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(56) Documents Cited:
GB 1471079 A **GB 0823961 A**
GB 0788683 A **WO 1983/001678 A1**
JP 2011202855 A **US 6370774 B1**
US 20030079868 A1

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(54) Title of the Invention: **Radiator fin**
Abstract Title: **Radiator fin having at least two offset apertures**

(57) A radiator fin 10 comprises first 13 and second 14 apertures that are adapted to receive a conductive element, such as a pipe connector adapted for the delivery of hot water. The first and second apertures are offset from one another such that, in use, the first and second apertures are not vertically aligned. The fin may comprise vertical fluting 19 to improve convection and a raised central section (21, figure 1) on a lower edge 16 to receive a mounting element of a radiator casing 41. A plurality of like fins mounted adjacent one another and spaced by flanges 26 located on side walls 17 and 18 may be used to form a heat exchange coil. Pipe connectors of the coil may be connected to a water heating system to supply hot water to the coil and to return water from the coil. The pipe connectors may include internal rifling or a swirler. The coil may be used in a convective radiator, such as a baseboard heater (i.e. skirting board radiator). Offsetting the first and second apertures improves convection heat transfer of the fin since a pipe connector in one aperture does not deflect air away from the other.

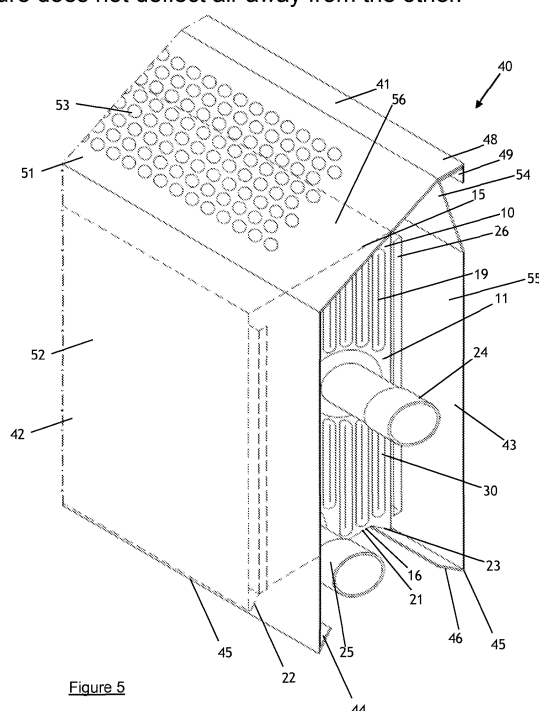
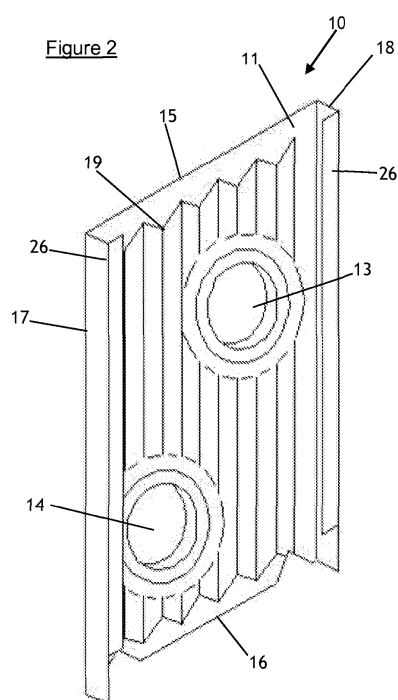


