

WATER HEATER/COOLER

This invention relates to a water heater/cooler, and relates particularly, though not exclusively, to a solar boosted heat pump water heater and method of
5 manufacture thereof.

In Australian Patent Nos. 582,291 and 603,510 there is described a solar boosted heat pump water heater where the water tank of the water heater is encircled along a substantial part of its length by a tube mechanically fixed by
10 welded saddles and fused solder. The tube carries a refrigerant fluid to heat the surface of the water tank to thereby heat the water contained within the water tank. The tube about the water tank is held under tension during bonding to reduce the likelihood of the heat-conductive bonding material breaking during expansion and contraction of the tube and tank during use. A
15 tin/lead/flux-acid solder paste is applied to the tube during its attachment to the water tank and the water tank is subsequently heated in an oven to melt the solder to complete the heat transfer bond between the tube and the water tank. The prewinding processes involving the grinding of the outer cylindrical surface to remove scale; a priming wash and a final wash with a copper
20 sulphate solution to aid tinning and maintaining the tube under tension slows the manufacturing cycle and the post heating of the complete water tank to melt the solder results in further production time losses. The gas required to heat the tank mass to solder fusion temperature and the resultant cooling time adds considerable expense and time to the manufacturing process. Further time
25 delays and costs occur as the tank must be washed down to remove residual soldering acid and treated with a bitumous anti-corrosion treatment. In addition the manufacturing process has the tube deforming/tensioning device about 600 mm from the tank when the tube is being applied which allows the tube to be randomly twisted as it leaves the rollers and may lead to loss of
30 contact between the water tank and the tube.

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It is therefore an object of the present invention to provide a water heater that improves on the concepts described in Australian Patent Nos. 582,291 and 603,510.

- 5 A further object of the present invention is to provide a water heater that is simpler to construct than that described in Australian Patent Nos. 582,291 and 603,510.

With these objects in view the present invention provides in one aspect a water
10 heater/cooler including a water tank having a wall formed from material having heat transfer properties, a tube adapted to carry, in use, a refrigerant fluid, is applied externally about said tank wall, a heat-conductive material is coextensive with the length of said tube to allow said tube to be in said in heat-conductive contact with said tank wall and at least one layer of material tightly
15 wrapped about said tank wall and said tube.

Preferably said tube is compressed against said tank wall and said compression is maintained by said at least one layer of material. Preferably said tube is of circular cross-section and during compression against said tank wall is
20 deformed into a D-shape in cross-section. Alternatively said tube is of circular cross-section and during compression against said tank wall is deformed into a bi-lobular profile. In a preferred embodiment said at least one layer of material includes at least one layer of stretch wrap film and at least one layer of a heat reflective material thereover. Preferably at least a further layer of stretch wrap
25 film is applied over said at least one layer of heat reflective material.

Preferably said stretch wrap film is polythene based. In a further embodiment said heat conductive material is a non-setting heat conductive paste. In yet a further embodiment said at least one layer of stretch wrap film surrounds said
30 heat conductive material in an airtight manner. Preferably said tube extends over at least 85% of the length of said tank.

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In a further aspect of the invention there is provided a method of forming a water heater/cooler, said method including the steps of winding a tube around the wall of a water tank under which a heat-conductive material coextensive with the length of said tube has been applied to either said tube or said wall of
5 said water tank to allow said tube to be in heat-conductive contact with said tank wall and tightly wrapping at least one layer of material about said tank wall and said tube.

Preferably beads of heat-conductive material are applied to said tank wall on
10 either side of said tube and said beads are formed into a join fillet to, in use, increase the heat transfer of said tube with said tank wall.

In order that the invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawing, in which: -

- 15 Fig. 1 is a perspective view of water heater made in accordance with a preferred embodiment of the invention;
Fig. 2 is a cross-sectional view of the water heater shown by the area circled "2" in Fig. 1;
Fig. 3 is an enlarged view shown by the area circled "3" in Fig. 2;
20 Fig. 4 is a sequence of steps to apply the tube to the water tank to make the water heater shown in Fig. 1; and
Fig. 5 is a variation of the profile shown in Fig. 3 without the wrappings.

