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(54) **Improvements in refrigerator heat exchangers.**

(57) A heat exchange unit mainly for a refrigerator comprises a sheet of metal which has been perforated by punching using a roller having a plurality of teeth which causes material to be displaced to form a rectangular perforation and the displaced material to be bent to one side of the sheet around the perforation. The roller forms a series of lines of perforations 2 between which is left an unperforated strip 3 having indentations 4 to which is spot welded the condenser tubing 5 in the form of a serpentine.

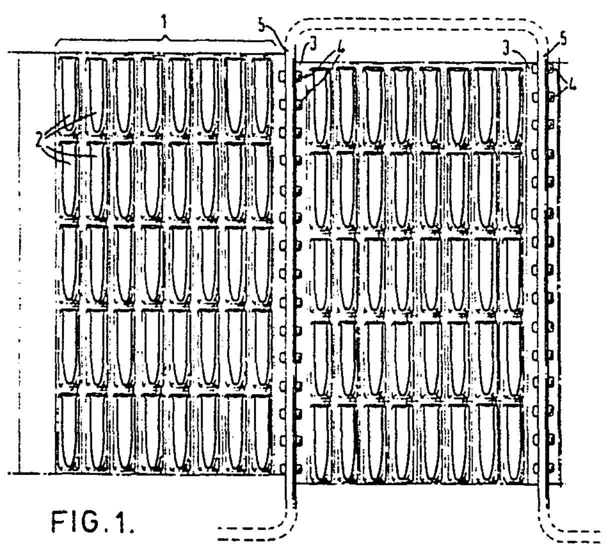

FIG.1.

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TITLE

"Improvements in refrigerator heat exchangers."

This invention relates to a heat exchange panel unit primarily for use in conjunction with a condenser coil of a refrigeration system in order to assist in the loss of heat to ambient air.

It is known to provide a heat exchanger comprising a "serpentine" arrangement for the condenser tubing which is joined by longitudinal parallel spaced rods spot welded to the tubing and serving as a support and heat dissipating means. Such an arrangement has limited contact points for heat conduction to the rods from the tubing and a limited area for heat dissipation. The arrangement does provide relatively unrestricted air through-flow however. This construction is heavy and involves a complex assembly routine. Arrangements using cooling fins connected with the tubing are also known, but such constructions cannot be made sufficiently flat for many installations and are expensive in materials and manufacture. It has been proposed to use "expanded" metal sheet and "louvred" metal sheet but in the former case the area of metal available for dissipation of heat in a given area of sheet is very small, due to the expanded fabrication technique, and in the latter case the through-flow of air shows little improvement over an unperforated sheet of metal.

In the use of such metal sheets two conflicting requirements arise between, firstly, the need to provide sufficient metal to effectively conduct heat from the tubing to the sheet and, secondly, the need to provide a sufficiently open metal free area for air flow and loss of heat to the air.

It is an object of this invention to provide a heat exchange unit mainly for a domestic refrigerator or freezer which is of simple construction, easy to produce and which affords good heat conduction and exchange properties together with simple means of attachment to the condenser piping.

Although this invention is primarily concerned with a condenser for a domestic refrigerator, it is nevertheless usable generally as a heat exchanger where a metal area is to be attached to a tubing to afford better cooling or possibly warming.

According to this invention there is provided a heat exchange unit primarily for a refrigerator, the unit comprising a perforated sheet of metal material to which a tubing element is attached, the tubing carrying a fluid medium from which heat is to be lost, characterised by a sheet material of metal which has been perforated by a roller forming a rotary punch between the pinch of which the sheet is fed, the sheet comprising a plurality of longitudinally extending lines of regular spaced perforations wherein the material of each perforation is displaced during punching and turned back to one side of the sheet and around the periphery of the punched aperture, the sheet further including un-perforated strips between areas of said longitudinal lines of perforations, the strips supporting the tubing.

