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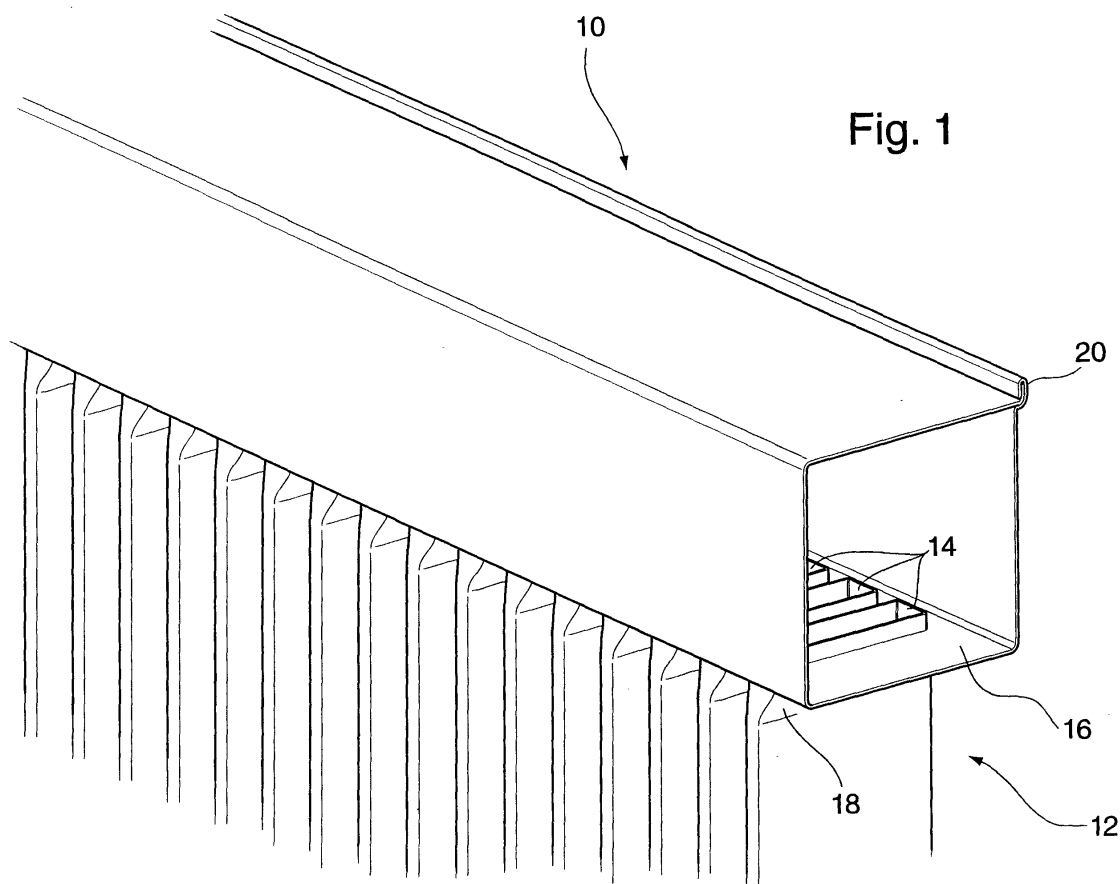
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(54) **Heat exchanger construction**

(57) A heat exchanger has a header tank 10 formed from punched and folded sheet metal folded up to form a chamber and closed along a seam 20. The base 16 of the tank is punched with apertures for coolant tubes

12. The sides can be formed with stiffening ribs or depressions 34 (Figure 4). The sheet metal can be the same metal as the coolant tubes, so that all the heat exchanger components can be brazed together in a single brazing operation.



## Description

**[0001]** This invention relates to a heat exchanger construction. The construction is particularly suitable for manufacturing heat exchangers to be used in motor vehicles, for example cooling radiators and air conditioning condensers, but the invention is not restricted to such applications.

**[0002]** Heat exchangers of the type to which this invention relates have header tanks to which a large number of coolant tubes are connected. The coolant tubes usually have fins which are mounted between the tubes, and the tubes and fins together form a heat exchanger core. Coolant flows from the header tank through the coolant tubes, and when the coolant passes through the coolant tubes it is in heat exchange relationship with another fluid flowing past the tubes. In a typical motor vehicle cooling circuit, the coolant passes through the vehicle engine and its temperature rises. It then passes through the radiator, entering the radiator through the header tank and then passing through coolant tubes where air flows over the tubes to remove heat from and to reduce the temperature of the coolant before the coolant is recirculated to the vehicle engine.

