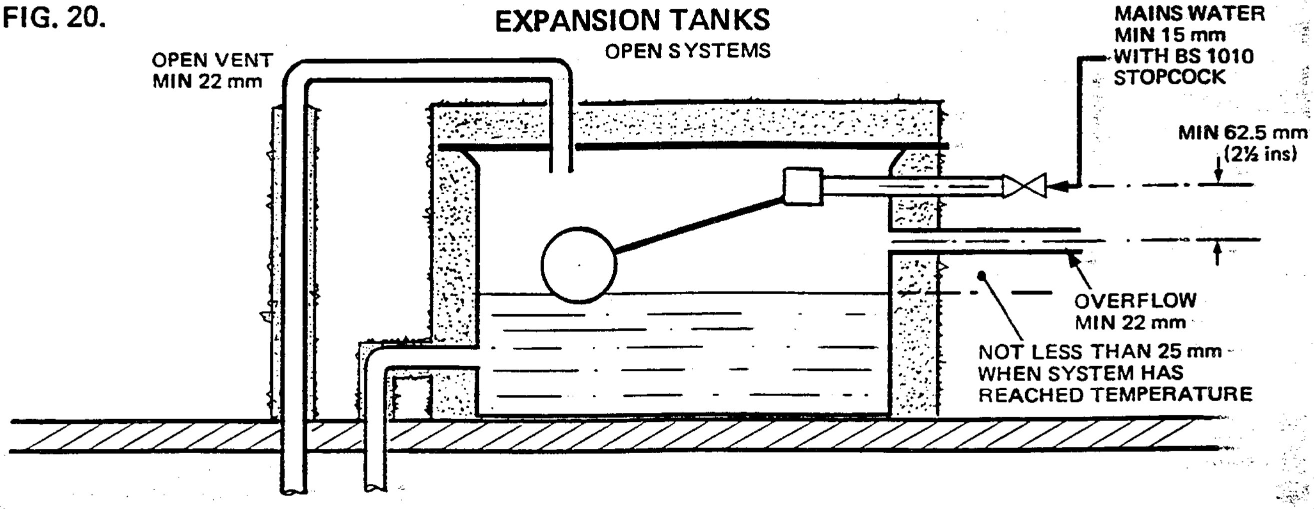
4. 6.1 EXPANSION TANKS

In an open system the feed and expansion tank performs two functions. It allows the system to fill and automatically replenishes water lost through evaporation and minor undetectable leaks. It also accepts the expansion of the system water content. Water, when heated, expands in volume approximately 1/20th of its cold volume.

The following notes are a guide to installation requirements.

1. Cistern water volume should not be less than 4 gallons.
2. Cistern must accept expansion volume of system — (1/20th of water content of system) between the water level cold and a point not closer than 25 mm (1 in) below the overflow connection.
3. Overflow should be 62.5 mm (2½ in) below entry of cold mains.
4. Stop cock should be fitted adjacent to cistern on mains and should be of BS 1010 pattern.
5. The tank should be supported over whole are of base.
6. Tank should be provided with lid.
7. Tank, if in unheated area, should be insulated over sides and top — not bottom.
8. Pipes should be insulated.
9. Ball valve should be 'high temperature'.

FIG. 20.



4. 6. 2 EXPANSION VESSELS SEALED SYSTEMS

On the Continent sealed systems are the accepted method of installation. The restriction in the UK is that it is not possible, at the present time, to make a permanent connection to the Water Authority main for filling and refilling.

The basic concept of a sealed system is that a sealed vessel with a flexible membrane replaces the expansion tank. The vessel must be capable of accepting the expansion volume when the water temperature rises. The vessel is divided into two compartments separated by a membrane. On one side is the system water, the other is charged with either nitrogen or air.

The position for the vessel must be on the low pressure side of the pump.

The advantages of a sealed system are:-

1. Reduction in labour and material costs.
2. The elevation of the boiling point of the water, thereby eliminating boiler noise (kettling).
3. Air does not enter the system, thereby minimising the problems of corrosion.
4. No cold feed, open vent or expansion tank.
5. Where static head is limited, i.e. flats.

Chaffoteaux boilers are designed, and British Gas approved, for sealed systems and are supplied, and fitted with a high temperature safety device as standard.

Before selecting a vessel it is necessary to decide the charge pressure this is usually the pressure to support the static head of the system above the vessel. If the boiler is the highest point on the system the charge pressure should be adequate to support the static head to the top of the boiler plus whatever is the minimum static head required, by the manufacturer, at the boiler. In this connection we recommend that the static head plus 10 ft. is adopted for all our domestic appliances.

Vessels are generally available with charge pressures of 0.5 bar to 1.5 bar.

0.5 bar = 7 psi = 5 metres of head = 17 ft. head
1.0 bar = 15 psi = 10 metres of head = 34 ft. head
1.5 bar = 22 psi = 15 metres of head = 50 ft. head

The correct size of vessel is important, the size is relative to:-

1. System water content.
2. Initial charge pressure. Final operating pressure.
3. The boiler flow temperature.

The system water content can be obtained by reference to Table 17.
Chart for vessel sizing is given in Table 18.

TABLE 17

For the purpose of the calculation, the volume of the system shall be determined as accurately as possible using manufacturers' data as appropriate. Alternatively the volumes given below may be used to give a conservative estimate of the system volume:

Conventional cast iron boiler	10 litres (2.2 gallons)
Low water capacity boiler	3.5 litres (0.8 gallons)
Small bore pipework	0.3 litres (0.07 gallons) per 0.292 kW (1,000 btu/h) of systems output
Microbore pipework	7 litres (1.5 gallons)
Steel panel radiators	2.3 litres (0.5 gallons) per 0.292 kW (1,000 btu/h) of system output
Low water capacity radiators	0.5 litres (0.1 gallons) 0.292 kW (1,000 btu/h) of system output
Hot water cylinder calorifier	2 litres (0.44 gallons)

a system is extended an expansion vessel of increased volume may be required unless previous provision has been made for the extension.
(B.G.C. Materials Installation Spec. 3rd Edit.)

TABLE 18

Sizing procedure for expansion vessels — vessel volume in litres — flow temp. 82°C.

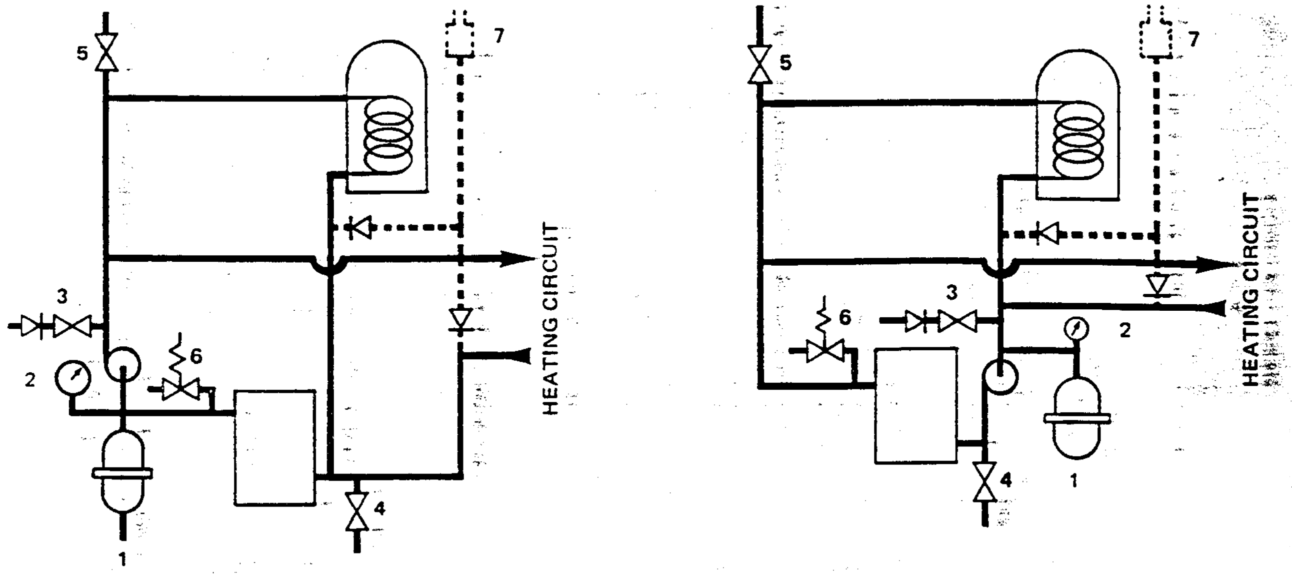
Safety valve (bar)		3.0								
Vessel charge pressure — bar		0.5				1.0			1.5	
Initial system pressure — bar		0.5	1.0	1.5	2.0	1.0	1.5	2.0	1.5	2.0
Total water content of system										
litres	gals.									
25	5.5	1.68	2.80	5.20	10.96	2.16	3.76	8.24	3.12	6.64
50	11.0	3.36	5.60	10.32	22.00	4.32	7.60	16.48	6.24	13.20
75	16.5	5.04	8.40	15.52	33.04	6.56	11.36	24.72	9.36	19.84
100	22.0	6.64	11.20	20.72	44.08	8.72	15.20	32.96	12.48	26.48
125	27.5	8.32	14.00	25.92	55.12	10.88	18.96	41.20	15.60	33.04
150	33.0	10.00	16.80	31.04	66.08	13.04	22.80	49.44	18.72	39.68
175	38.5	11.68	19.60	36.24	77.12	15.28	26.56	57.68	21.84	46.32
200	44.0	13.36	22.40	41.44	88.16	17.44	30.40	65.92	24.96	52.96

Safety valve (bar)		2.5						2.0		
Vessel charge pressure — bar		0.5		1.0			1.5	0.5		1.0
Initial system pressure — bar		0.5	1.0	1.5	1.0	1.5	1.5	0.5	1.0	1.0
Total water content of system										
litres	gals.									
25	5.5	1.84	3.60	7.92	2.64	5.92	4.72	2.24	5.36	4.00
50	11.0	3.76	7.12	15.76	5.36	11.84	9.44	4.48	10.72	8.00
75	16.5	5.60	10.72	23.68	8.00	17.76	14.16	6.72	16.08	12.00
100	22.0	7.52	14.32	31.60	10.72	23.76	18.96	9.04	21.44	16.00
125	27.5	9.36	17.92	39.52	13.36	29.68	23.68	11.28	26.80	20.00
150	33.0	11.28	21.44	47.36	16.08	35.60	28.40	13.52	32.16	24.00
175	38.5	13.12	25.04	55.28	18.72	41.52	33.12	15.76	37.52	28.00
200	44.0	15.04	28.64	63.2	21.44	47.52	37.92	18.08	42.88	32.00

Volume of expansion vessel should not be less than that given above.
Consult manufacturers literature and use next size up.
For flow temperatures over 93°C multiply by 1.25.
over 88°C multiply by 1.1

(Tables based on Table 3. BS 5449: Pt 1: 1977)

DIAGRAMS SHOWING SYSTEM LAYOUT



PUMP ON THE FLOW

PUMP ON THE RETURN

1. EXPANSION VESSEL
2. PRESSURE GAUGE
3. FILLING POINT
4. DRAIN COCK
5. AIR RELEASE POINT
6. SAFETY VALVE
7. TOP-UP BOTTLE

FIG. 21.

(B.G.C. Materials & Installation Spec. 3rd Edit.)

EXAMPLE

System has a connected heating load in panel radiators of 26,000 btu/h.

Radiator Volume from Table 17	$\frac{26,000}{1000} \times 0.5$	= 13.00
Pipework Volume from Table 17	$\frac{26,000}{1000} \times 0.07$	= 1.82
Boiler Volume Chaffoteaux 45 — from data sheet		= 0.58
Cylinder Volume from Table 17		= 0.44
System water content		= 15.84

Charge pressure 1 bar
Safety valve 2.5 bar
Vessel size 3.6 litres

It is necessary to fit a safety valve adjusted to the final system pressure plus 4 psi. The safety valve should discharge outside the building into a drain or safe place.

All high points should be vented, in addition it is recommended that an air purger and automatic air vent are fitted into the flow pipe adjacent to the boiler.

An altitude/temperature gauge should be fitted. Fig. 21 shows system layouts.

SEALED SYSTEMS
ACCEPTED METHODS OF FILLING
HVCA/IHVE GUIDE TO GOOD PRACTICE

1. CONNECTION MADE FROM TAP USED FOR OTHER PURPOSE

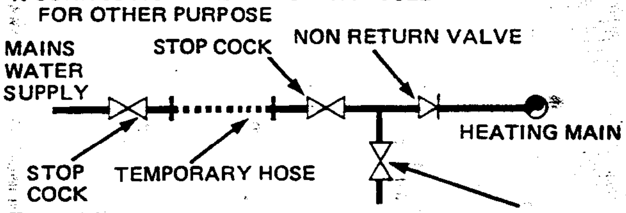


FIG. 22.