In the drawings there is shown a water heater 10 including a water tank 12 having
25 a bottom wall 14, typically concave or convex, a convex top wall 16 and a cylindrical sidewall 18. Water tank 12 can be formed of any suitable thermal conductive or heat transfer material preferably metallic or alloy based. In the preferred embodiment the water tank is formed from glass lined steel, stainless steel, copper or other suitable material. A cold water inlet (not shown) will be
30 installed adjacent bottom wall 14 and a hot water outlet (not shown) will be installed adjacent the top wall 16. The water tank 12 is held in a cylindrical casing 20 sealed by lid 22. Insulating foam (not shown) will fill the gaps between

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water tank 12 and cylindrical casing 20 and lid 22. Tube 24 is wrapped about cylindrical sidewall 18 and has an inlet 26 and outlet 28. Tube 24 is also formed of any suitable thermal conductive or heat transfer material preferably metallic or alloy based. In the preferred embodiment tube 24 is formed from copper in view
5 of its pliability and corrosion resistance. Tube 24 will typically extend over 85% of the length of cylindrical sidewall 18. Refrigerant (not shown), typically R22 and including R12 equivalents, is pumped through tube 24 to heat the cylindrical sidewall 18 and thus heat the water contained within water tank 12. Tube 24 is part of a solar boosted heat pump water heating system, which is described in
10 Australian Patent Nos. 582,291 and 603,510. In order to avoid duplication of description reference is made to Australian Patent Nos. 582,291 and 603,510, the contents of which are herein incorporated into this specification.

In Figs. 2 and 3 there is shown the application of tube 24 to cylindrical sidewall
15 18. Tube 24 has a D-shape (as shown), oval shape or other closed shape with a flattened base 30 and is formed by deforming a circular cross-sectional tube prior to its application to, or by form roller compression as shown), against the cylindrical sidewall 18. Tube 24 has a heat transfer paste 32 applied to the base 30 to maximise the heat transfer from tube 24 to cylindrical sidewall 18.
20 Tube 24 is applied under compression to cylindrical sidewall 18 and layers of material wrapped around water heater 10 to maintain the compression. Typically, two layers 34, 36 of a stretch wrap film are applied first. The stretch wrap film may be a polythene film of a suitable formulation. The next layer 38 is an aluminium foil and it will act as a reflector to turn back heat to water
25 heater 10. Finally, layer 38 is encased in a further four (4) layers 40,42,44,46 of stretch wrap film. The number, and interleaving of the layers of material, can be varied to suit requirements and are not restricted to the number and positioning of layers described. As the stretch wrap film is not exposed to ultraviolet light, denaturing of the film will not occur. The wrapping and
30 compression of the layers will ensure the integrity of the heat transfer paste 32 and will seal the paste against the possibility of air or heat cycle drying. Without the wrapping, the heat transfer paste 32 would tend to dry out and

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become crumbly when exposed to air over time. The heat cycling would also hasten this disintegration. The crumbling would reduce the heat conductive contact between tubing 25 and sidewall 18. The wrapping seals the paste 48 from air and avoids any drying or thickening effects.

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Fig. 4 shows the sequential steps of applying tube 24 to cylindrical sidewall 18. In this embodiment tube 24 is formed by roller compression. Firstly, a length of circular cross-sectional tubing 25, for example of 10 mm diameter, is moved into position and held against cylindrical sidewall 18. A bead, for example of 3 mm diameter, of heat transfer paste 48 is placed on the horizontally rotating water tank 12 from a dispenser (not shown) underneath where tubing 25 will be forced onto the cylindrical sidewall 18. The heat transfer paste 48 used in this embodiment is known as Bostik heat transfer sealer #1128 or #5603. The heat transfer paste 48 in this embodiment is a grease-like material with no bonding properties but a bonding type material may also be used. Secondly, tubing 25 is compressed to a D-shape (as shown) or an oval shape against cylindrical sidewall 18 to flatten the bead of heat transfer paste 48 and allow a uniform thickness of paste to be applied to base 30 of tube 24. Paste 48 will typically ooze out from underneath base 30. Tubing 25 is deformed into the D-shaped or oval tube 24 by a compression roller 64 which rotates about axle 66 to compress and deform tubing 25 onto cylindrical sidewall 18. Thirdly, a pair of parallel beads 50, 52, for example of 4 to 6 mm diameter, of heat transfer paste are applied to cylindrical sidewall 18 and opposing sides of tube 24. This step will increase the size of the heat transfer footprint. The final step is to mould the beads 50, 52 into a filleted join 56 to maximise the heat transfer. Tube 24 is typically wound from the bottom to the top and is held, but not attached, to cylindrical sidewall 18 at both ends by a bracket (not shown), typically plastic, which clips onto tube 24. The clips are held to cylindrical sidewall 18 by a non-stretch binding passing around the tank circumference and pulled tight. When the tube 24 reaches near the top wall 16 of water tank 12 the tube 24 is clipped to stabilise it while wrapping of the windings occurs. The windings of tube 24 are usually in a tighter spiral at the lower half 58 than at the upper half 60. Other variations of windings may be

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used, for example, a progressive spiral increase with a variable pitch, two separate winding, one above the other or interleaved. To complete the construction of water heater 10 the layers 34-46 are then applied as discussed with reference to Figs. 2 and 3. Tube 24 is then bent across the wrapped windings to provide outlet
5 28.

