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(54) **Damage resistant heat exchanger.**

(57) A damage-resistant radiator, typically for i.c. engines in land vehicles, has heat-exchange tubes extending between header tanks, said tubes being surrounded by a secondary heat exchange surface. The row of tubes adjacent the radiator face where impingement damage is anticipated is arranged so that the tubes are isolated from the route of the cooling fluid through the radiator. Alternatively the tubes in this row are replaced by solid rods.

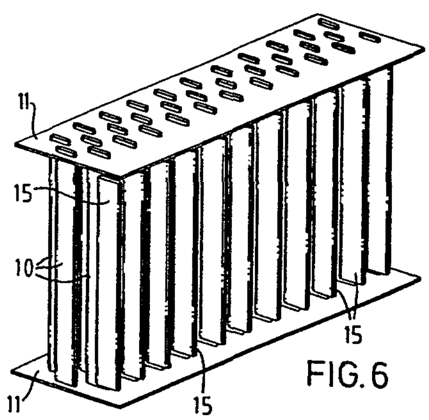

FIG. 6

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Damage Resistant Heat Exchanger

This invention relates to heat exchangers and particularly but not exclusively heat exchangers which form part of land vehicles, mobile air compressors or electricity generator sets and are used for the cooling by ambient air of a fluid such as a water/anti freeze solution or a lubricant or transmission oil. Such heat exchangers or radiators may be particularly susceptible to rupture and/or erosion damage by the impingement of stones, grit or other foreign bodies on the heat exchange surface of the radiator.

The heat exchange components of a typical vehicle radiator are generally relatively soft. The tubes may typically be made of relatively thin non-ferrous materials such as a copper or aluminium alloy which have good heat exchange and corrosion-resistant properties but are susceptible to fracture or erosion damage by the impact of relatively small particles. When the vehicle or heat exchanger is operated in a particularly deleterious atmosphere, the problems with impingement damage can be fairly serious, requiring the repair or replacement of radiator components, with the consequent temporary loss of service of the vehicle/equipment. This is particularly but not exclusively true in the type of environment associated with earth or refuse moving equipment. Typically, particles thrown up by the operation of equipment are sucked into the fan associated with the radiator and are thrown onto the core of the radiator. The initial impact absorbs much of the energy in these particles so that damage resulting in the loss of liquid from the cooling system is usually confined to the first row of tubes.

It has previously been proposed to safeguard radiators by the use of a separate mesh screen placed between the radiator and its associated fan. It has also been proposed to have a series of tube nose guards extending across the leading edges of the row of tubes on the side of the radiator on which damage is likely to occur.

It is an object of the present invention to provide an improved heat exchanger which is resistant to impingement damage.

According to one aspect of the invention, a heat exchanger, typically for use in a land vehicle, comprises a heat exchanger core extending between respective header plates each forming part of a header tank, said core including tubes carrying the fluid to be cooled and extending between said header plates, together with a secondary heat exchange surface bonded to said tubes, in which is provided integral means forming part of the core, which integral means is adapted to minimise impingement damage to the fluid-carrying tubes of said core.

The said secondary surface may be formed of fins or corrugations of suitable metal, with or without louvres therein.

The integral means may comprise a first row of tubes adjacent one face of the heat exchanger and communicating with the respective interiors of the header tanks, said first row of tubes being of increased wall thickness relative to tubes in other rows of the core.

Alternatively the integral means may comprise a first row of tubes adjacent one face of the heat exchanger and communicating with the respective interiors of the header tanks, said first row of tubes being made of material of increased resistance to impingement damage as compared with the material from which tubes employed in other rows of the core are made.

As a further alternative, the integral means may comprise a first row of tubes adjacent one face of the heat exchanger, but not communicating with the respective interiors of the header tanks. The material or wall thickness of said first row of tubes may be different from the tubes of the core through which fluid to be cooled can flow eg the first row of tubes may have a greater wall thickness than the tubes in the remaining rows. The first row of tubes may extend into a header plate but be blanked off by suitable means within the header tanks eg by solid brass inserts being inserted as a push fit into the open ends of each tube in said first row of tubes. Alternatively the first row of tubes may pass through all of the secondary heat exchange surface but may stop just short of the header plates. In either case, the first row of tubes may be supported by the secondary surface of the core with or without further support means which may be connected with another portion of the heat exchanger eg its frame. In another aspect of the invention, the first row of tubes may be supported solely by means extending from the core or other portions of the heat exchanger.