The sheet will preferably include a number of parallel spaced non-perforated strips each of which may include a series of regularly spaced protuberances formed by indentations, onto which a straight run of the heat exchange tube may be positioned and thereafter spot welded to provide a firm connection affording good heat exchange properties. The tube will preferably be in the form of a "serpentine" extending along and then back over the spaced strip portions on the sheet. The sheet material will preferably be perforated in the manner disclosed in British Patent specification 1,312,053, but the perforating rollers will include cutting teeth of larger dimensions which produce a slot of an elongated and somewhat triangular shape in plan.

Preferably the perforations have a length to breadth ratio of between 1:1 and 6:1. The roller producing the perforations may include across the width a number of teeth which form a series of perforations followed by a plain tooth-free zone which may be arranged to produce indentations in the unperforated strip, this then being followed by a second series of teeth and so on.

The perforations may be produced by the roller and a co-acting die between the pinch of which the sheet is fed to provide a continuous production method. By this means the perforated material is simply cut through and there is no wastage or loss of metal. In addition, the manner of cutting the slots forming the perforations forms a sheet having excellent heat exchange properties which allows free passage of air therethrough, and the shape offers good rigidity to bending in all directions.

The invention also is to be construed as embodying a method of manufacturing a heat exchanger substantially as hereinbefore defined.

An embodiment according to the invention is described by way of example in the accompanying drawings, wherein:-

Figure 1 shows a plan view of a portion of a heat exchanger showing the heat exchange tubing,

Figure 2 shows a reverse plan view of a portion of the heat exchanger, and

Figures 3 and 4 are respectively sections on AA and BB of Figure 2.

Referring firstly to Figure 1, a part only of the heat exchange sheet is shown and this comprises a series of lines 1 formed by narrow elongate generally rectangular perforations or slots 2. Between each series of lines 1 a strip of non-perforated sheet material 3 is provided, with the strips being regularly spaced across the sheet width and extending parallel over the length of the sheet. Each of the strip portions 3 includes a number of evenly spaced upstanding protuberances, as viewed in Figure 1, formed by indentations 4 which serve as a support and basis for spot welding thereto tubing 5 forming a heat exchange duct or, in this instance, the serpentine of a refrigerator system. At the side portion of the sheet the coil is curved to turn through 180° and then extends along the next adjacent strip 3, this sinuous arrangement being present over the whole of the sheet.

It will be seen that the slots 2 have an elongated rectangular or possibly triangular-like shape with the cut through material being displaced and generally turned back to one side. The method of cutting may be as disclosed in Patent specification 1,312,053 as example. Figures 2, 3 and 4 show the sheet in reverse side view and sections illustrating the configuration of the slots.

As may be seen from the sections, in particular the material remaining as ribs between adjacent lines of perforations has a U-shape sectional profile caused by the displaced and turned-back material; the same is true for the cross-pieces between each perforation in a line. This profile affords good rigidity to bending of the sheet.

The dimensions of the perforations may be adjusted according to requirements. For example, by making the length of each perforation smaller more cross-pieces are provided per unit length, giving better heat conduction from the strip 3, carrying the tubing, to the sheet between adjacent strips. However this also reduces the open area available for air-flow, thus effectively reducing heat loss to the air. In practice, therefore, a compromise by way of an optimum perforation dimension is provided according to a particular use.

In a preferred embodiment the pitch between the strips 3 is of the order of 5 to 6 centimetres and the pitch of the perforations (lengthwise) is two centimetres, whereas the pitch between adjacent slots forming the perforations is some 6 to 7 millimetres.

In another embodiment (not shown) better heat transfer from the tubing to the sheet is achieved by making the lengthwise dimension one centimetre. As can be seen from the sectional views of Figures 3 and 4, each perforation defines a smooth sided aperture through which air may flow and circulate readily whilst passing over a large area of metal to give good heat exchange and hence cooling. The pitch of the indentations 4 is of the order of 5 millimetres and is selected to provide sufficient contact to obtain good heat exchange from the tubing spot welded thereto.