**[0003]** In conventional radiator construction, the coolant tubes, together with the heat exchange fins arranged between the tubes, are sealed into a header plate which spans all the tubes at one or both ends of the radiator, and a fluid tight seal is formed between the header plate and the tubes, for example by brazing the seams. A separately formed header tank is then mounted on the header plate. The header tank is often a plastics moulding with an open face which is attached to the header plate. Usually a gasket will be fitted between the tank and the header plate, and the header tank will be secured by crimping edges of the header plate over edges of the tank.

**[0004]** While this method produces a satisfactory product, it is time consuming in terms of manufacture and requires three separate components, namely a header plate, a gasket and a header tank and several different manufacturing operations.

**[0005]** According to the present invention, there is provided a method of making a header tank for a heat exchanger from an initially flat, elongate sheet of material, the method comprising the steps of forming openings for coolant tubes along the length of the sheet, folding the sheet so that its longitudinal edges are in contact with one another, forming a clinched seam between the edges to make a tubular body, and closing the ends of the tubular body.

**[0006]** The tubular body may have a square cross-section, a round cross-section, an oval cross-section or indeed any other tubular shape.

**[0007]** The material is metal, preferably an aluminium alloy clad with a brazing flux.

**[0008]** The folded and clinched tank seam can be brazed to seal the tank.

**[0009]** Preferably portions of the sheet material are deformed out of the plane of the sheet to provide stiffness to the folded sheet.

**[0010]** The longitudinal edges can lie in two parallel, contacting planes with a terminal part of one edge being folded over the terminal part of the other edge. The clinched seam can be formed with three overlying layers of the sheet material, and mechanically crimped.

**[0011]** In a particularly advantageous embodiment, the folded over terminal part of one edge comprises a series of spaced apart tabs and corresponding terminal parts of one edge of another header tank also comprise a series of spaced apart tabs. The two tanks are then aligned with their clinched seams side by side, and the tabs of one tank alternate with the tabs of the other tanks along the length of the seam, and the tabs from one tank are folded over the edges of the other tank, and vice versa..

**[0012]** The tank or tanks are preferably fitted with end caps of the same sheet material, after the tanks have been folded and the clinched seams have been formed.

**[0013]** According to a second aspect of the invention, there is provided a heat exchanger for a motor vehicle having a header tank and a heat exchange core, wherein the header tank is made from an initially flat, elongate sheet of material which has openings for coolant tubes formed along the length of the sheet and wherein the sheet has been folded so that its longitudinal edges are in contact with one another to form a clinched seam between the edges to make a tubular body, and means for closing the ends of the tubular body.

**[0014]** The heat exchanger can be, for example, a motor vehicle radiator, a motor vehicle condenser for an air conditioning system or a motor vehicle intercooler.

**[0015]** Still further, the invention extends to a header tank unit for a plurality of heat exchangers, the unit comprising at least two header tanks for separate heat exchangers which are joined to one another along and by a common clinched seam.

**[0016]** The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is an isometric view from one end of a heat exchanger in accordance with the invention;

Figure 2 is a detail of a clinched seam used in the heat exchanger of the invention;

Figure 3 is a perspective view of one corner of a second embodiment of a heat exchanger in accordance with the invention;

Figure 4 is an end view showing header tanks of two interconnected heat exchangers;

Figure 5 is a view of the interconnected heat exchangers of Figure 4, on a larger scale, and

showing end caps in place;

Figure 6 is a view similar to Figure 4 but showing a third embodiment of heat exchanger in accordance with the invention;

Figure 7 shows a fourth embodiment in which the heat exchangers are of differing cross-sectional shapes; and

Figure 8 shows an arrangement where three heat exchangers are interlinked in accordance with the invention.

**[0017]** Figure 1 shows one edge of a heat exchanger with a header tank generally designated 10 and an array of coolant tubes generally designated 12. All the coolant tubes are parallel to one another. Although not shown in this drawing, there will conventionally be heat exchange fins spanning in a known way between the tubes 12.