2. MAKE UP VESSEL ABOVE HIGHEST POINT OF SYSTEM

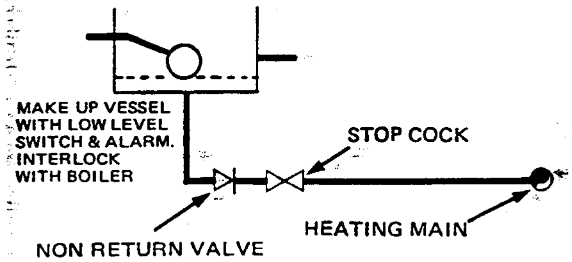


FIG. 23.

3. MAKE UP USING 'BREAK TANK' & PRESSURE PUMP

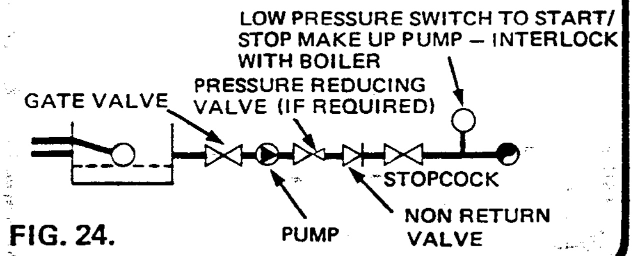


FIG. 24.

4.7 PRODUCTION OF HOT WATER

If the storage solution is chosen the hot water cylinder selected must be an indirect, high recovery, coil type cylinder. The cylinder should be to BS 1566 which ensures a minimum heating surface and should be of a grade suitable for the building static head – generally 30 ft. Grade 3.

Self priming cylinders are not suitable because the higher pump duties necessary for low water content boilers, can break the air seal, this leads to the exchange of water in the system and introduces air and hardness salts. The former can promote boiler noise and the latter lead to the premature scaling of the heat exchanger.

Gravity cylinders with an annular heating surface are not suitable since the higher velocities, with a pumped system, will cause noise which will concern the consumer.

The cylinder should be sized to meet the demands of the household. For instance, a family of four with one bathroom will require a minimum water storage of 25 gallons, the same with two bathrooms 35 gallons.

It is recommended that the cylinder should be capable of recovering in one hour, which, if a 25 gallon cylinder is utilised, means that the cylinder should initially be capable of absorbing 25,000 btu/h.

The high point on the circulating pipework should be vented preferably using an automatic vent of the bottle type.

To obtain the required flow and keep resistance to a minimum 22 mm pipes will normally be requ d for the primary circuit. A lockshield valve should be used in the circuit to balance the flow.

It is becoming increasingly popular to pump cylinders contraflow i.e. with the flow entering the bottom of the cylinder and the return taken from the higher tapping. The rate of heat exchange in the cylinder is relative to the temperature difference between the circulating and the stored water. If the cylinder is pumped contraflow the hottest circulating water is in contact with the coolest stored water and therefore the rate of heat exchange is improved. It also helps the venting of the coil.

The allowance made for water heating in the boiler sizing is a function of the recovery time selected and the method of control, usually 8 – 10,000 btu/h.

There are now available immersion elements which fit a standard 2¼ in. BSP boss to enable a di cylinder to be converted to indirect. As this type of element has a high resistance, a cylinder by pass may be necessary to maintain the flow rate needed to operate the boiler.

The heating of stored water is perhaps the most wasteful use to which a gas fired boiler is utilised. We not only heat up and continually maintain at temperature 30 gallons of water in case we might need it, we also lose heat from both the primary and secondary pipework and from the surface of even an insulated cylinder.

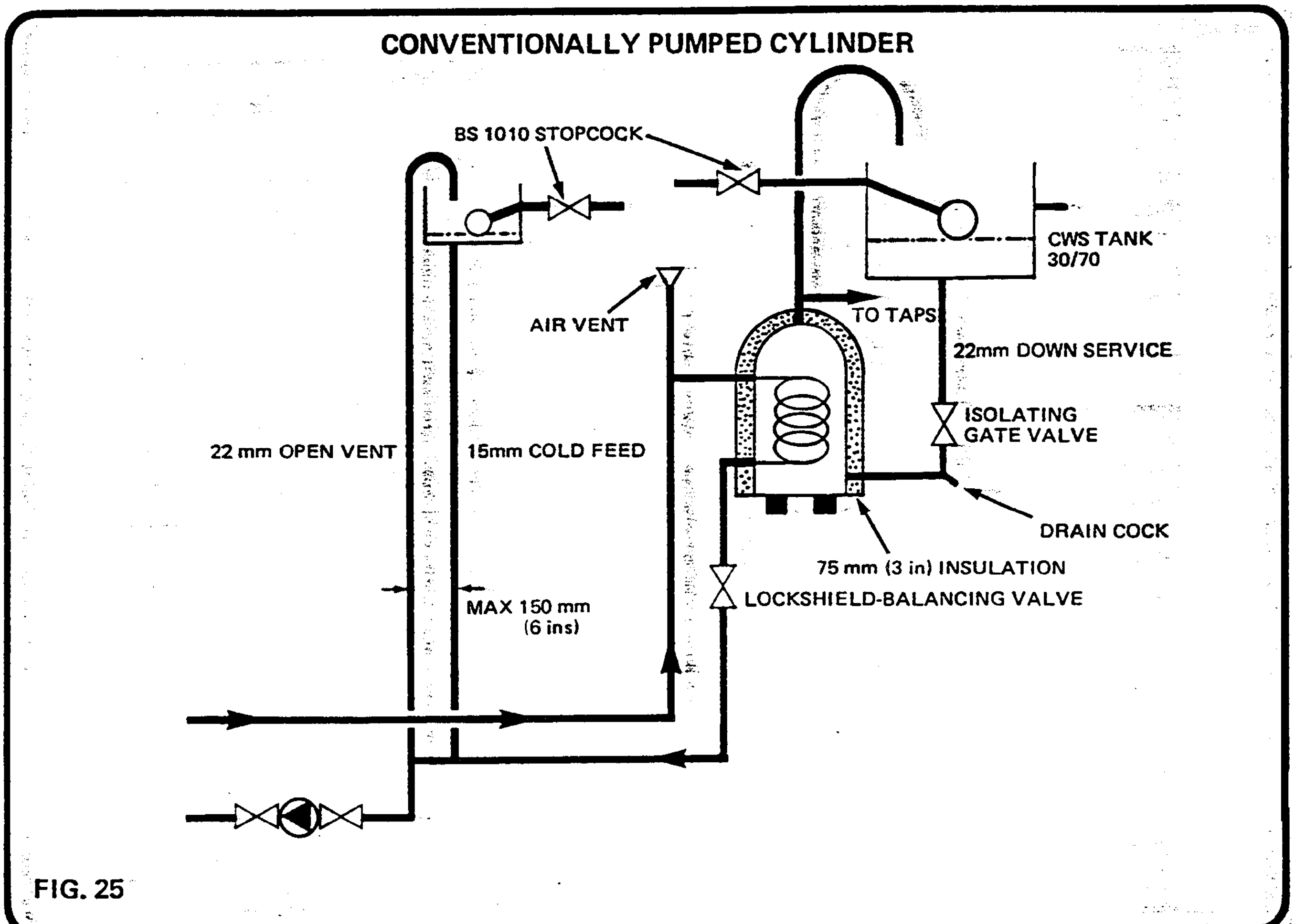


FIG. 25

CYLINDER PUMPED CONTRA-FLOW

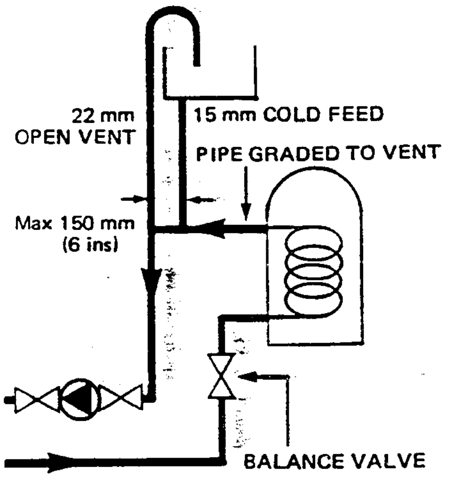


FIG. 26.

USE OF CONVERTION ELEMENTS

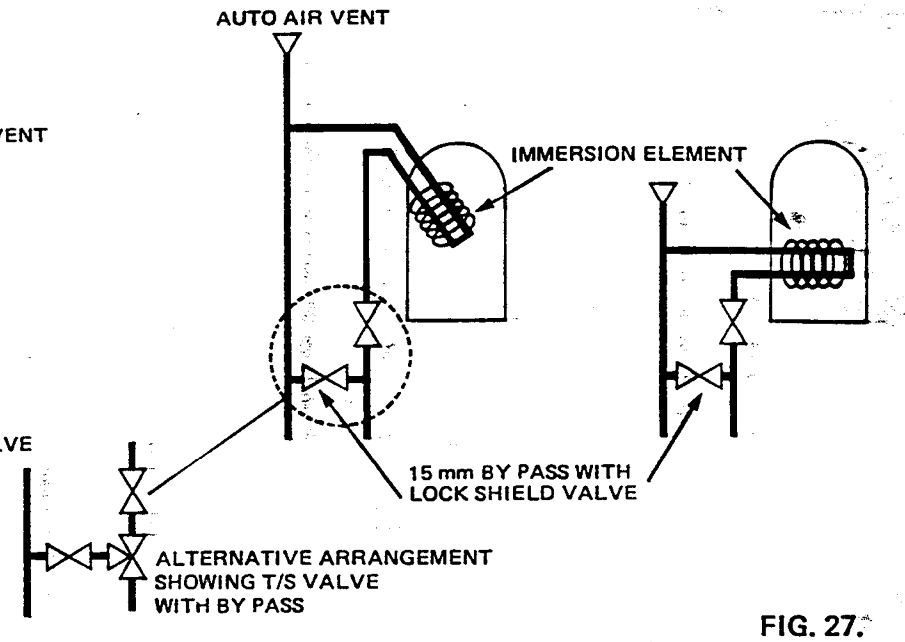


FIG. 27.

Certain applications requiring small quantities, at the kitchen sink, for showering and for the small family are more efficiently accomplished by using an instantaneous water heater.
Chaffoteaux manufacture a range of singlepoint and multipoint water heaters and also the first purpose made gas shower heater, the singlepoint heaters are flueless or open flued, the multipoints and shower heaters are balanced flue.
With the exception of the shower heater they are available for either mains connection (high pressure) or for connection to a cold water tank supply (low pressure).
Details of the performance of the water heaters are in the data sheet included in this booklet.
The multipoint water heater is also suitable for connection to a shower using a mixer valve to balance hot and cold water pressure. They are also suitable for connection to most modern washing machines provided that the machine is capable of accepting one gallon per minute of hot water.

5. CONTROLS

In these days of rising fuel prices it is increasingly important to have full and adequate control over the two functions of the system.

1) Hot water generation
2) Space heating

Hot water can be controlled either electrically or mechanically. Electrically using a cylinder thermostat and motorised valve. It is suggested that the thermostat is placed ⅓ up from the bottom of the cylinder. The setting temperature suggested is 46°C (140°F). There are a number of mechanical valves available all operated by the expansion of a heat sensitive medium. The most effective have a phial that can be entered via a pocket into the stored water, the least effective is that which is attached to the primary return pipe.

Space temperature is more usually electrically controlled by use of a room thermostat placed in a 'representative' position, usually the hall. A room thermostat should:

1) Be sited not more than 5 ft. above the floor level. (when you sit down you are only 3 ft. tall).
2) Not be influenced by local heat emmitters, radiators, television and the like.
3) Not be influenced by excessive draughts.
4) Not be exposed to direct sun light.

An alternative control is achieved by the use of thermostatic radiator valves, most of these are directional so care should be exercised in siting them. (The valve is stamped with an arrow indicating the direction of water flow.)

If a radiator has been boxed in or is likely to be behind a curtain then consideration should be given to fitting a valve with a remote sensor.

Various system layouts are illustrated together with some wiring diagrams. For further information you should contact the controls manufacturer.

The electrical controls must conform in all respects to the IEE Regulations and the local codes.

The installation should be fused with a fuse of a suitable value, usually 3 amp. The pump should have adjacent to it a means of isolation.