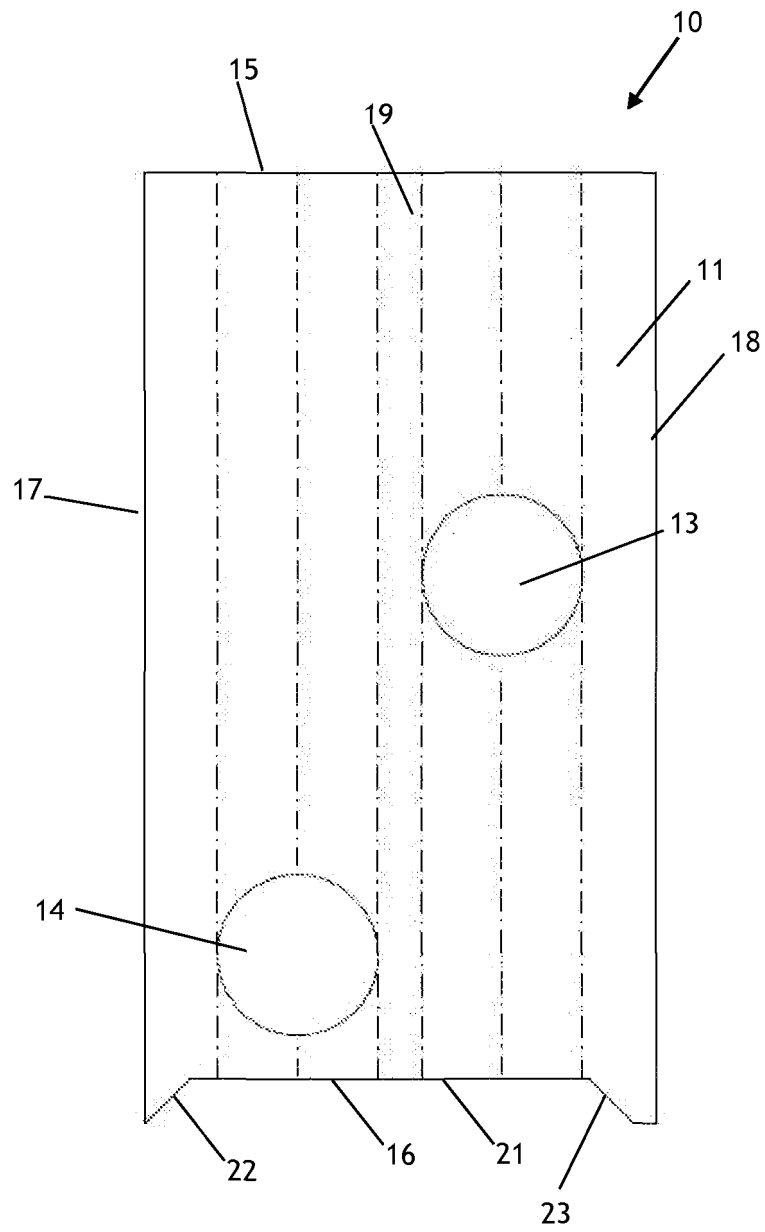
Figure 1

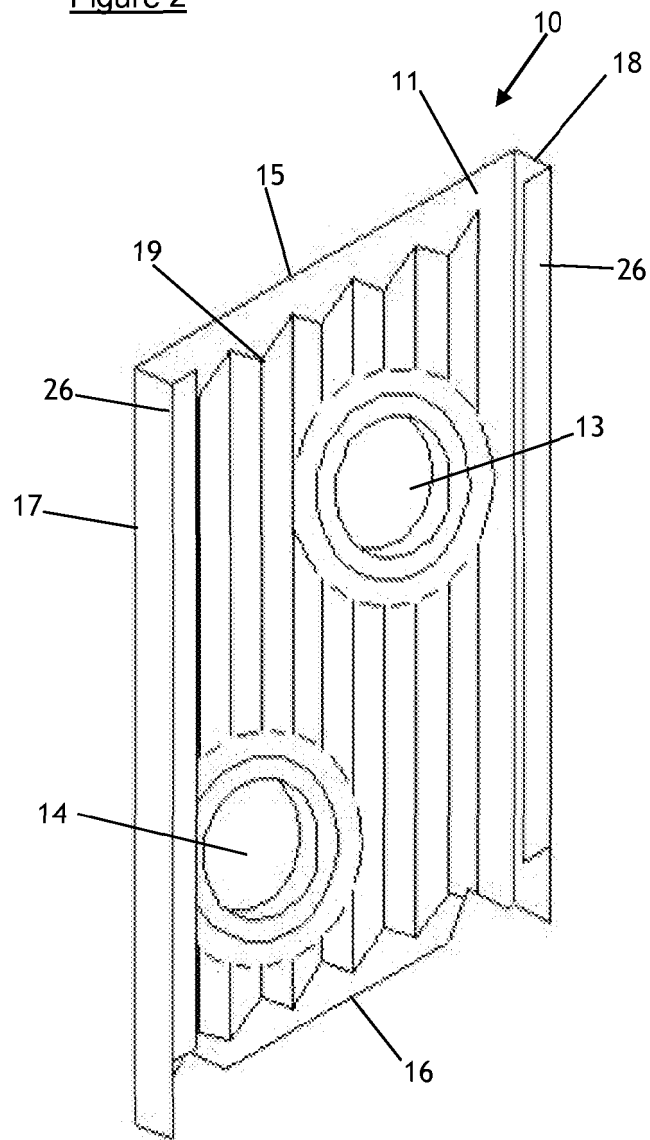
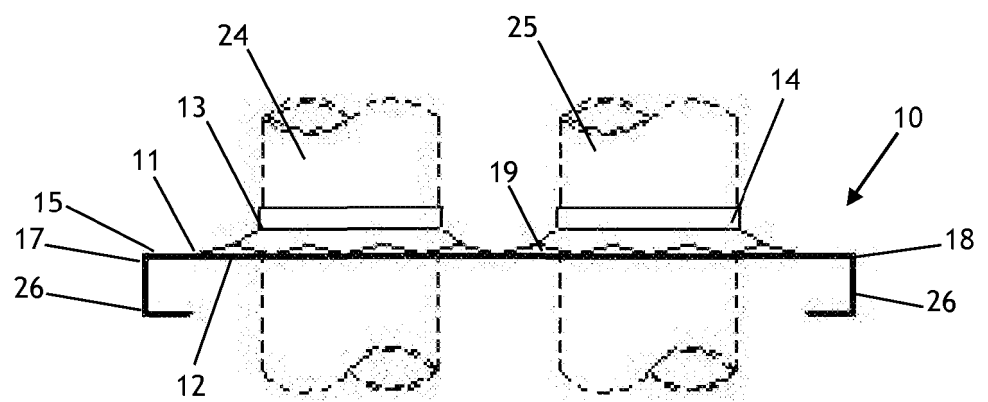
Figure 2Figure 3