Fig. 5 shows a variation of the D-shaped profile of tube 24. In this embodiment tube 24 is indented at 68 to provide a bi-lobular profile with lobes 70, 72. This will increase the concentration of heat mass to the edges of tube 24 and into the
10 paste fillets 56 to increase the refrigerant velocity in the areas of the tube where refrigerant oil accumulates to assist oil return and reliability.

The preferred embodiment discussed above simplifies construction of a water heater compared to the techniques disclosed in Australian Patent Nos. 582,291
15 and 603,510. In parallel testing the preferred embodiment shows a 28% increase in performance over the water heater shown in Australian Patent Nos. 582,291 and 603,510 and a reduction in the compressor/water temperature ratio of over 10 % in the mid to high temperature range. These performance improvements will directly increase efficiency and compressor life and reduce noise output.
20 The preferred embodiment had at least a 28% higher Coefficient of Performance. This value increased to a 38% increase when 24 hour heat losses and their subsequent recovery were taken into account.

Although the preferred embodiment has been described with reference to its use
25 as a water heater, water tank 12 could hold cooled water by reverse cycle refrigeration where the refrigerant in tube 24 is cold rather than hot.

Throughout this specification, unless the context requires otherwise, the word “comprise”, or variations such as “comprises” or “comprising”, will be
30 understood to imply the inclusion of a stated integer or group of integers, but not the exclusion of any other integer or group of integers.

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The invention will be understood to embrace many further modifications as will be readily apparent to persons skilled in the art and which will be deemed to reside within the broad scope and ambit of the invention, there having been set forth herein only the broad nature of the invention and a certain specific
5 embodiment by way of example.

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The claims defining the invention are as follows:-

1. A water heater/cooler including a water tank having a wall formed from material having heat transfer properties, a tube adapted to carry,
5 in use, a refrigerant fluid, is applied externally about said tank wall, a heat-conductive material is coextensive with the length of said tube to allow said tube to be in said in heat-conductive contact with said tank wall and at least one layer of material tightly wrapped about said tank wall and said tube.
- 10 2. The water heater/cooler of claim 1, wherein said tube is compressed against said tank wall and said compression is maintained by said at least one layer of material.
- 15 3. The water heater/cooler of claim 2, wherein said tube is of circular cross-section and during compression against said tank wall is deformed into a D-shape in cross-section.
- 20 4. The water heater/cooler of claim 2, wherein said tube is of circular cross-section and during compression against said tank wall is deformed into a bi-lobular profile.
- 25 5. The water heater/cooler of any one of the preceding claims, wherein said at least one layer of material includes at least one layer of stretch wrap film and at least one layer of a heat reflective material thereover.
6. The water heater/cooler of claim 5, wherein at least a further layer of stretch wrap film is applied over said at least one layer of heat reflective material.
- 30 7. The water heater/cooler of claim 5 or 6, wherein said stretch wrap film is polythene based.

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8. The water heater/cooler of any one of the preceding claims, wherein said heat conductive material is a non-setting heat conductive paste.

9. The water heater/cooler of any one of claims 5 to 8, wherein
5 said at least one layer of stretch wrap film surrounds said heat conductive material in an airtight manner.

10. The water heater/cooler of any one of the preceding claims, wherein said tube extends over at least 85% of the length of said tank.
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11. A method of forming a water heater/cooler, said method including the steps of winding a tube around the wall of a water tank under which a heat-conductive material coextensive with the length of said tube has been applied to either said tube or said wall of said water tank to allow said
15 tube to be in heat-conductive contact with said tank wall and tightly wrapping at least one layer of material about said tank wall and said tube.

12. The method of claim 11, wherein beads of heat-conductive material are applied to said tank wall on either side of said tube and said beads
20 are formed into a join fillet to, in use, increase the heat transfer of said tube with said tank wall.

13. A water heater/cooler substantially as hereinbefore described with reference to the accompanying drawings.

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