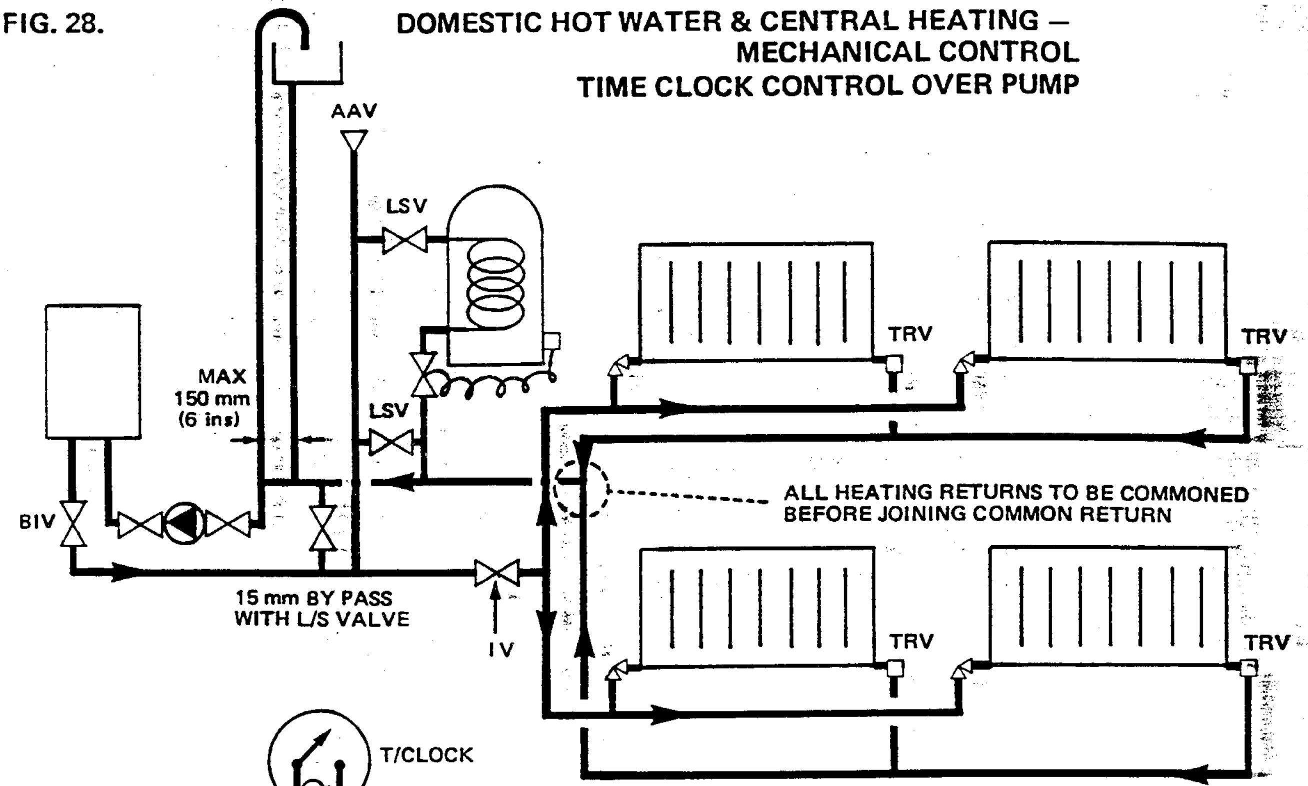
ABBREVIATIONS USED IN THE FOLLOWING DIAGRAMS

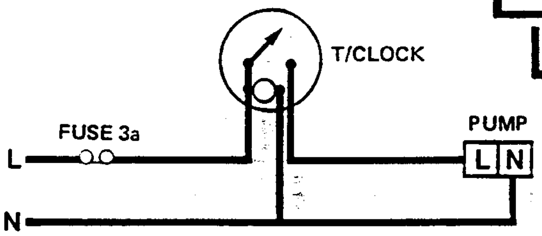
AAV	Automatic Air Vent
BIV	Boiler Isolating Valve
LSV	Lock Shield Valve
TRV	Thermostatic Radiator Valve
L	Live
N	Neutral
S	Satisfied — (stat. satisfied)
D	Demand — (stat. calling)
C	Common
⏚	Earth
2 PMV	Two Port Motorised Valve
3 PMV	Three Port Motorised Valve
CS	Cylinder Thermostat
RS	Room Thermostat
TC	Time Clock
Prog.	Programmer
IV	Isolating Valve
VO	Valve Open
VC	Valve Closed

NB 1. Neutrals and earths have not been drawn
2. The drawings are schematic only
3. For cylinder cupboard layout see page 30.

FIG. 28.

DOMESTIC HOT WATER & CENTRAL HEATING – MECHANICAL CONTROL TIME CLOCK CONTROL OVER PUMP



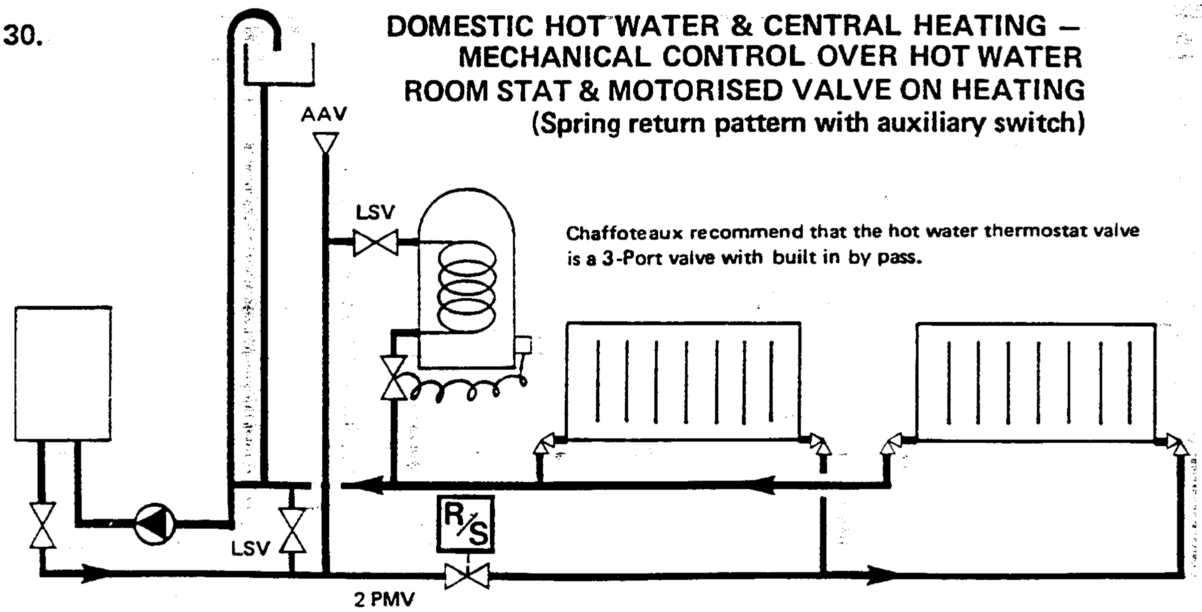


Chaffoteaux recommend that the hot water thermostat valve is a 3-Port valve with built in by pass.

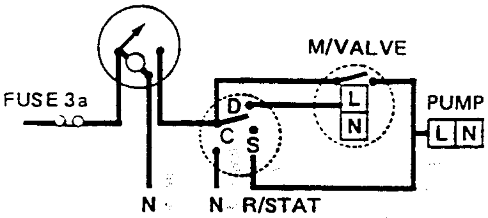
FIG. 29.

FIG 30.

DOMESTIC HOT WATER & CENTRAL HEATING – MECHANICAL CONTROL OVER HOT WATER ROOM STAT & MOTORISED VALVE ON HEATING (Spring return pattern with auxiliary switch)



Chaffoteaux recommend that the hot water thermostat valve is a 3-Port valve with built in by pass.



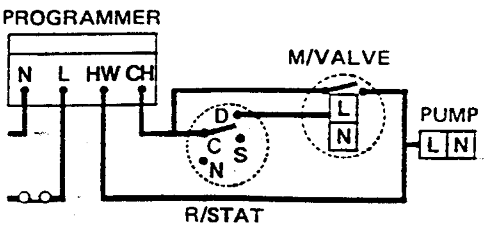
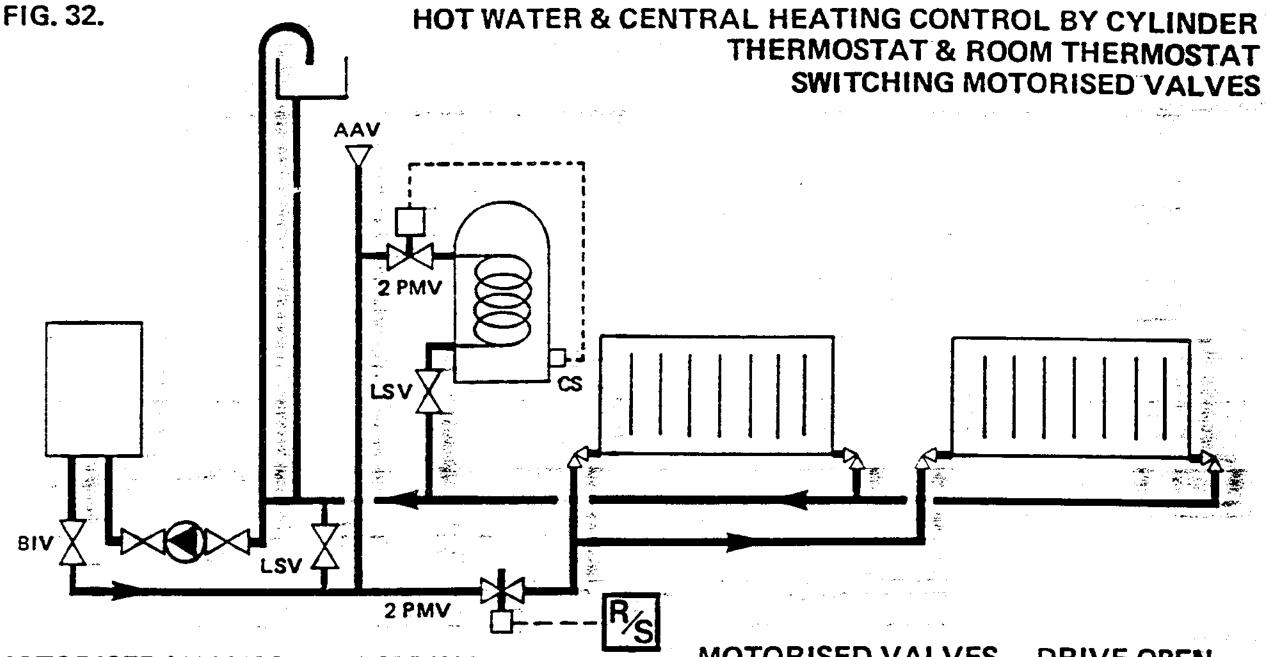


FIG. 31.

FIG. 32.

HOT WATER & CENTRAL HEATING CONTROL BY CYLINDER THERMOSTAT & ROOM THERMOSTAT SWITCHING MOTORISED VALVES



MOTORISED VALVES WITH SPRING RETURN WITH AUX. SWITCH

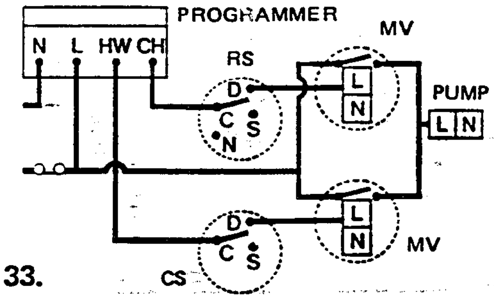


FIG. 33.

MOTORISED VALVES – DRIVE OPEN – DRIVE CLOSED

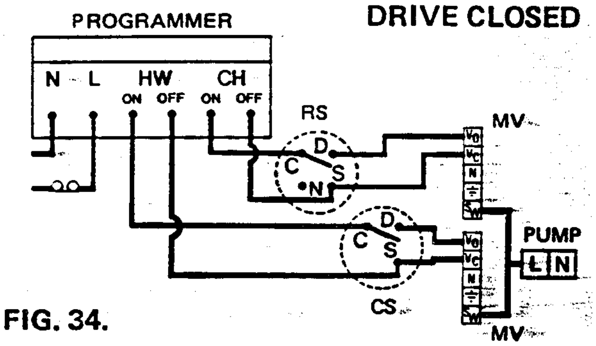
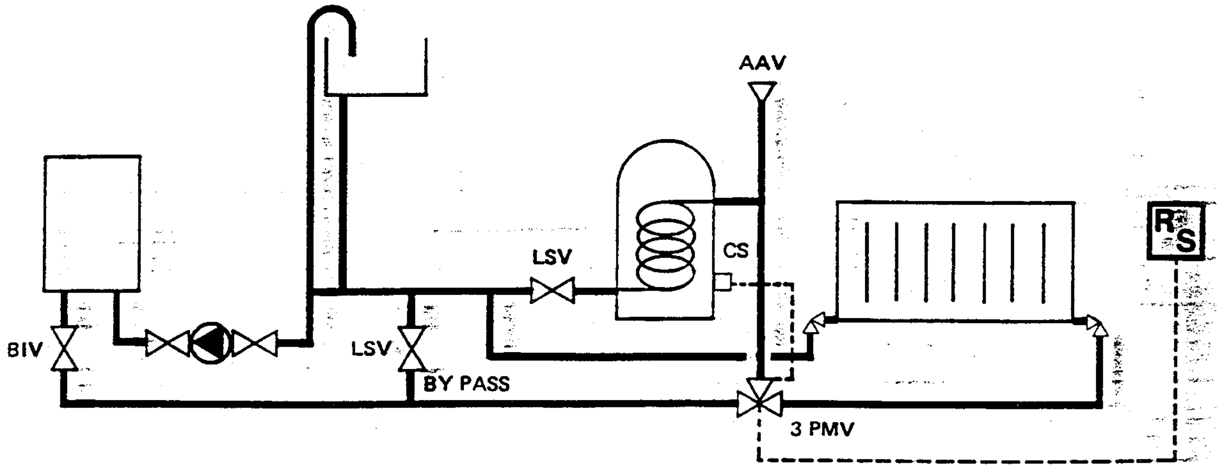


FIG. 34.