**[0018]** The tubes 12 end in open ends 14 which extend through a base 16 of the header tank 10. A transition region is shown at the top 18 of each tube 12 where the cross-section of the tube bells out and changes between a cross-section optimised for heat exchange flow past the tubes 11 and a cross-section optimised for fitting into the base 16 of the header tank.

**[0019]** The header tank 10 shown in Figure 1 has a generally square cross-section and is formed from a single folded sheet of metal, preferably aluminium. Prior to folding, the portion of the sheet which will form the base 16 is punched with holes for the upper ends 14 of the tubes 12.

**[0020]** The longitudinal edges of the sheet meet in a clinched seam 20, which can be seen in more detail in Figure 2. One of the edges 22 is bent up at right angles to the surface from which it projects. The other edge 24 is bent over the edge 22. The face 23 has a step 26 beneath the clinched seam 20, so that compression loads acting downwards on the top face 21 of the tank do not tend to disrupt the seam 20, and a surface 25.

**[0021]** After folding and interengagement of the edges 22 and 24 to achieve the condition shown in Figure 2, two further steps happen. Firstly a mechanical clinch is applied to the seam by applying forces in the directions indicated by the arrows A so that the materials are deformed into one another. Secondly, at a later stage of processing, a brazing operation takes place, and the braze material fills any cavities which have not been sealed by the clinching process, to form a fluid tight seal.

**[0022]** Figure 3 shows that the flange 24 can be interrupted at regular intervals along its length, to produce a castellated ridge 28 where the longitudinal edges of the sheet meet. This castellation formation can be used, as seen in the following figures, to join the header tanks of two or more heat exchangers together.

**[0023]** Figure 4 shows two header tanks 30 and 32. It

will be noted that both tanks have pressed-in recesses 34 of various shapes and forms which are provided in each face of the tank to provide stiffness to what would otherwise be plain, flat faces. The tanks also have slots 36 into which coolant tubes 12 are to be inserted in the manner shown in Figure 1.

**[0024]** The tanks are joined along the ridge 28. Starting from the open end shown at the front in the drawing, in the first section of the ridge 28, the tank 30 has up-standing edges 122 and 125, but the folded over flange 24 is not present. The tank 32 has edges 222 and 225, with the edge 225 ending in a flange 224 which folds over both the edges 122 and 125.

**[0025]** In the next section of the ridge 28, it is the edge 125 which carries a flange 124 and the edge 225 is without a flange. The flange 124 folds over the edges 222 and 225.

**[0026]** This pattern is repeated the length of the ridge 28, so that alternately a flange from one tank folds over and is clinched to the edges of the other tank, and vice versa.

**[0027]** As previously mentioned, the clinched seam is subsequently mechanically closed and then brazed.

**[0028]** Figures 1 to 4 have shown a square section tank, with open ends. Whilst it is possible to squeeze and crimp the ends of the tube to close them in the manner of a toothpaste tube, it is preferred to close the tank ends by fitting end caps as shown in Figure 5. The figure shows a single end cap 38, of the same sheet metal as the remainder of the tank, which closes both tanks 30 and 32. The end cap has plates 40, 42. The plate 40 has edge flanges 44 which fit inside the cross-section of the tank 30 and the plate 42 has edge flanges 46 which fit inside the cross-section of the tank 32. The plates 40 and 42 are joined by a top-hat section 48 which bridges across the parallel adjacent faces of the tanks 30 and 32. The cap will be brazed to the walls of the tank to form a fluid-tight seam. The top hat section 48 also helps to hold the two tanks 30,32 in the correct relative positions.

**[0029]** Figure 5 also shows the edges 122,222 formed with longitudinal ribs 50 which contribute to the formation of a robust mechanical seam along the ridge 28 after clinching has been completed.

**[0030]** Figure 6 shows an alternative embodiment in which none of the edges 322,324,422,424 have turned over flanges. Instead, a separate flange strip 300 is folded over all the adjacent edges 322,324,422,424 and is clinched and brazed in place. An advantage of using a separate clinch strip is that part 302 of the strip can be formed as an external mounting bracket. In Figure 6, this bracket is shown plain in form, but it will be obvious that it could take many forms, for example including holes for fasteners or the like, and that these forms could be incorporated into the strip by pressing or the like, before the clinching process.