In yet another alternative, the integral means may comprise solid longitudinal members extending parallel with the tubes through the secondary heat exchange surface adjacent one face of the heat exchanger. Said solid members may extend through one or both of the respective header plates of the heat exchanger. Said solid members may further be bonded or otherwise secured to the secondary heat exchange surface of the heat exchanger. They may be rectangular in cross-section, and of a similar size to that of the tubes in the heat exchanger. Typically, said solid members may be made of brass, tinned steel, aluminium or plastic.

The constructions hereinbefore described which employ a first row of tubes, or solid members similar to tubes, which pass through and are supported by the conventional secondary surface of fins or corrugations, enables a damage resistant radiator to be constructed without any special jigs over and above that normally required for the core assembly or the use of any separate sub-assemblies which need to be positioned over the face of the heat exchanger, or attached to it. The header plates for such constructions typically omit the conventional first line of tube holes.

Several embodiments of the invention will now be described, by way of example only, with reference to the accompanying schematic drawings, in which:-

Figure 1 is a perspective view of a first embodiment of the invention, being a radiator with its header tank and secondary heat exchange surface omitted.

Figure 2 is an enlarged perspective view of an element of a radiator which when applied to the radiator shown in Figure 1 provides a second embodiment of the invention,

Figure 3 is a perspective view of a further element of a radiator which when employed in the radiator of Figure 1 provides a third embodiment of the invention,

Figures 4 and 5 illustrate in perspective view typical tube and fin configurations of known radiators, and

Figure 6 is a perspective view of a further embodiment of the invention.

The radiator of Figure 1 has copper tubes 10 extending between brass header plates 11 which form part of the radiator header tank (not shown). There are four rows of tubes 10, each row being offset to permit efficient cooling of the tubes by air flowing across the radiator. The first row of tubes, adjacent the face of the radiator likely to receive impinging particles is identified by the arrow 12. Tubes 10 are typically brazed into the header plates 11 at each end to provide a water-tight joint. In these examples it is assumed that the fluid to be cooled, which passes through the header tanks and tubes 10, is the cooling water from the jacket of an i.c. engine.

A secondary heat exchange surface is typically bonded to tubes 10 to provide enhanced cooling. This is not illustrated in Figure 1 for reasons of clarity, but typical secondary heat exchange surfaces 20 and 21 are illustrated in Figures 4 and 5. That shown in Figure 4 employs a corrugation 20 and is known as a tube and corrugation configuration whilst that shown in Figure 5 employs fins 21 and is known as a tube and fin configuration. In each case it can be seen that the fins 21 or corrugations 22 have louvres which assist in directing the air flow around the fins or corrugations and the tubes 10 to be cooled.

The first row of tubes 12 in Figure 1 communicate with each header tank, and each tube 10 of the first row 12 has a greater wall thickness than the remainder of the tubes 10 in the core of the radiator. The tubes 10 in the first row 12 may have a wall thickness two or three times greater than that of the remainder of the tubes 10. Furthermore, the tubes 10 of the first row 12 may be made of a harder material eg brass as compared with copper for the remainder of tubes 10, and may be solid drawn tubes rather than lockseam tubes which are employed in the remainder of the core. Alternatively the tubes 10 in the first row 12 may be made of an impingement resistant alloy eg 17% chrome ferritic steel and have the same wall thickness as the remainder of tubes 10 in the radiator core.

Figure 2 shows a solid brass insert 13, one of which is to be inserted into each tube end of the first row of tubes 12 to be blanked off, the inserts

13 being brazed into position to provide a second embodiment of the invention. Each insert 13 is a push fit into each tube end, and in use extends into the tube end to a position level with or below the header plate 11. Inserts 13 are positioned in each tube end of the first row of tubes 12 at both ends of each tube, thereby preventing any fluid flow through the first row of tubes 12 from the header tanks. In this embodiment, the first row of tubes 12 may be of identical construction and material to the remainder of the tubes 10 in the radiator core, the impact of extraneous particles on the first row of tubes 12 being sufficient to absorb most of the energy of such particles so that they do no further damage in passing through the core, or rebound off the first row of tubes 12.