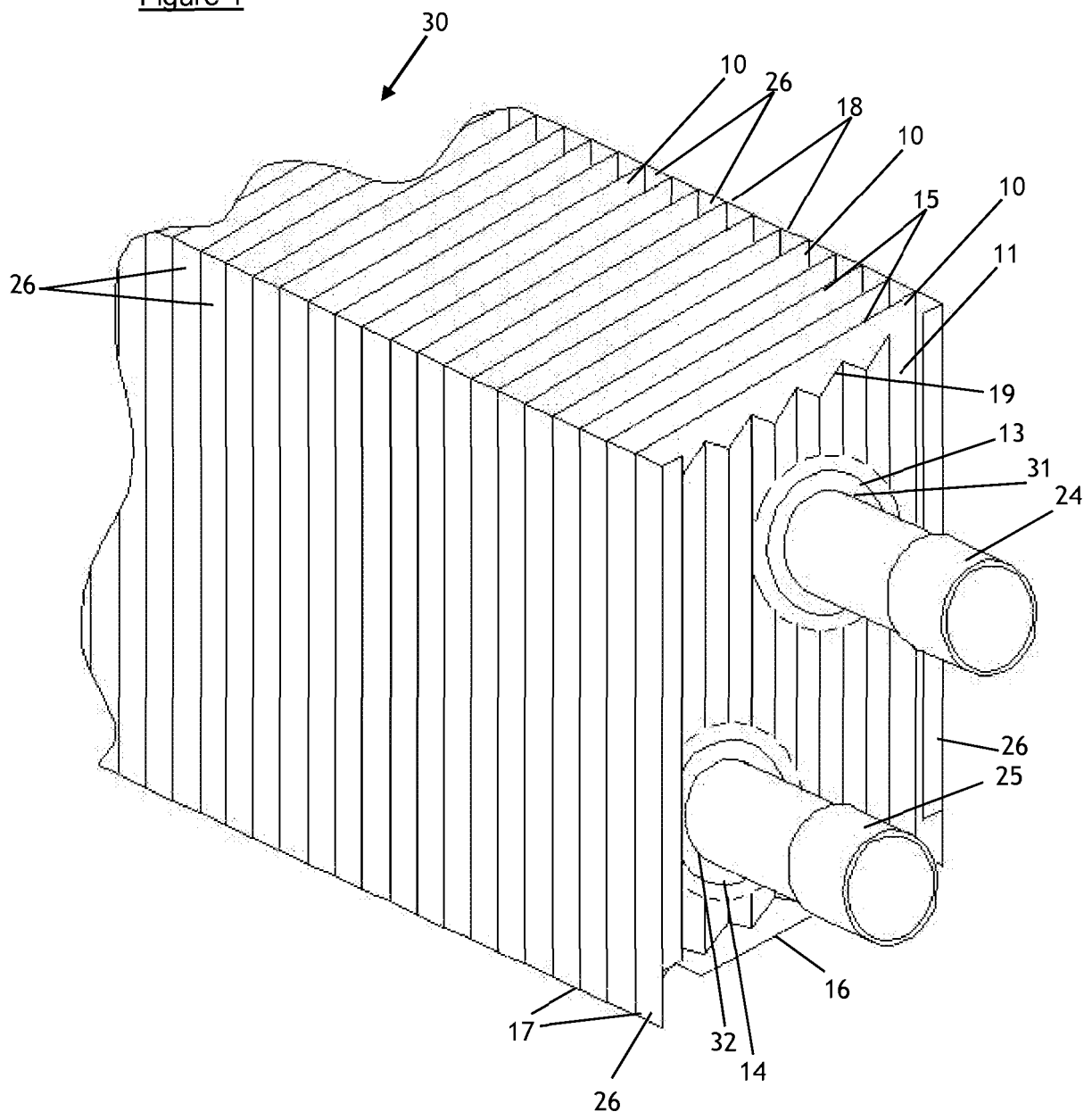
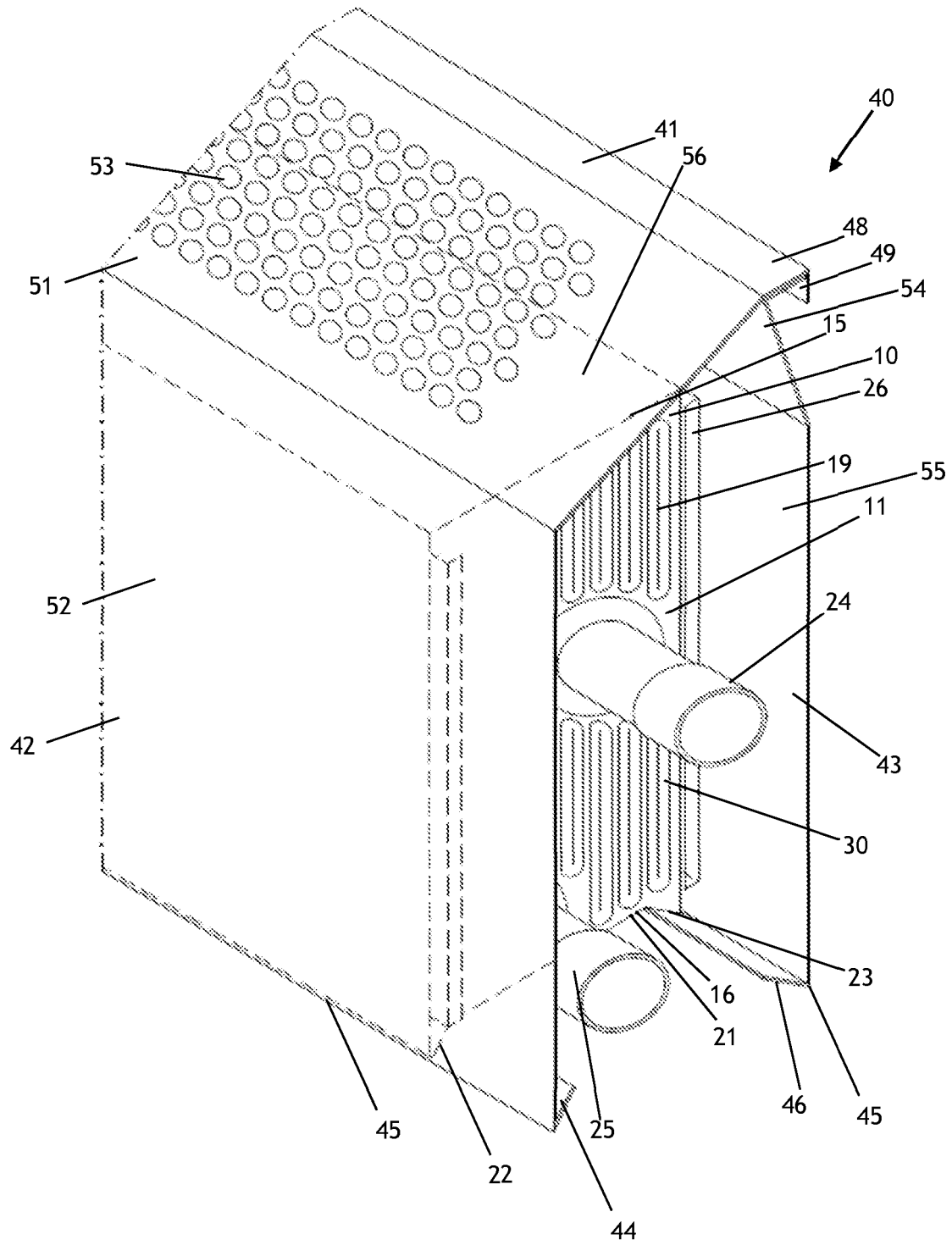
Figure 4