**[0031]** Figure 7 shows two connected header tanks 500,600. The tank 500 is a radiator header tank and the

tank 600 is for a condenser. The condenser tank has to operate at higher internal pressures than the radiator tank, and is therefore made of heavier gauge material. In spite of this use of differing material thicknesses, the tanks are still connected to one another in the manner described with reference to Figures 3 and 4. It may be desirable for the ends of the tanks 500,600 to be closed by separate end caps, rather than by one single end cap.

[0032] Figure 7 also shows that the cross-sectional shape of the tanks is not critical. Each tank probably needs to have one longitudinal straight edge to allow a seam to be formed along the ridge 28 in the manner described.

[0033] Finally, Figure 8 shows a heat exchanger unit in which three separate heat exchangers are combined, ie a radiator 700, an air-conditioning system condenser 800 and an intercooler 900. The intercooler and the radiator are made from relatively thin sheet metal and are therefore provided with pressed stiffening ribs and dimples. The condenser 800 is made of thicker material and, in cross-section, has curved walls so has no need for pressed in stiffening.

[0034] The material used for the header tanks of the invention is preferably aluminium alloy, clad with a suitable brazing agent. The same clad alloy can be used for all parts of the exchanger, ie not only the tank and any end caps, but also the coolant tubes and the heat exchange fins.

[0035] Where internal baffles are required in a header tank, they can be fitted to the tank internal walls before the tank is folded into its tubular form, and they can be brazed into position in the tank when the final brazing operation takes place.

[0036] The tanks will be provided with inlet and outlet spigots such as 502 (Figure 7). The initial pressing of the metal blank can provide an upstanding collar from the blank, and a preformed spigot 502 can be brazed into this collar.

[0037] By manufacturing the header tank from the same sheet material as is used for the header plate in a conventional radiator, several processing steps can be dispensed with. The technology and equipment to press, fold and braze the tank already exists in radiator plants, and the final brazing step can be carried out in common with the brazing of the fin and tube core.

[0038] The invention also facilitates the desirable production of an 'all aluminium' motor vehicle radiator.

## Claims

1. A method of making a header tank for a heat exchanger from an initially flat, elongate sheet of material, the method comprising the steps of forming openings for coolant tubes along the length of the sheet, folding the sheet so that its longitudinal edges are in contact with one another, forming a clinched seam between the edges to make a tubular

body, and closing the ends of the tubular body.

2. A method as claimed in Claim 1, wherein the material is metal.
3. A method as claimed in Claim 1 or Claim 2, wherein the material is an aluminium alloy clad with a brazing flux.
4. A method as claimed in any preceding claim, wherein the folded and clinched tank seam is brazed to seal the tank.
5. A method as claimed in any preceding claim, wherein portions of the sheet are deformed out of the plane of the sheet to provide stiffness to the folded sheet.
6. A method as claimed in any preceding claim, wherein the longitudinal edges lie in two parallel, contacting planes with a terminal part of one edge being folded over the terminal part of the other edge.
7. A method as claimed in any preceding claim, wherein the clinched seam is formed with three overlying layers of the sheet material.
8. A method as claimed in any preceding claim, wherein the clinched seam is mechanically crimped.
9. A method as claimed in any one of Claims 6 to 8, wherein the folded over terminal part of one edge comprises a series of spaced apart tabs..
10. A method as claimed in Claim 9, wherein terminal parts of one edge of another header tank also comprise a series of spaced apart tabs, the two tanks are aligned with their clinched seams side by side, and the tabs of one tank alternate with the tabs of the other tanks along the length of the seam, and the tabs from one tank are folded over the edges of the other tank, and vice versa..
11. A method as claimed in any preceding claim, wherein the tank or tanks are fitted with end caps of the same sheet material, after the tanks have been folded and the clinched seams have been formed.

12. A heat exchanger for a motor vehicle having a header tank and a heat exchange core, wherein the header tank is made from an initially flat, elongate sheet of material which has openings for coolant tubes formed along the length of the sheet and wherein the sheet has been folded so that its longitudinal edges are in contact with one another to form a clinched seam between the edges to make a tubular body, and means for closing the ends of the tubular body.