Figure 3 shows a rectangular cross-section element 14 a number of which can be used in place of the tubes 10 in the first row of tubes 12 to form a third embodiment of the invention. The elements 14 can be of sufficient length so that they are located at each end in suitable holes in the header plates 11 or they may be shorter than the tubes 10 and stop short at one or both ends from the header plates 11. Elements 14 can be solid and made of brass or tinned steel (particularly if they are to be brazed to the header plates 11) or aluminium or plastic. Where the elements 14 do not extend to the header plates 11 they will be supported by the secondary heat exchange surface 20 or 21 where they pass through said surface. Alternatively or additionally, supports for elements 14 will be provided extending from the core or from another part of the radiator eg its frame.

In the embodiment shown in Figure 6, the first row of tubes 15 pass through all of the secondary heat exchange surface but stop just short of each header plate 11. In this embodiment the header plates 11 have no orifices corresponding with the first row of tubes 15, which are supported by the secondary heat exchange surface 20 or 21, where they pass through said surface. Alternatively or additionally the first row of tubes 15 may be supported by separate means extending from the core or from some other part of the radiator. The first row of tubes have a greater wall thickness than the remainder of the tubes and are typically of lock-seam construction.

CLAIMS

1. A heat exchanger, typically for use in a land vehicle, comprising a heat exchanger core extending between respective header plates each forming part of a header tank, said core including tubes (10) carrying the fluid to be cooled and extending between said header plates (11), together with a secondary heat exchange surface (20, 21) bonded to said tubes (10), characterised in that integral means (14, 15) forming part of the core is adapted to minimise impingement damage to the fluid-carrying tubes (10) of said core.

2. A heat exchanger as claimed in Claim 1 characterised in that the integral means comprises a first row of tubes (10) adjacent one face of the heat exchanger and communicating with the respective interiors of the header tanks, said first row of tubes (10) being of increased wall thickness relative to tubes (10) in other rows of the core.

3. A heat exchanger as claimed in Claim 1 characterised in that the integral means comprises a first row of tubes (10) adjacent one face of the heat exchanger and communicating with the respective interiors of the header tanks, said first row of tubes (10) being made of material of increased resistance to impingement damage as compared with the material from tubes (10) employed in other rows of the core are made.

4. A heat exchanger as claimed in Claim 1 characterised in that the integral means comprises a first row of tubes (15) adjacent one face of the heat exchanger, but not communicating with the respective interiors of the header tanks.

5. A heat exchanger as claimed in Claim 4 characterised in that the first row of tubes (15) pass through the whole of the secondary heat exchange surface (20, 21) but stops just short of the header plates (11).

6. A heat exchanger as claimed in Claim 5 characterised in that the wall thickness of the first row of tubes (15) is greater than the wall thickness of the tubes (10) in the remaining rows.

7. A heat exchanger as claimed in Claim 5 or Claim 6 characterised in that the first row of tubes (15) is supported solely by the secondary surface (20, 21) of the core.

8. A heat exchanger as claimed in Claim 1 characterised in that the integral means comprise solid longitudinal members (14) extending parallel with the tubes (10) through the secondary heat exchange surface adjacent one face of the heat exchanger.

9. A heat exchanger as claimed in Claim 8 characterised in that the solid members (14) extend through one or both of the respective header plates (11) of the heat exchanger.

10. A heat exchanger as claimed in any preceding claim characterised in that the secondary surface (20, 21) is formed of fins or corrugations of suitable heat conductive material.