Figure 5



Radiator Fin

This invention relates, in a first aspect thereof, to an improved design of radiator fin. In further aspects thereof, the invention relates to a heat exchange coil formed from a plurality of such fins, and to a radiator incorporating such coils.

5 Fin radiators (sometimes referred to as finned radiators) comprise a heat exchange coil provided with a plurality of fins extending from the heating element and in conductive contact therewith. The purpose of the fins is to increase the surface area of the heat exchange coil and thereby increase the efficiency of heat transfer from the heating element to the surrounding air.

10 Fin radiators for domestic use typically utilise a metal pipe adapted to deliver heater water from a water heating system through the heat exchange coil. The pipe is generally arranged so as to be horizontal as it passes through the heat exchange coil, with the fins arranged vertically so as to channel air upwards through the heat exchange coil and over and around the pipe. The heat exchange coil is generally
15 housed within a decorative casing which can also serve to direct air flow. Fin radiators of this type have found use in perimeter heating applications, and in particular in low level heating installations on, or in place of, skirting boards or baseboards.

The applicant's own United States Patent No. 5,406,937 describes a
20 baseboard fin radiator having two horizontal pipes for the delivery of heated water, the pipes being arranged in vertical alignment with one another. The advantage of having two pipes is that either: both pipes may be used to deliver heated water to the radiator directly from the water heating system, thereby doubling the heat transfer efficiency; or one pipe may be designated a flow pipe to deliver heated water to the
25 radiator directly from the water heating system, with the other pipe designated a return pipe to return water to the water heating system.

A previously unrecognised drawback of the system disclosed in US 5,406,937 arises from the arrangement of the two pipes in vertical alignment. This results in air drawn up into the underside of the heat exchange coil flowing around the lower pipe,
30 but then being diverted past the sides of the upper pipe. That is to say, the lower pipe effectively blocks the air stream from fully contacting the upper pipe. This occurs because the relatively small height of the radiator – necessitated by its installation as a baseboard heater – means that the separation between the upper

and lower pipes is insufficient for the air to flow into the space between the pipes and then around the upper pipe, bearing in mind that the air flow is dictated only by natural convection. As a result of this restricted air flow around the upper pipe, the heat transfer efficiency of the unit is compromised.

5 The present invention seeks to provide an improved radiator fin, heat exchange coil, and fin radiator which overcome the above discussed drawbacks of the known prior art by enabling an enhanced air flow, thereby to optimise heat transfer efficiency.

10 According to a first aspect of the present invention there is provided a radiator fin having front and rear faces, and defined by upper and lower edges and opposed side edges, said fin having first and second apertures, each passing through the front and rear faces and adapted to receive and contact a conductive element for the transfer of heat to the fin, wherein the centre of the first aperture is offset relative to the centre of the second aperture, such that said first and second aperture centres
15 are not vertically aligned when the fin is installed.

20 The construction of the fin with offset apertures serves to enhance heat transfer by ensuring that both conductive elements are fully presented to a stream of air drawn upward over the fin by natural convection, when the fin is installed. This is distinct from the undesirable arrangement of the prior art where the lower conductive element blocks the air stream from fully contacting the upper conductive element.

25 In order further to optimise the air flow, and hence the heat transfer efficiency, the fin preferably further comprises a plurality of flutes on at least one of the front and rear faces, said flutes being arranged so as to be vertically oriented when the fin is installed. The vertical fluting serves to increase the surface area of the fin, and also to direct air flow to the conductive elements. The provision of fluting on fins to
30 increase surface area is known from the prior art, but such fluting tends to horizontal across the fin, which can be counter-productive for efficient air flow.

30 Whilst the fin may be of any shape or configuration, it is generally preferred that it be rectangular, with the upper and lower edges being substantially parallel to one another, and the opposed side edges being substantially parallel to one another and substantially perpendicular to the upper and lower edges. In rectangular embodiments of the fin, the flutes are preferably arranged substantially parallel to the opposed side edges.