FIG. 35.



HOT WATER PRIORITY

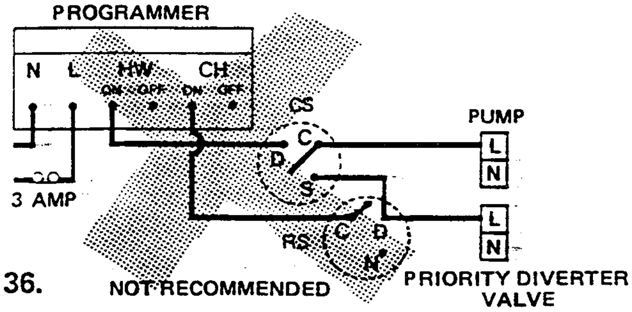


FIG. 36.

MID-POSITION FLOW SHARING VALVE

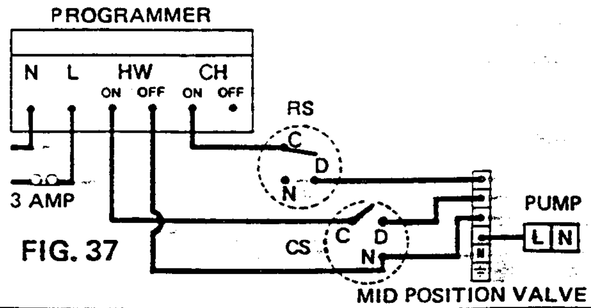


FIG. 37

It is often convenient to group all controls and the circulating pump in the cylinder cupboard. Ensure that all components so positioned are accessible. Chaffoteaux recommend that the flow and return pipework to the cylinder cupboard are run in 22 mm pipework. Cylinder cupboard layouts are given in Fig. 41.

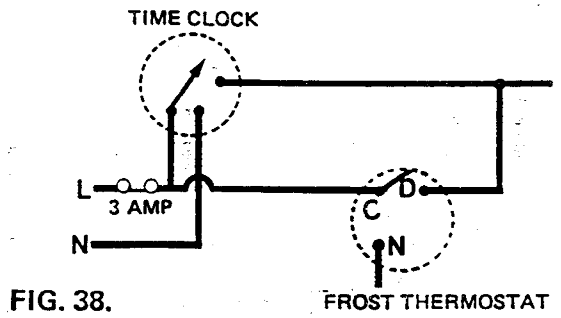


FIG. 38.

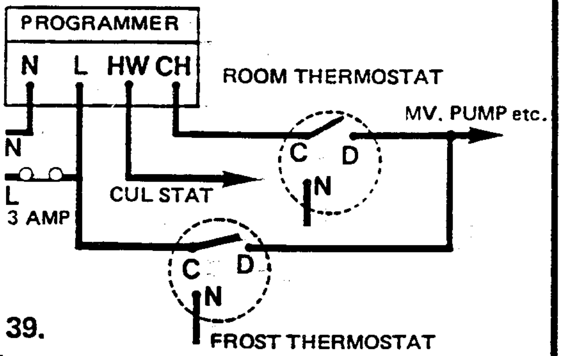


FIG 39.

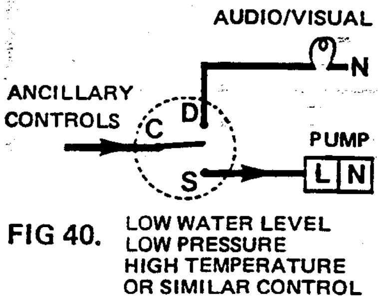


FIG 40.

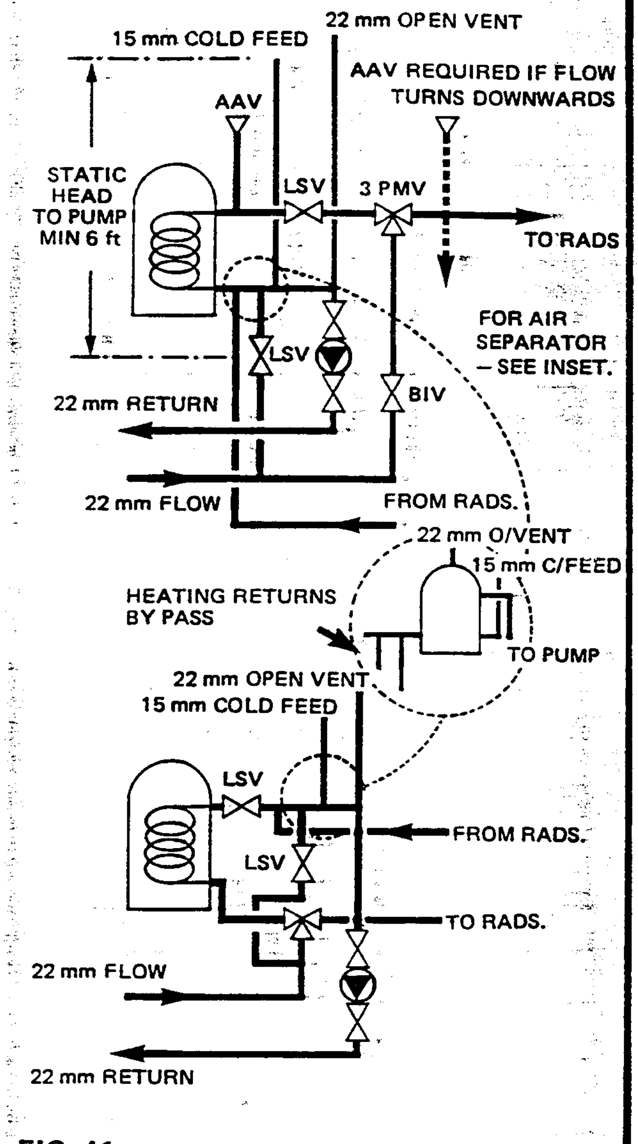


FIG. 41

6. FLUES AND VENTILATION

With all the boilers the installer should ensure that there is adequate combustion and ventilation air, the requirements for domestic boilers are set out in Table 19.
Open flues are governed both by the Building Regulations and the British Gas Regulations and are summarised in Fig. 43.
Balanced flue terminal positions and the restrictions on siting are summarised in Fig. 42
If the terminal is less than 6 ft. above the ground level it must be protected with a wire guard.
Some Chaffoteaux appliances of the room sealed type are approved for use with both Se duct and U duct installations.
Se duct is a method of multiple flueing in a multiple storey dwelling. The appliances on a Se duct receive combustion air from, and discharge their products into, the duct. Air for combustion and for ventilation of the duct is by means of two horizontal limbs, one to each side of the building at the base of the duct. See Fig. 44.
A variation of the Se duct is the U duct where air for combustion and ventilation is brought in from roof level.
The air intake duct is installed flush with the inside face of the duct. The flue duct from appliance is cut to length usually extending 1½ in beyond the inner face of the duct. Instructions for each appliance should be studied carefully.
A duct has a maximum carrying capacity and advic on sizing or the suitability of ducts is available from the local gas region.

TABLE 19

BOILER COMPARTMENT VENTILATION

POSITION OF OPENING	TYPE OF APPLIANCE			
	OPEN FLUED		BALANCED FLUE	
	AIR FROM ROOM	AIR DIRECT FROM OUTSIDE	AIR FROM ROOM	AIR DIRECT FROM OUTSIDE
HIGH LEVEL	9 cm^2 per kW 2 in^2 per 5000 btu/h	4.5 cm^2 per kW 1 in^2 per 5000 btu/h	9 cm^2 per kW 2 in^2 per 5000 btu/h	4.5 cm^2 per kW 1 in^2 per 5000 btu/h
LOW LEVEL	18 cm^2 per kW 4 in^2 per 5000 btu/h	9 cm^2 per kW 2 in^2 per 5000 btu/h	9 cm^2 per kW 2 in^2 per 5000 btu/h	4.5 cm^2 per kW 1 in^2 per 5000 btu/h

FLUELESS WATER HEATER (instantaneous) Not exceeding 12 kW — 40,900 btu/h
Minimum room volume 6 m^3 — 212 ft^3. Air vent 35 cm^2.
NB Areas specified are FREE AIR and are related to appliance INPUT.

VARIOUS ROUTES FOR VENTILATION

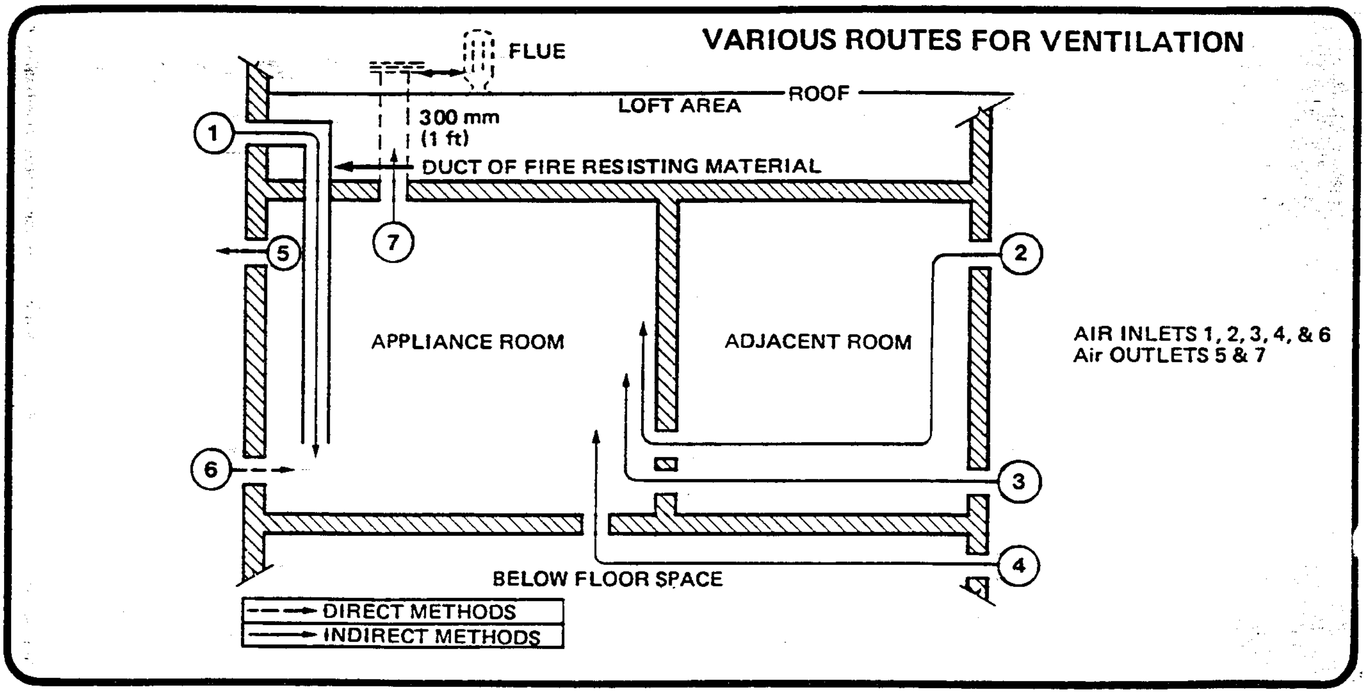
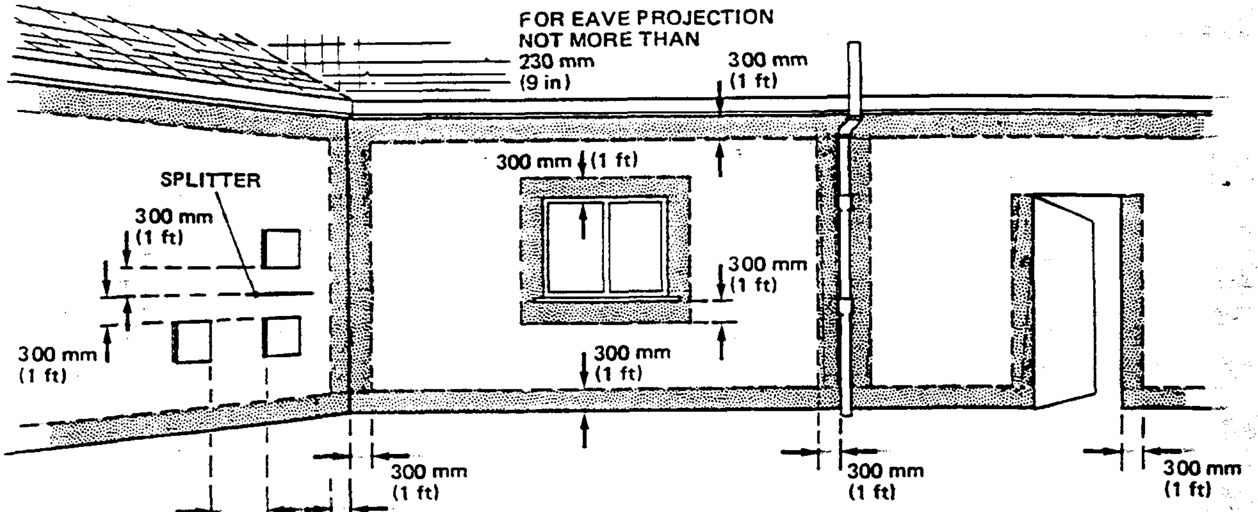


FIG. 42.