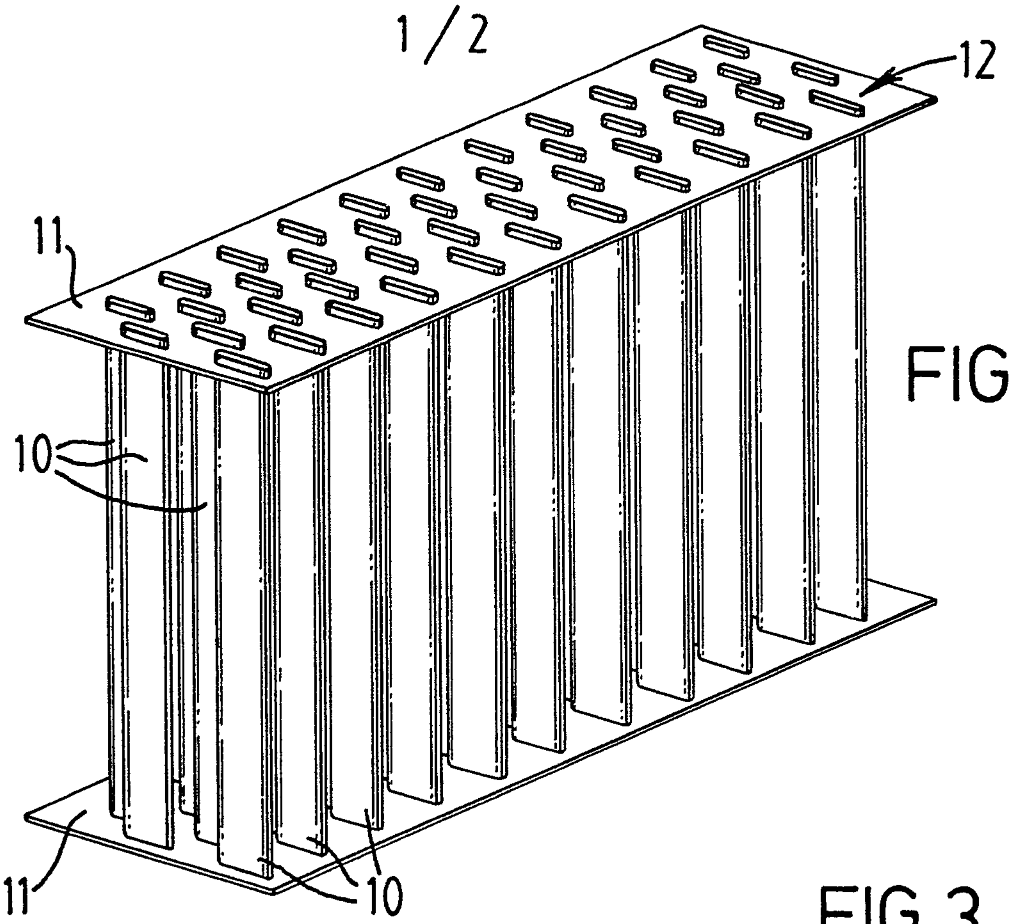

FIG.1

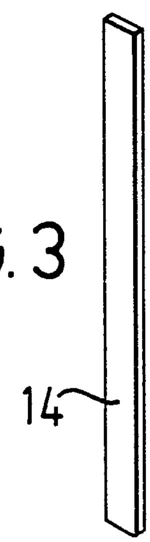

FIG. 3

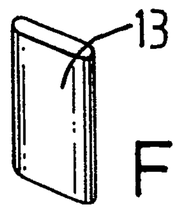

FIG. 2