The lower edge of the fin is preferably formed with a raised central section so as to present an oblique mounting surface adjacent the junction of the lower edge with each side edge, each said mounting surface being adapted to receive a mounting element of a radiator casing. This provides a simple but effective
5 mechanism for removable attaching a radiator casing to the fin.

The conductive elements which the fin apertures are adapted to receive and contact may be of any configuration and may include for example electric heating elements. It is generally preferred however that each said conductive element for transfer of heat to the fin is a pipe connector adapted to enable delivery of heated
10 water, for example from a domestic heating system.

The radiator fin according to the first aspect of the present invention may desirably be combined in an assembly of like fins to form a heat exchange coil suitable for use in a radiator.

Therefore, according to a second aspect of the present invention there is
15 provided a heat exchange coil comprising a plurality of like radiator fins mounted adjacent one another, each said radiator fin having:

front and rear faces, being defined by upper and lower edges and opposed side edges, and having first and second apertures, each passing through the front and rear faces and adapted to receive and contact a
20 conductive element for the transfer of heat to the fin, wherein the centre of the first aperture is offset relative to the centre of the second aperture, such that said first and second aperture centres are not vertically aligned when the fin is installed,

and wherein the first aperture of each fin is aligned with the first aperture of
25 each adjacent fin, and the second aperture of each fin is aligned with the second aperture of each adjacent fin, thereby to form first and second conduits extending through the heat exchange coil, each adapted to receive and contact a said conductive element for the transfer of heat to the fins.

The heat exchange coil according to the second aspect of the present
30 invention may comprise a plurality of like radiator fins according to any embodiment of the first aspect of the present invention as hereinbefore described, mounted adjacent one another.

As noted above with reference to the first aspect of the invention, the conductive element for transfer of heat to the fins is preferably a pipe connector adapted to enable delivery of heated water. In such preferred embodiments, the heat exchange coil further comprises a first said pipe connector mounted in the first conduit, and a second said pipe connector mounted in the second conduit, each said pipe connector being adapted for connection to a water heating system thereby to deliver heated water to the heat exchange coil.

Preferably, one of said first and second pipe connectors is adapted for connection to a flow pipe to deliver heated water from the water heating system to the heat exchange coil, and the other of said first and second pipe connectors is adapted for connection to a return pipe to return water from the heat exchange coil to the water heating system. Alternatively, both first and second pipe connectors may be arranged for delivery of heated water to the heat exchange coil directly from the water heating system.

To further improve the heat transfer efficiency, at least one of said first and second pipe connectors may be provided with internal rifling. Alternatively, or additionally, at least one of said first and second pipe connectors may be provided with at least one internal swirler. These optional components serve to promote mixing, and thus temperature equalisation, within the water stream.

In embodiments of heat exchange coil which comprise a plurality of like radiator fins having oblique mounting surfaces as hereinbefore described, the oblique mounting surfaces of each fin are preferably aligned with the oblique mounting surfaces of each adjacent fin, thereby to form elongated oblique mounting surfaces extending along the underside of the heat exchange coil.

The heat exchange coil according to the second aspect of the present invention may desirably be combined with a radiator casing to form a fin radiator suitable for use as a baseboard heater.

Therefore, according to a third aspect of the present invention there is provided a radiator comprising:

- a heat exchange coil formed from a plurality of like radiator fins mounted adjacent one another, each said radiator fin having:

front and rear faces, being defined by upper and lower edges and opposed side edges, and having first and second apertures, each

passing through the front and rear faces and adapted to receive and contact a conductive element for the transfer of heat to the fin, wherein the centre of the first aperture is offset relative to the centre of the second aperture, such that said first and second aperture centres are not vertically aligned when the fin is installed,

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and wherein the first aperture of each fin is aligned with the first aperture of each adjacent fin, and the second aperture of each fin is aligned with the second aperture of each adjacent fin, thereby to form first and second conduits extending through the heat exchange coil, each adapted to receive and contact a said conductive element for the transfer of heat to the fins; and
- a radiator casing adapted to be mounted on said heat exchange coil.

10

The radiator according to the third aspect of the present invention may comprise a heat exchange coil formed from a plurality of like radiator fins according to any embodiment of the first aspect of the present invention as hereinbefore described, mounted adjacent one another.

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Independently of the above, the radiator according to the third aspect of the present invention may comprise a heat exchange coil according to any embodiment of the second aspect of the present invention as hereinbefore described.

The radiator casing preferably comprises a back plate adapted to be secured to a wall, and further adapted to engage with the heat exchange coil, and a front panel adapted to engage with the back plate and with the heat exchange coil.

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In preferred embodiments of radiator which comprise a heat exchange coil having oblique mounting surfaces as hereinbefore described, each of the back plate and the front panel preferably further comprises a mounting element adapted to engage with a respective oblique mounting surface.

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Each of the front panel and the back plate preferably comprises an upper portion extending beyond the upper edge of the heat exchange coil, defined by the upper edges of the plurality of fins, thereby to define an air space above the heat exchange coil. The upper portion of the front panel preferably comprises a grille section located adjacent said air space, thereby to enable heated air to flow from said air space into a room in which the radiator is mounted.

30

The upper portion of the front panel may preferably be angled relative to the upper edge of the heat exchange coil, towards the back plate. Similarly, the upper

portion of the back plate may preferably be angled relative to the upper edge of the heat exchange coil, towards the front panel. In such embodiments, the upper portion of the front panel is preferably adapted to engage with the upper portion of the back plate. This arrangement give rise to a chimney effect caused by the angled upper
5 portion of the back plate directing warmed air in the air space out through the grille in the angled upper portion of the front panel. The angled upper portion of the back plate also serves to project the warmed air forwards and away from a wall on which the radiator is mounted. This helps to alleviate dust marks on walls and further to increase heating efficiency by projecting heat into the room rather than into the wall.