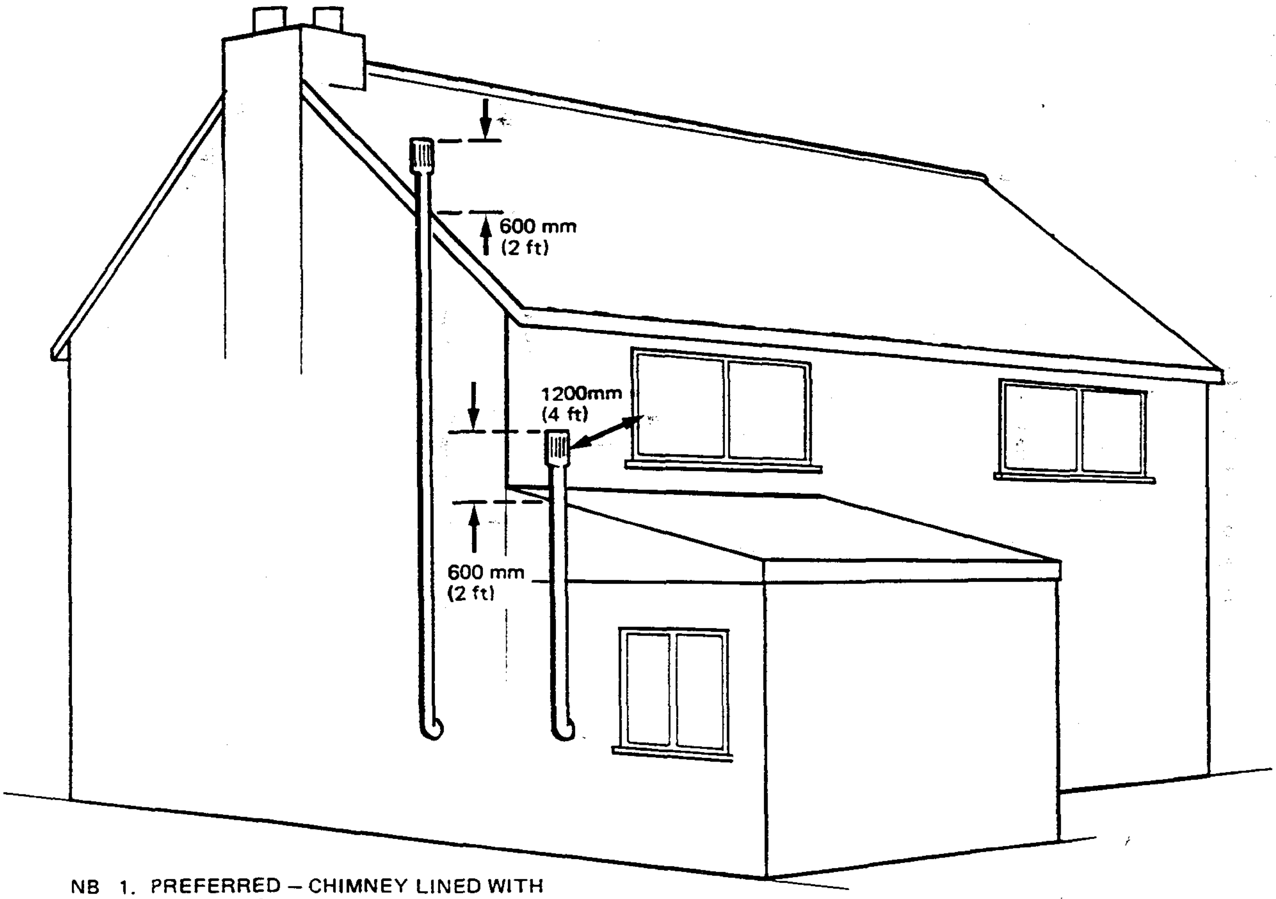
BALANCED FLUES



NB 1. TERMINALS MUST NOT BE FITTED IN SHADED AREAS
2. IF LESS THAN 1,800 mm (6ft) ABOVE GROUND LEVEL FIT TERMINAL GUARD
3. If 300mm (1 ft) BELOW EAVE FIT DEFLECTOR TO SOFFIT 600mm (2 ft) ON EITHER SIDE OF TERMINAL & EXTENDING TO INCLUDE PLASTIC GUTTER

FIG. 43.

OPEN FLUES



NB 1. PREFERRED – CHIMNEY LINED WITH STAINLESS STEEL LINER
2. EXISTING CHIMNEY MUST BE SWEPT BEFORE LINING
3. ALL EXTERNAL FLUES SHOULD BE INSULATED.

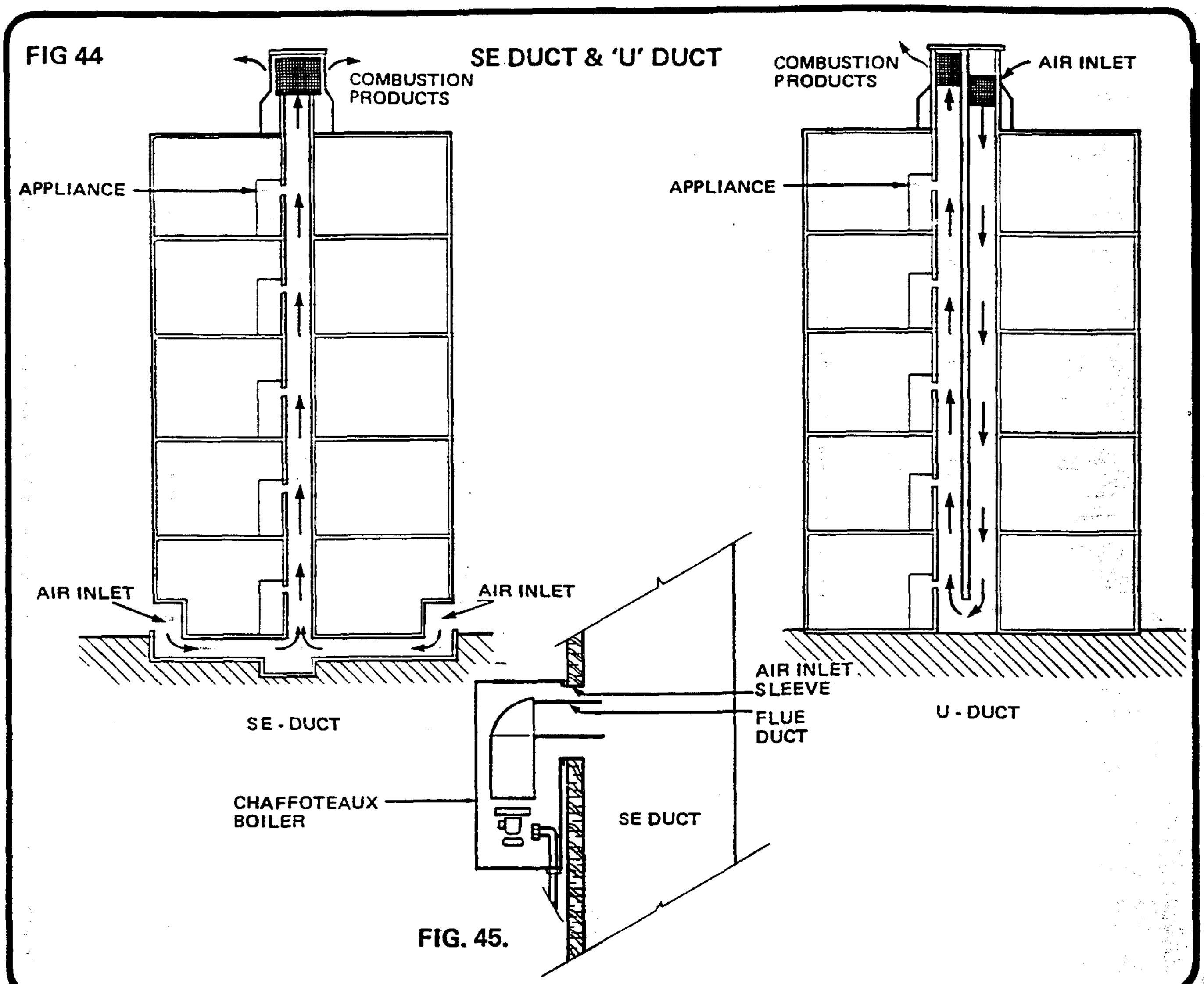


FIG 44

FIG. 45.

TESTING OPEN FLUES

All appliances connected to a conventional open flue should be checked for 'spillage'.

The following are suggested methods:-

1) Hold a lighted taper so that the flame is below the lower edge of the draught diverter (Fig. 46.). Spillage is indicated by the flame being displaced outwards.
2) Hold a piece of cold polished metal or mirror close to the lower edge of the draught diverter. Spillage is indicated by the polished surface becoming clouded.
3) Ignite a smoke pellet in the combustion chamber. Spillage is indicated by escape of smoke from the draught diverter.

If an extractor fan is fitted first carry out test on flue with the fan off. If this is satisfactory open door to room in which appliance is fitted, connecting to room in which fan is fitted, and close all other doors. Close all windows in the property. Switch on fan and repeat test. If spillage is detected open window until spillage ceases. If the open area of the window is less than 10 in^2 put in additional ventilation, equivalent to area of opening.

If the area is greater than 10 in^2 consult the local gas region.

This test is very important since the installer has a statutory duty under the Gas Safety Regulations, Section 47:

> No person shall use or permit a gas appliance be used if at any time he knows or has any reason to suspect:-
>
> a) That the removal of the products of combustion from an appliance is not safely being carried out.

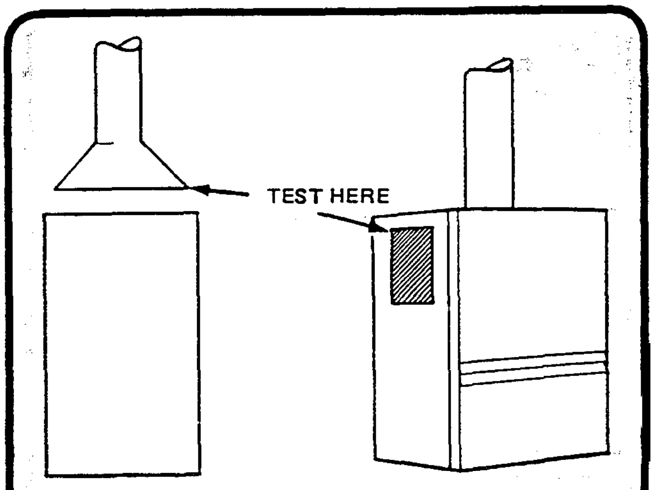


FIG. 46.

7 WARM AIR

7. WARM AIR

Warm air heating is the distribution of heated air, either directly or indirectly, and with the aid of a fan and ducting delivering it to the area in which it is required.
Chaffoteaux market a range of warm air heaters of the indirect variety.
Water heated by a boiler is the heating medium. The heated water passes through a water to air heat exchanger. The heated air is passed to the rooms. See Figs. 52 & 53.
With modern building methods, where buildings are of low mass and highly insulated:-

1) a smaller heating requirement is required to be met by the system,
2) because the buildings are low mass the structure does not retain the heat.

The advantages of heating by warm air are:-

1) design temperatures are more quickly met from a cold start,
2) less wall space is used,
3) less conspicuous,
4) continuous air circulation and filtration.

Chaffoteaux, with their appliances, can add:-

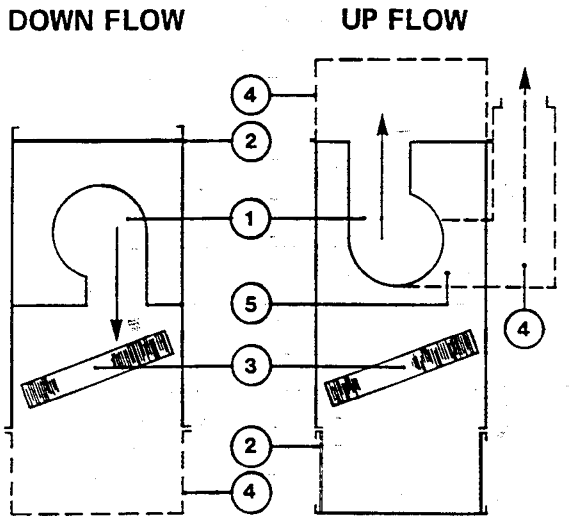
5) flexibility – the boiler providing the heated water can also provide hot water or additional radiators,
6) lower risk of corrosion because the boiler heat exchanger, the water to air heat exchanger and the pipes and cylinder are all copper.

There is also another and important function which Chaffoteaux can satisfy. Many of the direct fired units installed in the 1960's are now due for replacement, and a higher level of comfort is now required, like heated bedrooms. Further, few of the generation of heaters installed at that time were able to supply domestic hot water, this was provided by an instantaneous water heater or circulator.
Warm air heat exchangers are of two basic types:-

Upflow Air is passed over the heat exchanger and discharged at the top of the unit. (Fig. 47.).