13. A heat exchanger as claimed in Claim 12, being a motor vehicle radiator
14. A heat exchanger as claimed in Claim 12, being a motor vehicle condenser for an air conditioning system. 5
15. A heat exchanger as claimed in Claim 12, being a motor vehicle intercooler. 10
16. A header tank unit for a plurality of heat exchangers, the unit comprising at least two header tanks for separate heat exchangers which are joined to one another along and by a common clinch seam. 15

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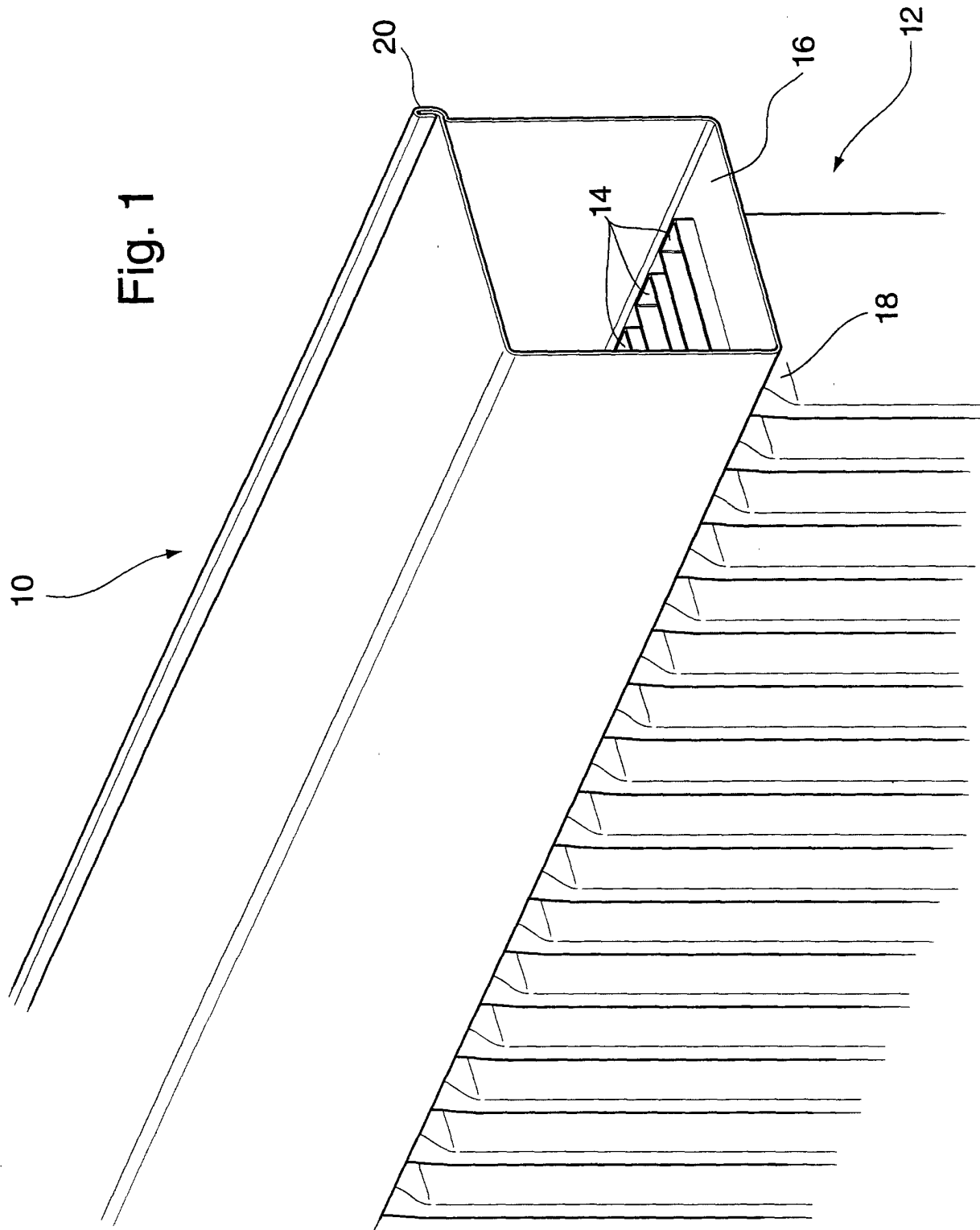


Fig. 2