10 The radiator according to the third aspect of the present invention is preferably adapted to be installed on, or in place of, a skirting board or baseboard, and most preferably is adapted to be installed as a perimeter heating system.

In order that the present invention may be more clearly understood, a preferred embodiment thereof will now be described in detail, though only by way of
15 example, with reference to the accompanying drawings, in which:

Figure 1 shows a front view of a radiator fin according to a first aspect of the present invention;

Figure 2 shows a perspective view of the radiator fin of Figure 1;

Figure 3 shows a top view of the radiator fin of Figures 1 and 2;

20 Figure 4 shows a perspective view of a heat exchange coil according to a second aspect of the present invention; and

Figure 5 shows a perspective view of a radiator according to a third aspect of the present invention.

Referring first to Figures 1 to 3, there is shown a preferred embodiment of
25 radiator fin, generally indicated 10, according to a first aspect of the present invention. The fin has a front face 11 and a rear face 12 (shown in Figure 3) with a first upper aperture 13 and a second lower aperture 14 passing therethrough. The fin 10 has a generally rectangular shape and is defined by opposed parallel upper and lower edges 15, 16 and opposed parallel first and second side edges 17, 18.

30 As can best be seen from Figure 2, the front face 11 of the fin 10 is provided with fluting 19 taking the form of a number of vertical ridges, grooves or channels in or on the face 11 of the fin 10. These act to increase the surface area and channel air flow.

As can best be seen from Figure 1, the centres of the upper and lower apertures 13, 14 are horizontally offset so that the apertures are not in vertical alignment. In use, when the fin is installed in a heat exchange coil 30 or radiator 40, as will be described in more detail below with reference to Figures 4 and 5, the apertures 13, 14 are each provided with a pipe connector 24, 25 adapted for the delivery of heated water from a heating system, as can be seen in Figure 3. The offset arrangement of the apertures 13, 14, and hence the pipe connectors 24, 25 mounted therein, ensures a more efficient heat transfer by presenting both pipe connectors 24, 25 to an air stream rising from the lower edge 16 of the fin over the face 11 towards the upper edge 15, as a result of natural convection. The vertical fluting 19 further assists in directing the air stream to the pipe connectors 24, 25 in the apertures 13, 14.

As can best be seen in Figure 1, the lower edge 16 of the fin 10 is formed with a raised central section 21 so as to present a first oblique mounting surface 22 adjacent the junction of the lower edge 16 with the first side edge 17, and a second oblique mounting surface 23 adjacent the junction of the lower edge 16 with the second side edge 18. In use, when the fin 10 is installed in a radiator 40, as will be described in more detail below with reference to Figure 5, the oblique mounting surfaces 22, 23 engage with mounting elements of a radiator casing.

As can be seen from Figures 2 and 3, the fin 10 may be provided with protruding flanges 26 adjacent the side edges 17, 18 in order to provide constant spacing between adjacent like fins 10 when assembled together in a heat exchange coil 30. The flange 26 may either protrude over the front face 11 as shown in Figure 2, or the rear face 12 as shown in Figure 3.

The dimensions for the preferred embodiment of radiator fin 10 shown in Figures 1 to 3 are: a height of substantially 130mm, and a width of substantially 70mm. The horizontal separation between the centres of the apertures 13, 14 is substantially 28mm, whilst the vertical separation is substantially 52mm. The diameter of the apertures is substantially 22mm. The centre of the upper aperture 13 is substantially 21mm from the second side edge 18, and substantially 55mm from the upper edge 15; whilst the centre of the lower aperture 14 is substantially 21mm from the first side edge 17, and substantially 23mm from the bottom of the lower edge 16 (that is, that part of the lower edge 16 which does not form the raised central

section 21). The raised central section 21 has a vertical separation of substantially 6mm over the bottom of the lower edge 16, and the oblique mounting surfaces 22, 23 each present an angle of substantially 45°, relative to the raised section 21.

Referring now to Figure 4, a plurality of like fins 10 are mounted closely adjacent one another to form a preferred embodiment of heat exchange coil, generally indicated 30, according to the second aspect of the present invention. As can be seen, the flanges 26 of each fin provide a surface an adjacent fin to abut against, thus providing constant spacing throughout the array of fins 10 constituting the heat exchange coil 30. The fins 20 are aligned so that the apertures 13, 14 in each fin line up with the apertures 13, 14 in adjacent fins to form first and second conduits 31, 32 extending through the heat exchange coil 30. First and second pipe connectors 24, 25 are then mounted in said conduits 31, 32 such that there is a heat conductive connection between the pipe connectors 24, 25 and each fin 10.

The alignment of the fins 10 also enables the formation of extended oblique mounting surfaces (not visible in Figure 4) by aligning the first oblique mounting surface 22 of each fin 10 with the first oblique mounting surface 22 on adjacent fins 10, and aligning the second oblique mounting surface 23 of each fin 10 with the second oblique mounting surface 23 on adjacent fins 10.

During use, heated water flows through the pipe connectors 24, 25 and heat is transferred to the fins 10. Warmed air rises up through the heat exchange coil 30 from the lower edges 16 towards the upper edges 15 of each fin 10, driven by natural convection. As it rises, the fluting 19 directs the air flow onto and around each pipe connector 24, 25 to maximise heat transfer efficiency.