Downflow Air is passed over the heat exchanger and discharged at the bottom of the unit.

FIG. 47.



1 FAN
2 FILTER
3 HEAT EXCHANGER
4 PLENUM – NOT SUPPLIED BY CHAFFOTEAUX
5 ALTERNATIVE FAN POSITION

FIG. 48.
STUB DUCT

FIG. 49.
RADIAL

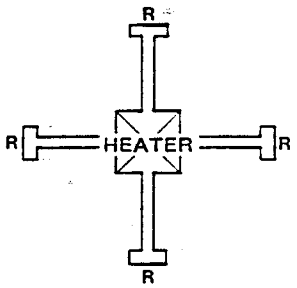


FIG. 50.
EXTENDED PLENUM

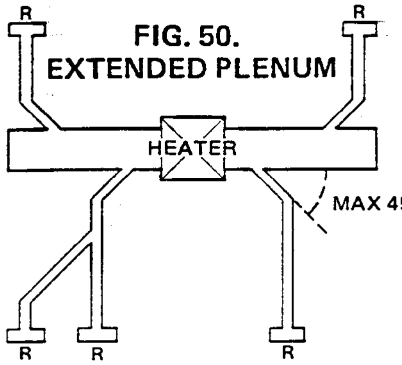
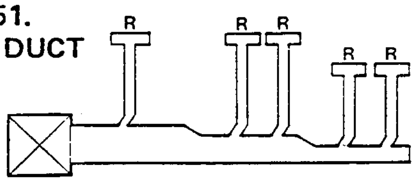


FIG. 51.
STEP DUCT



Distribution of the air is then directed, by ducts, the outlets of which may be:-

Stubducts — Registers to rooms directly off the plenum.

Floor perimeter — Air is passed through round or square ducts from the plenum to discharge through the floor, preferably under windows, to get the best entrainment.

Ceiling perimeter — As floor perimeter but discharging from the ceiling (used where there is a loft or large void above the rooms).

Low side wall — The registers are placed in the walls at low level. The discharge rate should not exceed 300 fpm (ft. per minute).

High side wall — Registers are placed at high level on inside walls. Care as to be taken with the choice of grille so that no discomfort is caused to the occupants.

The distribution systems are of four types. (See Figs. 48 to 51).

Radial — The ducts radiate to registers from the central heat source.

Extended Plenum — The plenum is extended and the supply to the registers is taken from the large duct. Air flow should not exceed 500 CFM and the plenum should not be more than 20 ft. in length.

Step duct — Where the duct gradually reduces in size and the supply ducts are taken off the main duct.

FIG. 52.

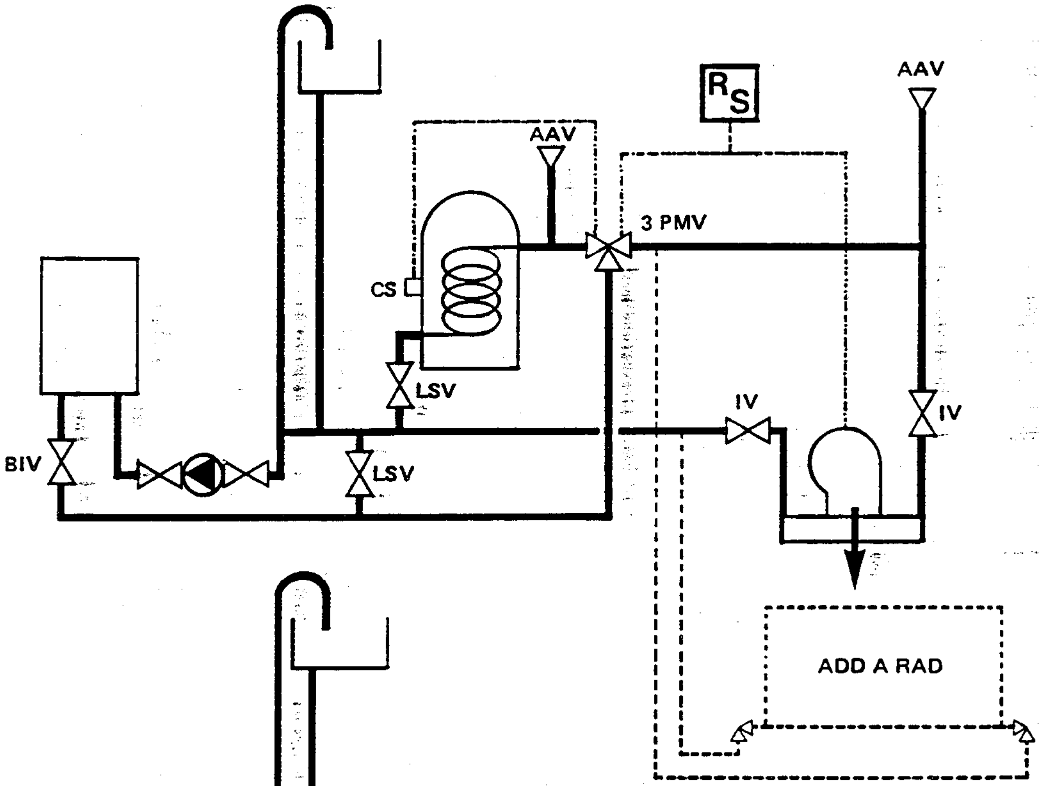
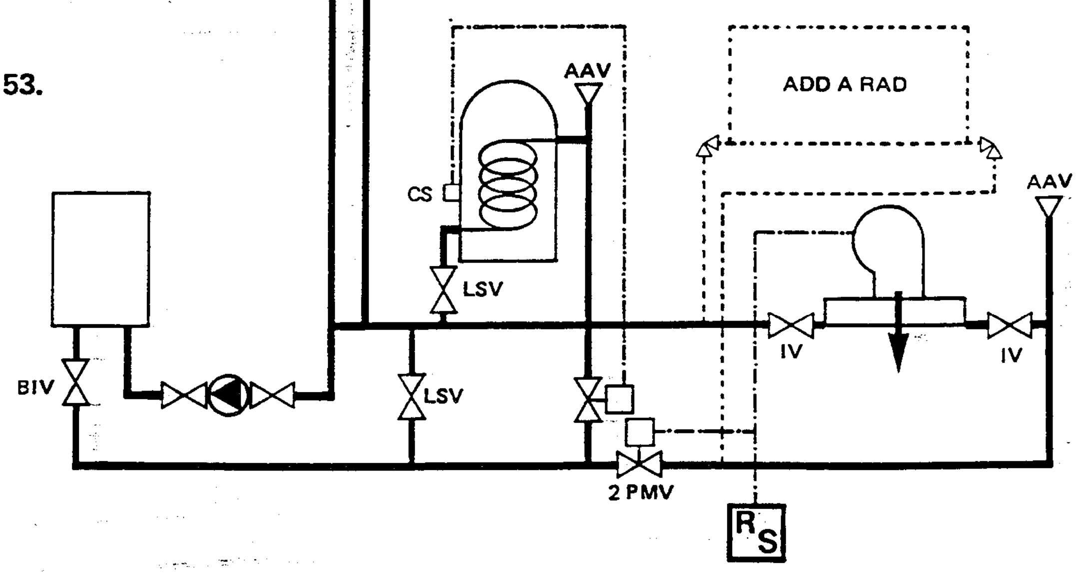


FIG. 53.



8 GAS SERVICES

8. GAS SERVICE

It is equally necessary to correctly size the gas pipes as to size the pipes carrying water. In the same way that pipes offer resistance to water so they do to the passage of gas. The carrying capacities of gas pipes are shown in Table 20., expressed in ft^3 for metres run.

It is therefore a pre-requisite to calculate the volume of gas required.

This is obtained by the following:-

$$\frac{\text{Boiler input in btu/h}}{\text{CV of gas}}$$

The calorific value of natural gas is normally 30 btu/h/ft^3.

To convert from ft^3 to m^3 divide by 35.31.

When commissioning an appliance it is recommended that first the pressure is checked with a gauge at the inlet to the appliance when running and all other gas appliances in the property in operation. At the inlet to the appliance under the conditions as above the pressure should not be less than 8 in.w.g.

Next the pressure at the burner manifold should be checked and adjusted after 10 minutes in operation. When setting/checking the pressure on a balanced flue boiler ensure that all doors and windows are closed to the room in which the boiler is situated.

Having set the burner pressure all other appliances should be turned off including the pilot lights and the consumption checked at the meter to confirm that the gas consumption is as shown on the data badge of the appliance.

TABLE 20.

Discharge on straight horizontal copper tube with 1 mbar differential pressure between ends for gas of relative density 0.6 (Air = 1).

Size of Pipe	Length of tube — metres									
	3	6	9	12	15	20	25	30	40	50
	Gas discharge in ft^3/hr									
15 mm	102	67	56	46	38	33	32	31	21	18
22 mm	307	204	162	137	120	102	92	81	67	60
28 mm	635	423	332	314	247	208	183	165	137	134

9. LPG

LPG is liquified petroleum gas. The fuel source is either crude oil or direct from the North Sea. The gasses available are either Propane or Butane.
The gasses are stored as liquids under pressure. Propane turns into gas at a lower temperature than butane and is, therefore, stored at a higher pressure. When the tap is opened the pressure is released, the liquid boils and gas is evolved.

TABLE 21

LENGTH OF TUBING		BRITISH STANDARD IRON PIPE							
		8 mm (¼ in)		15 mm (½ in)		20 mm (¾ in)		25 mm (1 in)	
Metres	Feet	m^3/h	ft^3/h	m^3/h	ft^3/h	m^3/h	ft^3/h	m^3/h	ft^3/h
3	10	0.51	18.0	4.25	150	8.50	300	18.7	660
6	20	0.36	12.6	2.85	100	5.95	210	12.7	450
9	30	0.29	10.4	2.25	80	4.65	165	9.9	350
12	40	0.25	9.0	2.00	70	4.00	140	8.5	300
15	50	0.23	8.0	1.70	60	3.40	120	7.4	260
18	60	0.20	7.2	1.53	54	3.10	110	6.8	240
21	70	0.19	6.8	1.40	50	2.90	103	6.2	220
24	80	0.18	6.3	1.25	45	2.70	96	5.7	200
27	90	0.17	6.0	1.20	43	2.55	90	5.4	190
31	100	0.16	5.7	1.16	41	2.45	86	5.1	180
37	120	0.14	5.0	1.00	36	2.20	78	4.4	155
43	140	0.13	4.7	0.95	34	2.00	70	4.1	145
49	160	0.12	4.4	0.90	31	1.85	65	3.8	135
55	180	0.12	4.1	0.80	29	1.75	61	3.6	130
61	200	0.11	4.0	0.80	28	1.65	59	3.4	120

OUTSIDE DIAMETER OF COPPER TUBING

LENGTH OF TUBING		Metric 6 mm		Imp. ¼ in	Metric 10 mm		Imp ⅜ in	Metric 12 mm		Imp ½ in	Metric 22 mm		Imp ¾ in	Metric 28 mm		Imp 1 in
Metres	Feet	m^3/h	ft^3/h	ft^3/h	m^3/h	ft^3/h	ft^3/h	m^3/h	ft^3/h	ft^3/h	m^3/h	ft^3/h	ft^3/h	m^3/h	ft^3/h	ft^3/h
3	10	0.12	4.3	5.5	0.88	31.0	21.0	1.49	52.6	62.0	8.01	283.0	195.0	15.96	562.0	444.0
6	20	0.09	3.0	3.9	0.57	20.0	14.0	1.01	35.6	42.0	5.21	184.0	127.0	10.85	313.0	300.0
9	30	0.07	2.5	3.2	0.48	17.0	11.5	0.79	28.0	33.0	4.19	148.0	102.0	8.23	294.0	230.0
12	40	0.06	2.1	2.7	0.42	14.8	10.0	0.68	24.6	29.0	3.62	128.0	88.0	7.25	256.0	200.0
15	50	0.05	1.9	2.4	0.38	13.3	9.0	0.60	21.2	25.0	3.20	113.0	78.0	6.51	230.0	180.0
18	60	0.05	1.1	2.1	0.35	12.3	8.3	0.53	18.6	22.0	2.86	101.0	70.0	5.61	198.0	155.0
21	70	0.04	1.4	1.9	0.32	11.2	7.6	0.50	17.8	21.0	2.58	91.3	63.0	5.24	185.0	145.0
24	80	0.04	1.4	1.8	0.29	10.4	7.0	0.47	16.5	19.5	2.38	84.0	58.0	4.87	172.0	135.0
27	90	0.04	1.3	1.7	0.29	10.1	6.8	0.44	15.7	18.5	2.26	79.7	55.0	4.70	166.0	130.0
31	100	0.03	1.2	1.6	0.27	9.6	6.5	0.42	14.8	17.5	2.12	75.0	52.0	4.33	153.0	120.0
37	120	0.03	1.1	1.5	0.24	8.4	5.7	0.36	12.7	15.0	1.85	65.2	45.0	3.91	138.0	108.0
43	140	0.03	1.1	1.4	0.22	7.8	5.3	0.33	11.8	14.0	1.72	60.9	42.0	3.62	128.0	100.0
49	160	0.03	1.0	1.3	0.21	7.4	5.0	0.31	11.0	13.0	1.56	55.2	38.0	3.34	118.0	92.0
55	180	0.02	0.9	1.2	0.20	7.0	4.7	0.29	10.1	12.0	1.48	52.3	36.0	3.17	112.0	88.0
61	200	0.02	0.9	1.1	0.19	6.7	4.5	0.26	9.3	11.0	1.40	49.3	34.0	3.03	107.0	84.0

All Chaffoteaux appliances will burn either propane or butane in their LPG form. Remember, however, if you change gas from propane to butane or vice versa, it will be necessary to reset the pressure regulator.
For propane the regulator should be set to give a working pressure of 14.6 in.w.g. at the appliance and 11 in.w.g. for butane.
Tables 22. & 23. show the properties of the two gasses.
LPG is heavier than air, and therefore care should be exercised in storing the gas cylinders. They should be stored external to the property and above ground level.
So far as installation is concerned the only factors of system design which differ from natural gas are the pressure drop in gas pipes. This is summarised in Table 21. and the necessity to use the appropriate isolating valve (usually a diaphragm type) where the supply pipe enters the building and appliance.