This arrangement, when applied to a heat exchanger, offers considerable advantage as compared with a conventional refrigerator heat exchanger which uses a series of rods welded to the heat exchange serpentine. In the present invention the surface area is much increased affording better heat dissipation and assembly, and manufacturing costs are significantly reduced as individual rods do not have to be placed in a jig and thereafter spot welded to the tube. A complete sheet of the perforated material in one piece may be placed over the whole serpentine and spot welded into place in a simple manner.

The perforations in the sheet material may be produced by a method other than that herein disclosed and the perforations may be of differing shapes and sizes according to requirements.

The embodiment disclosed shows the tubing 5 welded at intervals to the protrusions 4 but it is equally possible to simply spot weld the tube at spaced locations to the flat strip or to form the strip with a channel in which the tube is laid and then welded. It is important to provide good heat conduction between the tube and strip and where spot welding is used the spacing of the welds should be close enough to obtain good heat transference commensurate with economic production. Other arrangements comprise two staggered lines of protrusions between which the tube is positioned and welded thereto, or an arrangement where the strip has a deep channel in which the tube can be pressed so as to embrace a greater part of the tube thus providing good heat transfer. A second strip could be used to sandwich the tube the second strip being welded or otherwise connected with the strip on the sheet. In general, welding is preferred for the tube to strip connection so as to provide continuity of metal for heat transference.

CLAIMS

1. A heat exchange unit primarily for a refrigerator, the unit comprising a perforated sheet of metal material to which a tubing element is attached, the tubing carrying a fluid medium from which heat is to be lost, characterised by a sheet material of metal which has been perforated by a roller forming a rotary punch between the pinch of which the sheet is fed, the sheet comprising a plurality of longitudinally extending lines of regular spaced perforations, wherein the material of each perforation is displaced during punching and turned back to one side of the sheet and around the periphery of the punched aperture, the sheet further including un-perforated strips between areas of said longitudinal lines of perforations, the strips supporting the tubing.

2. A heat exchanger in accordance with Claim 1, characterised by the perforations being substantially rectangular with a ratio between length and breadth of between 1:1 and 6:1.

3. A heat exchanger in accordance with Claim 1 or 2, characterised by the un-perforated strips including a longitudinal series of protuberances formed by indentations.

4. A heat exchanger in accordance with any preceding Claim, characterised by the tubing being secured to the strips by spot-welding.

5. A heat exchanger in accordance with any preceding Claim, characterised by the tubing extending across the sheet in the form of a serpentine with parallel adjacent runs thereof secured to respective strips of the sheet.

6. A heat exchanger in accordance with any preceding Claim, characterised by the roller having a plurality of teeth to form a first series of lines of perforations, a tooth-free zone to form an unperforated strip, and a second plurality of teeth to form a second series of lines of perforations and so forth according to the required sheet width.

7. A heat exchanger according to any preceding Claim, characterised by the material displaced by punching being turned back so as to provide a rib of U-shape between adjacent lines of perforations.

8. A heat exchanger according to any preceding Claim, characterised by the material displaced by punching being turned back so as to provide a cross-piece of U-shape between adjacent perforations in a line.

9. A heat exchanger according to any preceding Claim, wherein the width of material between adjacent lines of perforations is substantially less than the width of the perforation, and of the order of one third the width.

10. A heat exchanger according to Claim 9, wherein the width of material between adjacent perforations in a line is comparable with the width of material between adjacent lines of perforations.