Referring now to Figure 5, there is shown a preferred embodiment of radiator, generally 40, according to a third aspect of the present invention. The radiator 40 incorporates the heat exchange coil 30 as described above with reference to Figure 4, together with a radiator casing 41 comprising a front panel 42 and a back plate 43. The front panel 42 is provided with a mounting element 44 along its lower edge 45, which mounting element 44 is adapted to clip onto the extended first oblique mounting surface 22 of the heat exchange coil 30. Similarly, the back plate 43 is provided with a mounting element 46 along its lower edge 47, which mounting element 46 is adapted to clip onto the extended second oblique mounting surface 23 of the heat exchange coil 30.

The upper edge 48 of the front panel 42 and the upper edge 49 of the back plate 43 are shaped so as to have a complementary profile to one another such the upper edge 48 of the front panel 42 can clip over the upper edge 49 of the back plate 43 to retain the former in place. In use, the back plate 43 will be secured to a wall
5 using conventional wall fixings (not shown).

As can also be seen from Figure 5, the front panel 42 has an upper portion 51 which extends upwardly beyond the upper edges 15 of the fins 10 of the heat exchange coil 30. The upper portion 51 is also angled relative to the main part 52 of the front panel 42 and has a grille 53 therein to permit the flow of warmed air from the
10 heat exchange coil 30 to the room in which the radiator 40 is located. The back plate 42 also has an upper portion 54 which extends upwardly beyond the upper edges 15 of the fins 10 of the heat exchange coil 30, and is also slightly angled relative to the main part 55 of the back plate 43. The construction of the radiator casing 41 in this way defines an air space 56 within the casing 41, above the heat exchange coil 30, in
15 which warmed air can accumulate. The angled upper portion 54 of the back plate 43 causes a chimney effect which directs the warmed air out through the grille 53 and enhances the flow of air through the radiator 40 by natural convection.

Claims

1. A radiator fin having front and rear faces, and defined by upper and lower edges and opposed side edges, said fin having first and second apertures, each passing through the front and rear faces and adapted to receive and contact a
5 conductive element for the transfer of heat to the fin, wherein the centre of the first aperture is offset relative to the centre of the second aperture, such that said first and second aperture centres are not vertically aligned when the fin is installed.

2. A radiator fin as claimed in claim 1, further comprising a plurality of flutes on at least one of the front and rear faces, said flutes being arranged so as to be vertically
10 oriented when the fin is installed.

3. A radiator fin as claimed in claim 1 or claim 2, wherein said fin is generally rectangular, with the upper and lower edges being substantially parallel to one another, and the opposed side edges being substantially parallel to one another and substantially perpendicular to the upper and lower edges.

4. A radiator fin as claimed in claim 3 when dependent upon claim 2, wherein the flutes are arranged substantially parallel to the opposed side edges.

5. A radiator fin as claimed in any of the preceding claims, wherein the lower edge is formed with a raised central section so as to present an oblique mounting surface adjacent the junction of the lower edge with each side edge, each said
20 mounting surface being adapted to receive a mounting element of a radiator casing.

6. A radiator fin as claimed in any of the preceding claims, wherein each said conductive element for transfer of heat to the fin is a pipe connector adapted for the delivery of heated water.

7. A radiator fin as claimed in claim 1 and substantially as hereinbefore described
25 with reference to the accompanying drawings.

8. A heat exchange coil comprising a plurality of like radiator fins mounted adjacent one another, each said radiator fin having:

front and rear faces, being defined by upper and lower edges and opposed side edges, and having first and second apertures, each passing
30 through the front and rear faces and adapted to receive and contact a conductive element for the transfer of heat to the fin, wherein the centre of the first aperture is offset relative to the centre of the second aperture, such that

said first and second aperture centres are not vertically aligned when the fin is installed,

and wherein the first aperture of each fin is aligned with the first aperture of each adjacent fin, and the second aperture of each fin is aligned with the second aperture of each adjacent fin, thereby to form first and second conduits extending through the heat exchange coil, each adapted to receive and contact a said conductive element for the transfer of heat to the fins.

9. A heat exchange coil as claimed in claim 8, comprising a plurality of like radiator fins as claimed in any of claims 1 to 7, mounted adjacent one another.

10. A heat exchange coil as claimed in claim 9, wherein each said conductive element for transfer of heat to the fins is a pipe connector adapted for the delivery heated water, and wherein the heat exchange coil further comprises a first said pipe connector mounted in the first conduit, and a second said pipe connector mounted in the second conduit, each said pipe connector being adapted for the delivery of heated water to the heat exchange coil.

11. A heat exchange coil as claimed in claim 10, wherein one of said first and second pipe connectors is adapted for connection to a flow pipe for delivery of heated water from the water heating system to the heat exchange coil, and the other of said first and second pipe connectors is adapted for connection to a return pipe to return water from the heat exchange coil to the water heating system.

12. A heat exchange coil as claimed in claim 10, wherein each of said first and second pipe connectors is adapted for connection to a flow pipe for delivery of heated water directly from the water heating system to the heat exchange coil.

13. A heat exchange coil as claimed in any of claims 10 to 12, wherein at least one of said first and second pipe connectors is provided with internal rifling.

14. A heat exchange coil as claimed in any of claims 10 to 13, wherein at least one of said first and second pipe connectors is provided with at least one internal swirler.

15. A heat exchange coil as claimed in any of claims 8 to 14, comprising a plurality of like radiator fins as claimed in 5, wherein the oblique mounting surfaces of each fin are aligned with the oblique mounting surfaces of each adjacent fin, thereby to form elongated oblique mounting surfaces extending along the underside of the heat exchange coil.

16. A heat exchange coil as claimed in claim 8 and substantially as hereinbefore described with reference to the accompanying drawings.