TYPICAL **PROPERTIES OF BUTANE AND** PROPANE

TABLE OF PROPERTIES

The following tables shown typical physical properties for commercial grades of Butane and Propane. All Metric units relate to Metric Standard conditions of 15°C and 1013.25 mbar (dry).
Imperial units relate to Normal Temperature and Pressure Condition of 60°F and 30 ins. Hg (saturated).

STORAGE AND HANDLING

Storage tanks should be located in accordance with Table 24 based upon the capacity of storage concerned. The separation distance given in Table 24 must be maintained at all times, and no building extensions, fixed ignition sources, etc. should ever be allowed to encroach within it.
The whole of the area within a distance of 3 m. from tanks up to 2250 litres water capacity, or 10 m from larger tanks, should be maintained at ALL times — free from weeds, long grass or combustible materials. Tanks should not be sited adjacent to any pits, drains or other depressions.
Tanks should be protected by industrial type fencing where the risk of trespass or tampering is high. Large tanks should always be protected.
Where damage to LPG systems from vehicular traffic is a possibility precautions against such damage should be taken. The degree of protection required will depend on actual site conditions, including the density of traffic, the nature of the traffic, and the overhang or reach of the vehicles. Strategically located motorway type crash barriers or concrete or steel bollards will be suitable for most installations.
Where an earthing point is provided for the discharge of static electricity, this should be clearly visible and readily accessible at all times.
Metalled vehicular access to the tanks should be provided.

TABLE 22

BUTANE	METRIC UNITS	IMPERIAL UNITS
Calorific Value (Vaporised)	121.5 MJ/in^3 49.2 MJ/kg 28.2 MJ/litre	3200 btu/ft^3 21150 btu/lb 121610 btu/gal
Volume of gas produced per Mass of Liquid	0.41 m^3/kg	6.6 ft^3/lb
Volume Occupied per Mass of Liquid	1743 1/tonne	390 gal/ton
Volume of Air to burn Unit Volume of Gas	30	30

TABLE 23

PROPANE	METRIC UNITS	IMPERIAL UNITS
Calorific Value (Vaporised)	95 MJ/m^3 50 MJ/kg 25.5 MJ/litre	2500 btu/ft^3 21500 btu/lb 110080 btu/gal
Volume of Gas Produced per Mass of Liquid	0.54 m^3/kg	8.6 ft^3/lb
Volume Occupied per Mass of Liquid	1957 1/tonne	437 gal/ton
Volume of Air to burn Unit Volume of Gas	23	23

Location and spacing for tanks for industrial, commercial and domestic bulk storage.

TABLE 24

Maximum water capacity of any single tank in Litres (Gallons)	Maximum total water capacity of all tanks in Litres (Gallons)	Minimum Separation Distance in Metres (Feet)				
		From building, boundary, property line* or fixed source of ignition			Between tanks	
			Below ground			
		Above ground	Buried portion	Valve assembly† and and loading/ unloading point above ground	Above ground	Below ground
450 (Up to 100)	1350 (300)	None**	3 (10)	3 (10)	None	1.5 (5)
450–2250 (Over 100–500)	6750 (1500)	3 (10)	3 (10)	3 (10)	1 (3)	1.5 (5)
2250–9000 (Over 500–2000)	27000 (6000)	7.5 (25)	3 (10)	7.5 (25)	1 (3)	1.5 (5)
9000–135000 (Over 2000–30 000)	450 000 (100 000)	15 (50)	3 (10)	7.5 (25)	1.5 (5)	1.5 (5)

* Whether built on or not.

** Where tanks up to 450 litres water capacity are sited adjacent to mobile homes, caravans, site huts and similar buildings of a non-permanent nature constructed of combustible materials, additional precautions should be taken. In such circumstances the minimum distance between the shell of the tank and the building should be one metre, and the minimum distance between the filler valve on the tank and any door, openable window, ventilator or other point of gas entry into the building, should be three metres.

† The isolation valves, filling valves and pressure relief valves located on the manhole cover of the underground tank.

10 SERVICING AND SYSTEM FAULT FINDING

10. SERVICING AND FAULT FINDING

Annual servicing should be carried out by a competent person and a servicing schedule is set out below. For ease of servicing, Chaffoteaux recomment that the boiler is valved on both sides as shown in the various system diagrams.

Annual Service

1 Clean the Burner
2 Clean the Heating Body
3 Clean the Pilot Assembly, Thermocouple and Spark Electrode
4 Clean the Gas Filter
5 Clean the Thermostat Capsule
6 Clean the water filter

Three Yearly Service

1 Clean Burner, Heating Body, Pilot Assembly and Thermocouple
2 Replace the Gas Filter
3 Replace the Diaphragm
4 Clean the Gas Valve

FAULT FINDING CHART – SYSTEM

FAULT	CAUSE	REMEDY
Insufficient heat to room	Insufficient gas flow	Check inlet pressure at gas cock. Check manifold pressure and adjust.
	Insufficient water flow	Open all valves and by pass.
	Boiler not coming up to full gas	Check by consumption at meter. Refer to Installation and Maintenance Instructions for remedy. Change pump if necessary.
	Short cycling around cylinder	Check a balance valve is fitted and correctly adjusted.
	Short cycling around by pass	Check and adjust – see Installation Instructions. Check system resistance is within pump duty.
	Heat loss incorrect	Check heat loss – look for excessive ventilation – unrestricted chimney etc.
	Radiator too small	Check radiator output and adjust for temperature difference of 20°C.
	Radiator obstructed	Remove obstruction or re-locate radiator.
	Too large a temperature difference	Balance System.
	Room thermostat	1. Out of calibration. 2. Neutral not connected. 3. Influenced by local heat source, TV etc.
Insufficient hot water	Cylinder not high recovery.	Replace.
	Mechanical valve used with by pass	Check and fit if necessary and adjust.
	Air in coil	Ensure cylinder is vented.
	Cylinder stat. too high on cylinder	Re-locate ⅓ from bottom of cylinder.

FAULT	CAUSE	REMEDY
Delay in switch to heating in DHW priority system (as for insufficient heat) plus	Cylinder stat. out of calibration Poor contact between cylinder stat. and cylinder	Replace Clean surface of cylinder and re-locate using heat grease.
Boiler noise	Air in system Insufficient Head Incorrect cylinder fitted Scale in heat exchanger	Check cylinder and air vent as recommendations in Section 4.2. Vent high points. Is charge pressure correct on sealed system? Have recommendations been followed regarding pump, cold feed and vent positions. Check cylinder is an indirect type and is not a self priming type. Check for system leaks. De-scale heating body if necessary.
Noise from system	Water velocity exceeds recommendations Air in system	Check pipe sizes and enlarge if necessary. Vent system thoroughly.
Overflowing expansion tank	Insufficient capacity	Replace.
Radiators hot when motorised valve is closed.	Reverse circulation	Ensure heating returns commoned before joining main return.

WARM AIR		
Insufficient heat	Incorrect fan speed Incorrect duct sizing Register not balanced Filter dirty Low mean water temperature Too large a differential on room stat.	Check calculation and adjust. Increase fan speed (take care with noise). Re-balance system. Remove and clean. Check pump duty and boiler operation. Ensure anticipator is connected.
Noise (mechanical)	Loss of dynamic balance due to accumulation of dust. Distortion of rotor or bearings Fan hunting	Clean Fan. Lubricate or replace as necessary. Clean filters. Check size of relief grilles and return air register and ensure of adequate size.
Noise (system)	Fan speed Duct sizing Restricted register Obstruction in duct	Adjust. Replace in correct size. Adjust. Remove.

11 DATA

WATER HEATERS

WATER HEATERS				BRITONY II Balanced flue Multipoint	CELT Open flue Spout or remote	SH12 Balanced flue Single point Shower
Heat input				30.27 kW 103280 btu/h	11.6 kW 39580 btu/h	11.3 kW 38600 btu/h
Heat output				22.7 kW 77450 btu/h	8.7 kW 29700 btu/h	8.5 kW 29000 btu/h
Burner pressure				15 mbar 6 in.w.g.	6 mbar 2.4 in.w.g.	12.7 mbar 5.1 in.w.g.
Restrictor size				None	2.65	3.5 mm
Part No				None	37252	37251
Manifold injector No & (No off)				113 (14)	118 (8)	113 (6)
Part No				14154/21	14154/18	14154/21
Gas Consumption (Max)			m^3/hr	2.81	1.1	1.08
			ft^3/hr	99.24	38.67	38.14
Case Dimensions	High		mm	655	420	600
			ins	26	16.5	23.6
	Wide		mm	395	228	267
			ins	15.5	9	10.5
	Deep		mm	253	203	210
			ins	10	8	8.25
Clearances	Top		mm	65	600	100
			ins	2.6	24	4
	Bottom		mm	178	50	152
			ins	7	2	6
	Sides		mm	NIL	75	NIL
			ins	NIL	3	NIL
Gas connection				15 mm copper	15 mm copper	15 mm copper
Water connection				15 mm copper	Inlet 15 mm copper outlet spout or 15 mm copper	15 mm copper
Water flow rate	Raised 50°C – (90°F)		1/min	6.5	2.5	Raised 20°C (36°F) 6.3
			gpm	1.44	0.55	1.39
	Raised 30°C – (54°F)		1/min	11.1	4.16	Raised 35°C (63°F) 3.6
			gpm	2.44	0.92	.79
Head	Min normal pressure			1 bar – 15 psi	0.45 bar 6.5 psi	0.5 bar 7.5 psi
	Max normal pressure			10 bar – 150 psi	10 bar 150 psi	10 bar 150 psi
	Min low pressure			1.5 m 4.9 ft	1.3 m 4.26 ft	– –
	Max low pressure			25 m 82 ft	24 m 80 ft	– –
Weight				19 Kg 42 lbs	6.9 Kg 15.25 lbs	10.7 Kg 23.5 lbs
Flue size			Height	205 mm 8 ins	Flueless or 3 ins Ø	125 mm 4.9 ins
			Width	305 mm 12 ins		240 mm 3.4 ins
Combustion & ventilation air free area	From Internal	High	cm^2	102		
			in^2	15.8		
		Low	cm^2	102		
			in^2	15.8		
	From External	High	cm^2	51	35	
			in^2	7.9	5.4	
		Low	cm^2	51	Plus opening window	
			in^2	7.9		
LPG — Propane						
Burner pressure				10 in.w.g.	10 in.w.g.	10 in.w.g.
Restrictors				None	2.75 mm 41909	3.25 mm 37251
Manifold injector				074 14154/19	070 14154/10	072 14154/12
Gas Consumption			m^3/h	1.17	.434	.437
			ft^3/h	41.3	15.32	15.44
Gas Connection				½ in BSP	12 mm copper	½ in BSP

N.B. BRITONY LOW PRESSURE

Heat Input	29.21 kW	99,600 Btu/h
Heat Output	21.90 kW	74,700 Btu/h
Burner Pressure	13.5 mbar	5.3 ins.w.g.
Manifold Injector Size	118	
Gas Consumption	2.78 m^3/hr	98.18 ft^3/hr
Water Connection	22 mm copper	
Water Flow Rate	Raised 50°C (90°F) 6.31/min	1.38 g.p.m.