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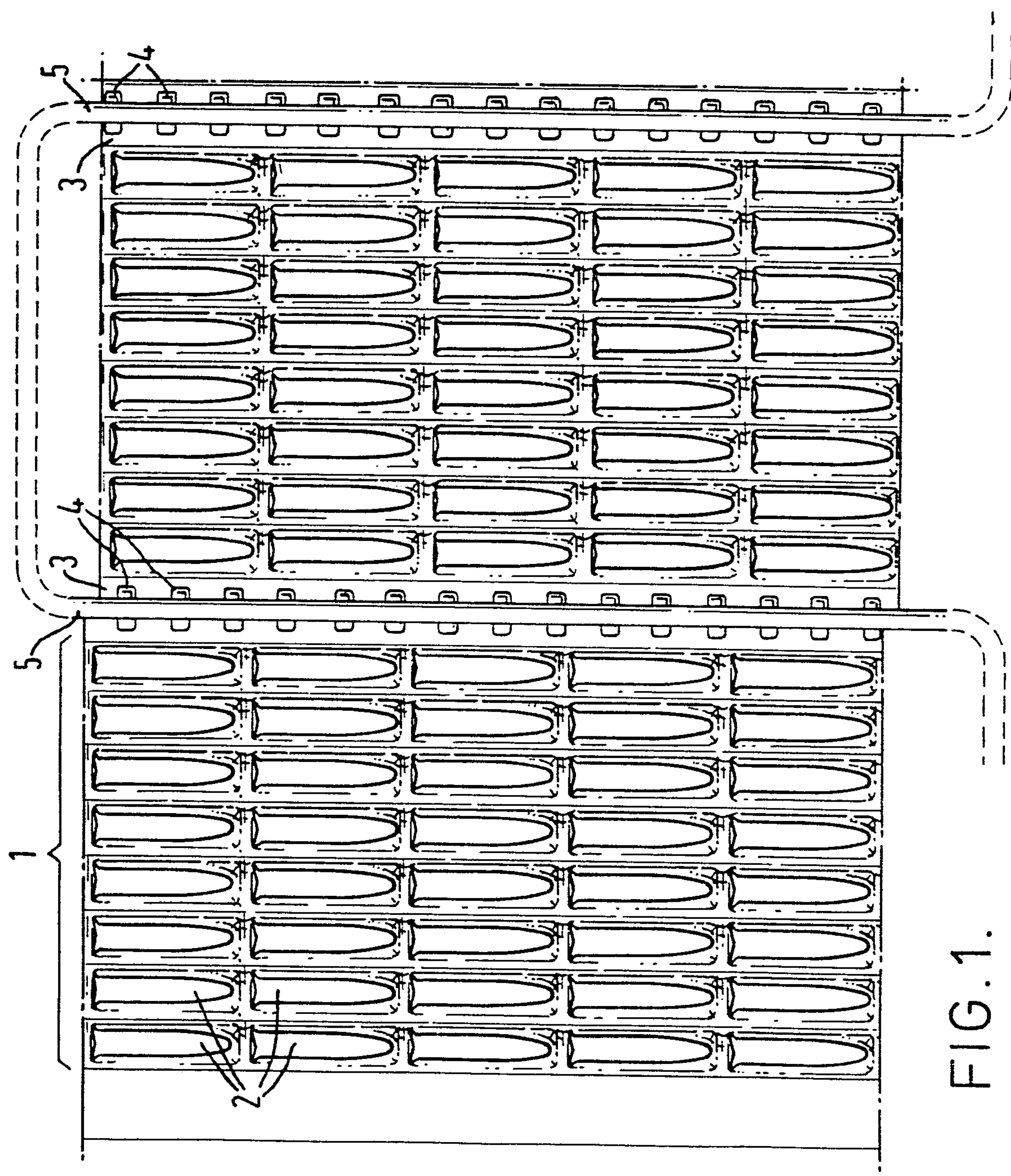

FIG. 1.