17. A radiator comprising:

- a heat exchange coil formed from a plurality of like radiator fins mounted adjacent one another, each said radiator fin having:

front and rear faces, being defined by upper and lower edges and opposed side edges, and having first and second apertures, each passing through the front and rear faces and adapted to receive and contact a conductive element for the transfer of heat to the fin, wherein the centre of the first aperture is offset relative to the centre of the second aperture, such that said first and second aperture centres are not vertically aligned when the fin is installed,

and wherein the first aperture of each fin is aligned with the first aperture of each adjacent fin, and the second aperture of each fin is aligned with the second aperture of each adjacent fin, thereby to form first and second conduits extending through the heat exchange coil, each adapted to receive and contact a said conductive element for the transfer of heat to the fins; and

- a radiator casing adapted to be mounted on said heat exchange coil.

18. A radiator as claimed in claim 17 comprising a heat exchange coil formed from a plurality of like radiator fins as claimed in any of claims 1 to 7, mounted adjacent one another.

19. A radiator as claimed in claim 17 or claim 18, comprising a heat exchange coil as claimed in any of claims 8 to 16.

20. A radiator as claimed in any of claims 17 to 19, wherein the radiator casing comprises a back plate adapted to be secured to wall, and further adapted to engage with the heat exchange coil, and a front panel adapted to engage with the back plate and with the heat exchange coil.

21. A radiator as claimed in claim 20, comprising a heat exchange coil as claimed in claim 15, wherein each of the back plate and the front panel further comprises a mounting element adapted to engage with a respective oblique mounting surface.

22. A radiator as claimed in claim 20 or claim 21, wherein each of the front panel and the back plate comprises an upper portion extending beyond the upper edge of

the heat exchange coil, defined by the upper edges of the plurality of fins, thereby to define an air space above the heat exchange coil.

23. A radiator as claimed in claim 22, wherein said upper portion of the front panel comprises a grille section located adjacent said air space, thereby to enable heated
5 air to flow from said air space into a room in which the radiator is mounted.

24. A radiator as claimed in claim 22 or claim 23, wherein the upper portion of the front panel is angled relative to the upper edge of the heat exchange coil.

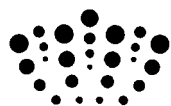
25. A radiator as claimed in any of claims 22 to 24, wherein the upper portion of the back plate is angled relative to the upper edge of the heat exchange coil.

10 26. A radiator as claimed in any of claims 22 to 25, wherein the upper portion of the front panel is adapted to engage with the upper portion of the back plate.

27. A radiator as claimed in any of claims 17 to 26, adapted to be installed on a skirting board or baseboard.

15 28. A radiator as claimed in any of claims 17 to 27, adapted to be installed as a perimeter heating system.

29. A radiator as claimed in claim 17, and substantially as hereinbefore described with reference to the accompanying drawings.



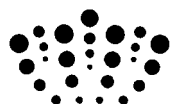
Application No: GB1120739.6
Claims searched: 1-6, 8-15 and 17-28

Examiner: Colin Whitbread
Date of search: 22 February 2012

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X,Y	X:1, 3, 6, 8-10, 12-14, 17-19 and 27-28 Y:2 and 4	GB 823961 A (CRANE CO) See especially figures 1-4, noting fins 9 that receive and contact heat exchange tubes 11 and 12 (i.e. conductive elements) in apertures that are offset from one another.
X,Y	X:1, 6, 8-14, 17-19 and 28 Y:2 and 4	GB 788683 A (IDEAL BOILERS & RADIATORS LTD) See especially figures 2, 7 and 11-12, noting sections 1 (i.e. radiator fins) that receive and contact inlet 18 and outlet 19 ducts (i.e. conductive elements) in bores 2 and 3 (i.e. apertures) that are offset from one another.
X,Y	X:1-4 and 8-9 Y:2 and 4	GB 1471079 A (HITACHI LTD) See especially figures 1 and 6, noting fins 7 that receive and contact heat conductive tubes 3 (i.e. conductive elements) in circular holes (i.e. apertures) that are offset from one another.
X	1, 3 and 8-9	JP 2011202855 A (PANASONIC CORP) 13.10.11 (See especially WPI Abstract Accession No. 2011-M73949 [68] and figures 1a-b and 5-7, noting heat exchanger plate fin 3 (i.e. radiator fin) that receives and contacts coolant tube 2 (i.e. conductive element) in holes 4 (i.e. apertures) that are offset from one another).
X	1, 3 and 8-9	US 6370774 B1 (SHEU) See especially figure 3, noting fins 21 that receive and contact rivets 23 (i.e. conductive elements) in holes 211 (i.e. apertures) that are offset from one another, wherein the rivets 23 are suitable for 'the transfer of heat to the fin'.
X	1, 3 and 8-9	US 2003/079868 A1 (BOUZIDA ET AL) See especially figure 2 and paragraph 0031, noting fins 2 that receive and contact tubes 1 (i.e. conductive elements) in holes 4 (i.e. apertures) that are offset from one another.
Y	2 and 4	WO 83/01678 A1 (HISELIUS) See especially figures 2 and 4, noting radiator fin adjacent convector discs 2a and 2b (i.e. radiator fins), the discs having corrugations 21 and 22 (i.e. vertical fluting) and side portions 23 and 24 (i.e. flanged edges).



Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

Worldwide search of patent documents classified in the following areas of the IPC

F24D; F28F

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
F24D	0019/04	01/01/2006
F28F	0001/24	01/01/2006
F28F	0001/30	01/01/2006