DOMESTIC BOILERS

			CORVEC 28						CORVEC 45						MAXIFLAME		
			Balanced Flue			Open Flue			Balanced Flue			Open Flue			Balanced Flue		
Heat output		Btu	28000	22350	13660	28000	22350	13660	45000	35000	25000	45000	35000	25000	60000	50000	40000
		Kw	8.2	6.5	4	8.2	6.5	4	13.2	10.3	7.3	13.2	10.3	7.3	17.58	14.6	11.[illegible]
Heat input		Btu	35480	28660	17740	35480	28660	17740	58000	45750	32750	58000	45750	32750	73000	65750	51000
		Kw	10.4	8.4	5.2	10.4	8.4	5.2	17	13.4	9.6	17	13.4	9.6	23.35	19.28	14.94
Burner Setting Pressure		mbar	9.2	6.2	2.7	9.2	6.2	2.7	10.2	6.6	3.5	10.2	6.6	3.5	9	6.6	4.3
		in.w.g.	3.7	2.5	1	3.7	2.5	1	4.1	2.6	1.4	4.1	2.6	1.4	3.6	2.8	1.7
Restrictor size		Burner	2.8	2.2	1.7	2.8	2.2	1.7	3.7	3.0	2.3	3.7	3.0	2.3	4.3	4.3	4.3
Part No.			43095	43096	43097	43095	43096	43097	43090	37262	43089	43090	37262	43089	32684/01	32684/01	32684/01
Manifold injector			118	118	118	118	118	118	113	113	113	113	113	113	118	118	118
Part No			14154/18						14154/21						14154/18		
Gas consumption per hr		ft³	34.45	27.83	17.22	34.45	27.83	27.22	56.3	44.42	31.8	56.3	44.42	31.8	76.7	63.8	49.5
		m³	0.98	0.79	0.49	0.98	0.79	0.49	1.59	1.25	0.90	1.59	1.25	0.90	2.17	1.8	1.4
Case Dimensions	High	in	23.6			23.6			24			24.6			26		
		mm	600			600			612			626			655		
	Wide	in	10.6			10.6			13.1			12.75			15.5		
		mm	269			269			334			324			395		
	Deep	in	8.6			8.6			10			8.7			10		
		mm	218			218			255			220			250		
Clearances	Top	in	3			3			3			3			0.4		
		mm	76			76			76			76			10		
	Bottom	in	5			5			5			5			4.5		
		mm	127			127			127			127			115		
	Sides	in	1			3			1			3			NIL		
		mm	25			76			25			76			NIL		
Gas connection			½ in BSP Male			½ in BSP Male			½ in BSP Male			½ BSP Male			¾ BSP Male		
Water connection			¾ BSP F			¾ BSP Male			¾ BSP F			¾ BSP Male			¾ BSP Male		
Min flow rate			450 lit/h 1.65 gpm			450 lit/h 1.65 gpm			575 lit/h 2.1 gpm			575 lit/h 2.1 gpm			720 lit/h 2.6 gpm		
Resistance at min flow rate			3.2 m 10.5 ft			2.9 m 9.5 ft			1.6 m 5.25 ft			1.6 m 5.25 ft			1.7 m 5.5 ft		
Min static head	Pump on return		0.15 m 0.5 ft			0.15 m 0.5 ft			1.0 m 3.28 ft			1.0 m 3.28 ft			1.0 m 3.28 ft		
	Pump on flow		2.0 m 6.5 ft			2.0 m 6.5 ft			3.5 m 11.5 ft.			3.5 m 11.5 ft			3.0 m 9.75 ft		
Max static head			30 m 98 ft			30 m 98 ft			30 m 98 ft			30 m 98 ft			30 m 98 ft		
Weight			13.6 Kg 30 lbs			13.6 Kg 30 lbs			14.3 Kg 31.5 lbs			14.3 Kg 31.5 lbs			19 Kg 42 lbs		
Water capacity			0.182 lit 0.04 gals			0.182 lit 0.04 gals			0.58 lit 1.02 pts			0.58 lit 1.02 pts			– – –		
Flue size		Height	125 mm 4.9 ins			4 in Ø 100 mm Ø			205 mm 8 ins			4 in Ø 100 mm Ø			205 mm 8 ins		
		Width	240 mm 9.4 ins						305 mm 12 ins						305 mm 12 ins		
Combustion & Ventilation Free Area	From Internal – High	cm²	90			90			150			150			210		
		in²	14			14			23			23			31		
	From Internal – Low	cm²	90			180			150			300			210		
		in²	14			28			23			46			31		
	From External – High	cm²	45			45			75			75			105		
		in²	7			7			11.5			11.5			15.5		
	From External – Low	cm²	45			90			75			75			105		
		in²	7			14			11.5			11.5			15.5		
LPG Propane																	
Burner pressure		mbar	24.8	16.4		28.4	16.4		24.9	16.2	10	24.9	16.2	10	24.9	16.2	11.2
		in.w.g.	11.4	6.6		11.4	6.6		10	6.5	4	10	6.5	4	10	6.5	4.5
Restrictor			2.7	1.7		2.7	1.7		3	2.3	1.7	3	2.3	1.7	4.3	4.3	2.5
Part No			43103	43097		43103	43097		37262	43089	43097	37262	43089	43097	32684	32684	23991
Manifold injector			070	070		070	070		070	070	070	070	070	070	070	070	070
Part No			14154/10			14154/10			14154/10			14154/10			14154/10		
Gas consumption		ft³	14.12	11.07		14.12	11.07		23.1	18.14	13.8	23.1	18.14	13.8	31.6	26.23	20.40
		m³	0.4	0.3		0.4	0.3		0.64	0.51	0.38	0.64	0.51	0.38	0.9	0.74	0.58

FUEL COST ESTIMATING

The following table of fuel consumptions is based n the energy consumption of houses as published ' the I.H.V.E. (Ref. B.1817).

ın the table the following assumptions are made:-

1) Equal amounts of daytime heat for full house heating.
2) Temperatures that are controlled and allowed to fall at night.
3) Properly insulated properties.
4) Consumptions related to the S.E. England (adjust for other Regions).
5) Internal temperatues of 21°C (70°F), 18°C (65°F) and 16°C (60°F) (see Table 1.).
6) Domestic hot water allowed on a percentage basis.

Estimated consumptions allow for appliance efficiencies. Allow for standing charges, hire charges, servicing or the repayment of loans when calculating running costs.

To compare fuel cost multiply the fuel consumption by the appropriate fuel cost.

TABLE 25.

FUEL	CALORIFIC VALUE	3 Bed semi 80 m^2	3 Bed det. 122 m^2	3 Bed det. bungalow 117 m^2	3 Bed det. 185 m^2	4 Bed det. 240 m^2	5/6 Bed det. 400 m^2
GAS N. Gas	29.31 kwh/therm	936 therms	1355 therms	1515 therms	2020 therms	2821 therms	5582 therms
L.P.G. (propane)	7.113 kwh/litre	3856 litres	5582 litres	6241 litres	8322 litres	1162 litres	22997 litres
OIL 28 sec	10.18 kwh/litre	2802 litres	4079 litres	4611 litres	6030 litres	8477 litres	13656 litres
35 sec	10.57 kwh/litre	2689 litres	3915 litres	4426 litres	5788 litres	8137 litres	13109 litres
SOLID FUEL Sunbright E	7.495 kwh/kg	6022 kg	8672 kg	9635 kg	12767 kg	17922 kg	29389 kg
Anthracite	8.593 kwh/kg	3908 kg	5631 kg	6303 kg	8404 kg	11766 kg	22860 kg
ELECTRICITY ON Peak	1 kwh	18777 kwh	27444 kwh	31054 kwh	40804 kwh	57777 kwh	93165 kwh
OFF Peak	1 kwh	25638 kwh	37064 kwh	41888 kwh	55250 kwh	77638 kwh	125304 kwh

12. GLOSSARY OF TERMS

Btu/h – Is a measure of heat and stands for British Thermal Units per hour. It is the amount of heat required to raise 1 lb of water 1°F.

Calorific value – The amount of heat released by the combustion of a given quantity of fuel.

Cold feed – The pipe leading from the feed and expansion tank to join the system through which water is introduced into the system. It should not be less than 15 mm. The point at which the cold feed enters is called the neutral point.

Conduction – The transfer of heat from a hot to a cold mass with which it is in contact. (direct means).

Contraflow – Against the normal direction of flow.

Convection – The transfer of heat from a hot to a cold mass by the action of air, gas or liquid passing over it.

Delta (symbol Δ) – Difference – Δt = temperature difference
– Δp = pressure difference.

Expansion – All liquids gasses and solids expand in volume on a rise in temperature.
In a heating system it is necessary to make provision for:
1. Expansion in water volume.
2. Expansion in pipes.

Gas rate – The amount of gas consumed in a measured period of time.

Grille – A non adjustable facing used on the termination of a duct.

Index Circuit – The heating circuit with the greatest resistance.

K factor – A factor given to building materials relative to the resistance they offer to the conducting of heat – surface to surface.

L.P.G. – Liquified Petroleum Gas.

Microbore – Systems in which connections to radiators are made in 6 mm, 8 mm or 10 mm tube usually from a central manifold.

Open Vent – Also called the safety vent pipe or expansion pipe. A pipe of not less than 22 mm Ø rising throughout its entire length to vent atmosphere above the water level in the feed and expansion tank. Its purpose is to relieve pressure in the system in the event of thermostat failure and to accommodate changes in water level due to the operation of the pump.

Neutral point – Point at which cold feed is connected to the system. Called the neutral point since the pressure is always the static head pressure and is not influenced by the operation of the pump.

Plenum – The take off from a warm air unit to which the distribution ducts are connected.

Pump head – The pressure imposed on a system by the operation of the circulating pump. The ability of a pump to overcome a resistance as to support a column of water.

Radiation – The heat transferred from one body to another by wave motion.

Small bore – A system of circulation using 15 mm, 22 mm and 28 mm pipes.

Static head – The pressure imposed on a system by the height of the feed and expansion tank above any part of it.

Thermocouple – A heat sensitive probe made of dissimilar metals which, when heated create an electrical current (measured in millivolts) due to the Δt between the hot and cold junctions.

'U' values – The amount of heat per hour passing through a measured area of a given material of given thickness per °C or °F.

Venturi – A restriction in a pipe which creates a pressure differential.

13 CONVERSION TABLES

13. CONVERSION FACTORS AND USEFUL COMPARISONS

MULTIPLICATION FACTORS FOR UNIT CONVERSION

Imperial to SI		SI to Imperial	
LENGTH			
Inch to millimetre (mm)	25.4	Millimetre to inch (in)	0.039
foot to metre (m)	0.305	metre to foot (ft)	3.281
mile to kilometre (km)	1.609	kilometre to mile	0.621
AREA			
sq. inch to sq. centimetre (cm^2)	0.093	sq. metre to sq. foot (ft^2)	10.764
VOLUME			
cubic foot to cubic metre (m^3)	0.028	cubic metre to cubic foot (ft^3)	35.31
cubic foot to litre (l) or cubic decimetre* (dm^3)	28.32	litre or cubic decimetre to cubic foot (ft^3)	0.35
pint to litre (l)	0.586	litre to pint	1.76
gallon to litre (l)	4.546	litre to gallon	0.22
MASS			
ounce to gramme (g)	28.35	gramme to ounce (oz)	0.035
pound to kilogramme (kg)	0.454	kilogramme to pound (lb)	2.205
ton (U.K.) to tonne (t)	1.016	tonne to ton (U.K.)	0.984
HEAT			
Btu to kilojoule (kJ)	1.055	kilojoule to Btu	0.948
therm to megajoule (MJ)	105.5	megajoule to therm	0.00948
HEAT FLOW (Input and Output)			
Btu/hour to watt (W)	0.293	watt to Btu/hour (Btu/h)	3.412
1,000 Btu/hour to kilowatt (kW)	0.293	kilowatt to 1,000 Btu/hour	3.412
1,000 Btu/hour to megajoule/hour (MJ/h)	1.055	megajoule/hour to 1,000 Btu/hour (Btu/h)	0.948
FLOW RATE			
cubic foot/hour to cubic metre/hour (m^3/h) (gas)	0.028	cubic metre/hour to cubic foot/hour (ft^3/h) (gas)	35.31
cubic foot/hour to litre/hour (l/h)	28.32	litre/hour to cubic foot/hour	0.035
cubic foot/hour to millilitre/second (ml/s)	7.866	millilitre/second to cubic foot/hour (ft^3/h)	0.127
gallon/hour to litre/hour (l/h)	4.546	litre/hour to gallon/hour	0.22
gallon/hour to millilitre/second (ml/s)	1.263	millilitre/second to gallon/hour (Gal/h)	0.792
gallon/minute to cubic metre/hour (m^3/g)	0.273	cubic metre/hour to gallon/minute (gal/m)	3.67
gallon/minute to litre/second	0.076	litre/second to gallon/minute	13.198
PRESSURE			
inch w.g. to millibar (mbar)	2.5	millibar to inch w.g. (in.w.g.)	0.4
pound force/sq. inch to bar	0.069	bar to pound force/sq. inch	14.5
CALORIFIC VALUE			
Btu/cubic foot to megajoule/cubic metre (MJ/m^3)	0.038	megajoule/cubic metre to btu/cubic foot (Btu/ft^3)	26.34

Cubic decimetres will be used in the gas industry to express gas volumes and the space occupied by appliances, etc.

USEFUL COMPARISONS

1 gallon water = 10 lbs = 0.16 ft^3

1 ft^3 water = 6.23 gallons = 62.35 lbs.

1 Btu will raise 1 lb water 1°F in 1 hour.

1 K cal will raise 1 Kg (1 litre) water 1°C in 1 hour.

1 m^3 water = 1000 Kg = 1000 litres.

°C to °F = 1.8 C + 32

°F to °C = $\frac{5}{9}$ (°F − 32)

1 bar = 10 m of head = 15 psi = 34 ft. of head.

1 psi = 2.31 ft of water = 703.03 mm of water.