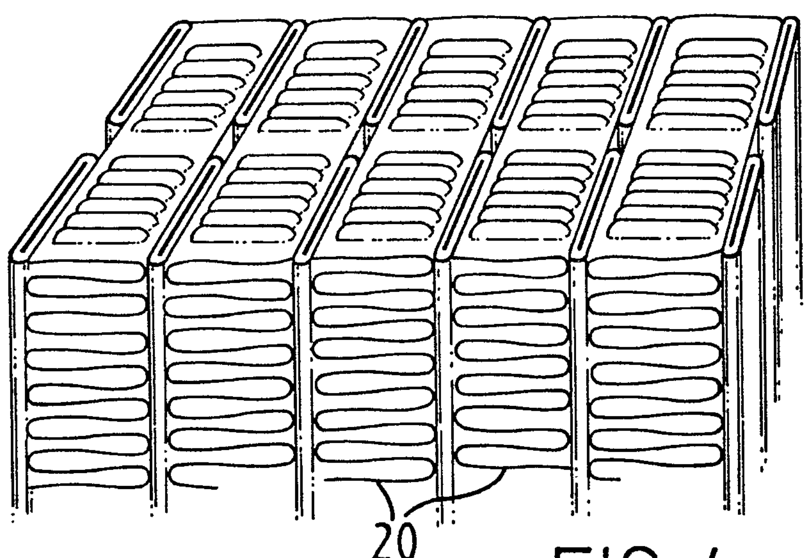

FIG. 4

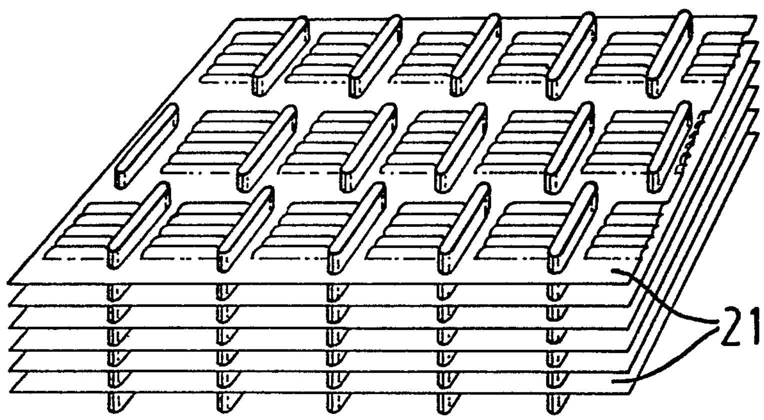

FIG. 5

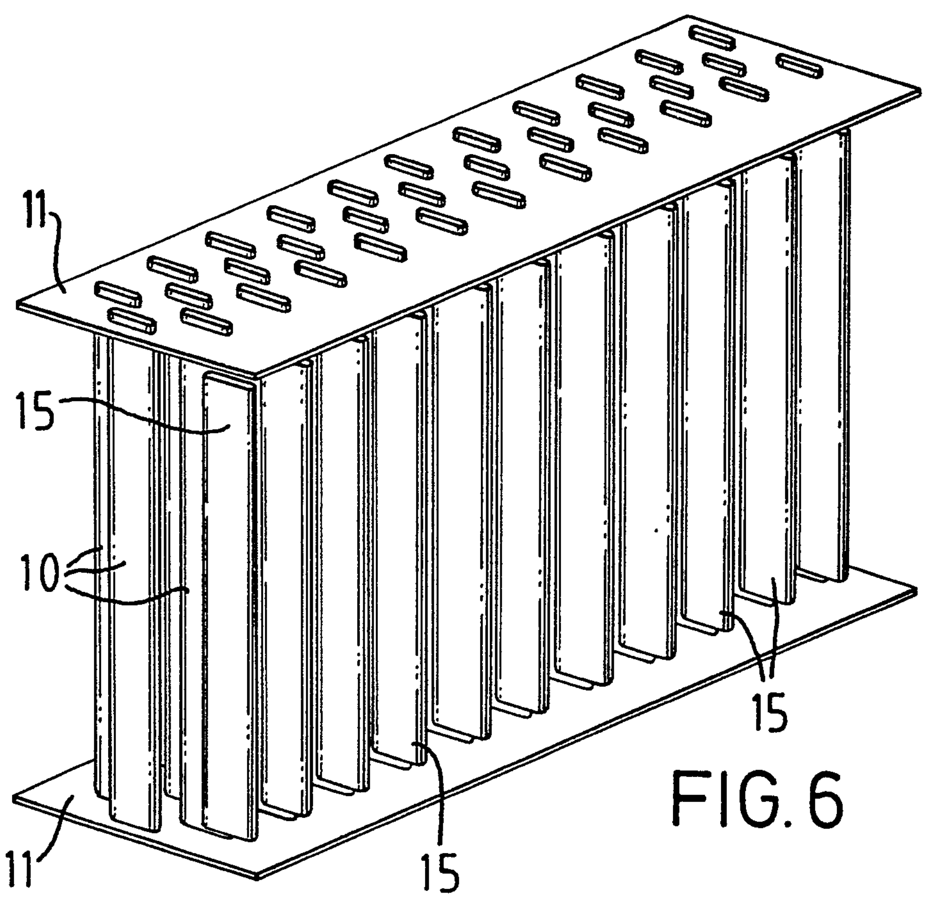

FIG. 6