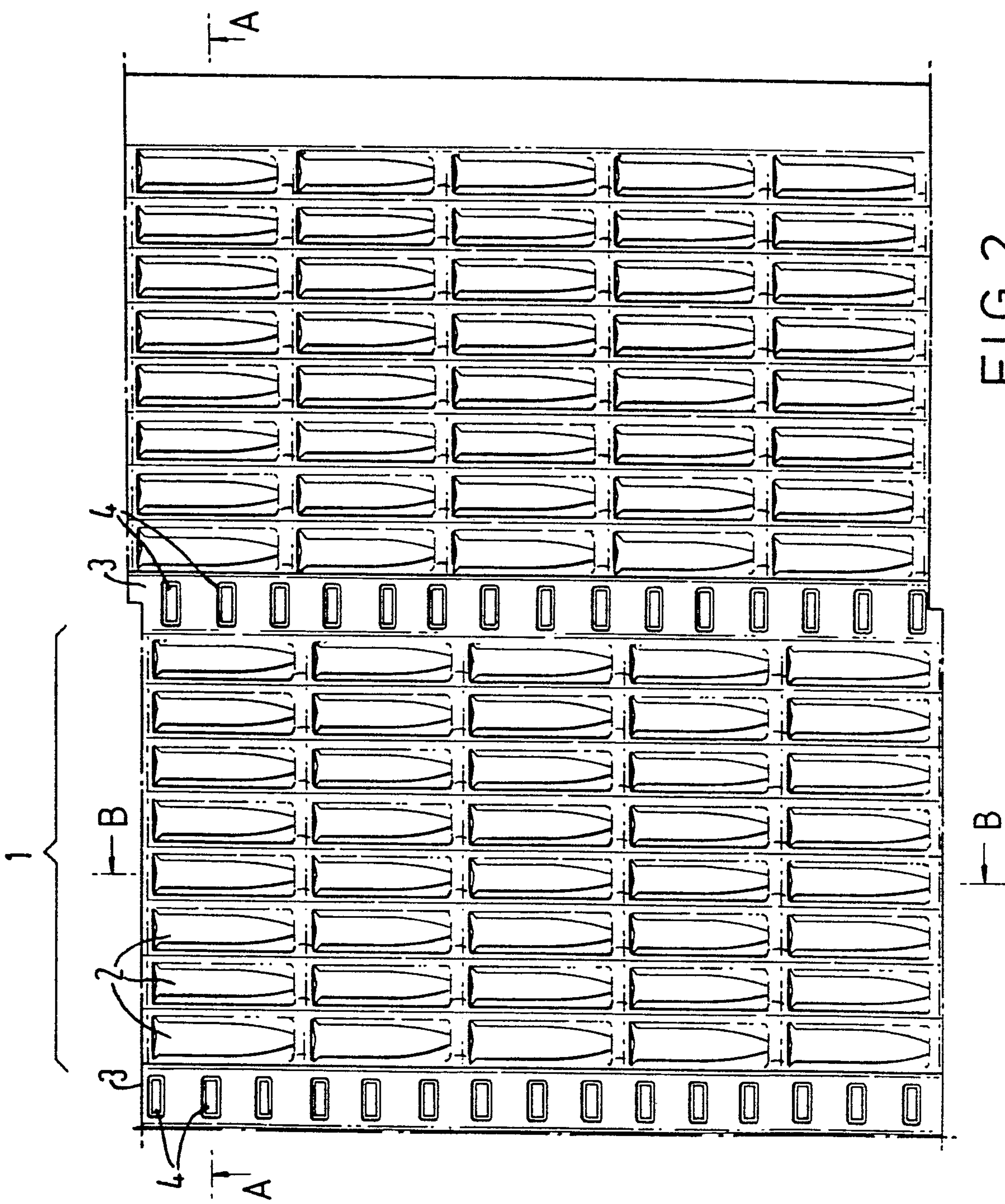

FIG.2.

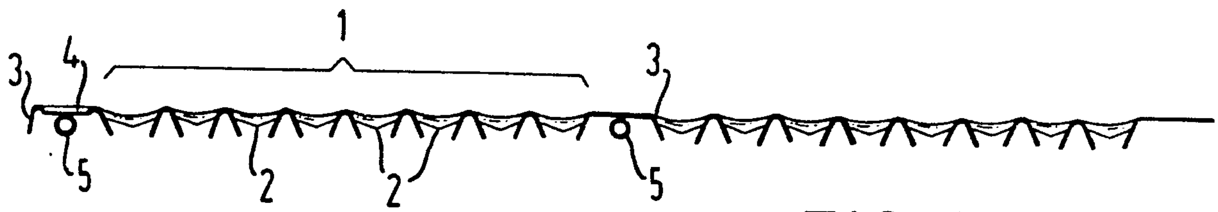

FIG. 3.

FIG. 4.