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(12) # EUROPEAN PATENT APPLICATION

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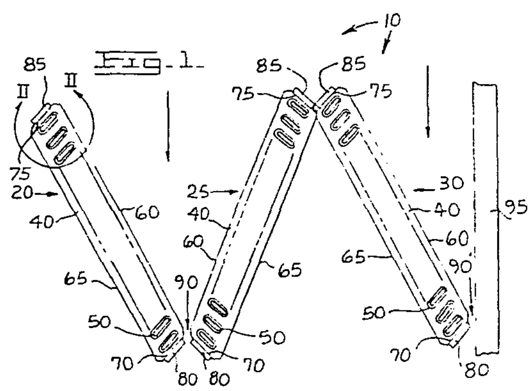
(54) **Heat exchanger core and heat exchanger comprising such a core.**

(57) The outermost tubes (50) of a heat exchanger core (20) have not previously been cooled as adequately as the interior tubes (50) by the flow of air between the fins (40) and the tubes (50). In this invention a cover (80,85) is connected over the edges (45) of the fins (40) defining a respective one of first and second end surfaces (70,75) and is spaced from the air inlet surface (60) of the core (20). Consequently, the outermost tube (50), which is nearest the cover (80,85) is cooled substantially to the same degree as the other tubes (50). In one example, about a 5% increase in the thermal efficiency of the core (20) is attained.

Fig-1



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TITLE MODIFIED
see front page

CATERPILLAR TRACTOR CO., GJE 5280/224.

HEAT EXCHANGER CORE.

This invention relates to a heat exchanger core, and, more particularly, to a core construction for increasing heat rejection and improving cooling.

Heat exchangers, such as those used in earthmoving vehicles, must have sufficient capacity to cool the engine by the passage of air through and around the heat exchanger core. In the past, it has at times been necessary to use large fans operating at relatively high speeds to provide sufficient air flow through the heat exchanger core. Unfortunately, large fans may use excessive power and cause vibration and noise which is undesirable. Current noise regulations, in fact, restrict the use of large noisy fans so that other means must be found to provide effective cooling without excessive noise.

One way to increase cooling capacity is shown in U.S. Patent Specification No. 4,034,804. This specification discloses a radiator operable with a flow of air for cooling a quantity of water and is formed as zig zag or folded walls, each of which contains air ducts. Cooling water tubes with elongate cross-sections are arranged in a number of flat cores being of the same width as the tube widths. The upper and lower sides of the cores are located in the front and rear planes, respectively, of the radiator. The cores are connected together alternately on their front and rear sides in an airtight manner. Similarly, Figure 1B, page 866 of the technical paper, "A High Performance Radiator" by Asselman, Mulder, and Meijer presented at the 1972 Intersociety Energy Conversion Engineering Conference, shows core connection members which completely cover the ends of the fins.

The zig zag pattern increases the cooling capacity by increasing the radiator surface area exposed to the flow of air without increasing the frontal area of the radiator. However, a problem exists with the zig zag core patterns disclosed above in that the air-duct surfaces of the respective core connection members are shaped and positioned substantially differently from the air-duct surface of the respective cooling water tubes such that the outermost ducts at both ends of the cores, formed by the respective outermost tube, core connection member, and adjacent fins, do not provide the same resistance to air flow as the ducts formed between adjacent tubes and fins. Consequently, the outermost tubes at both ends of the cores are not cooled to the same degree as the other tubes. Hence, such folded or zig zag pattern cores have heretofore not been fully effectively utilized at or near their maximum cooling efficiency.

Another problem with such zig zag pattern cores is that the cores become plugged with debris at the apexes defined by the zig zag pattern. U.S. Patent Specification No. 4,034,804 illustrates one solution to this debris problem in the form of a fine gauze plaçed around the outside of each core. Another attempt to solve this problem is described in U.S. Patent Specification No. 4,116,265. This latter specification discloses gaps between converging, adjacent cores which are closed by movable plugs during normal use and

and which are opened when periodic debris purging is performed. U.S.Patent Specification No.4,076,072 discloses a zig zag pattern of cores which are spaced apart a short distance so as continually to permit debris that would normally pile up in the converging trough to go on through.

It is therefore desirable to have a heat exchanger core which will more closely approach theoretical efficiency for cooling. It is also desirable to avoid the debris collection problem in such an efficient heat exchanger core.

In accordance with the present invention a heat exchanger core comprises a plurality of closely spaced fins having peripheral edges defining an air inlet surface, an air outlet surface, and first and second end surfaces; and at least one tube extending through the fins spaced from the air inlet surface; wherein one of the first and second core end surfaces is provided with a first cover, the cover being spaced from the air inlet surface.

Preferably, the core is positioned with the inlet surface oriented at between 10° and 40° to the direction of incident air flow in use, with the first and second end surfaces offset in the air flow direction.

The or each tube may have an elongate cross-section the tube being positioned with the elongate dimension extending generally between the air inlet and the air outlet surface.

Preferably, a heat exchanger has first and second such cores the cores being mounted in a generally "V" configuration with the first end surfaces of the cores at the apex of the "V".

Two examples of a heat exchanger incorporating cores in accordance with the present invention are illustrated in the accompanying drawings, in which:-

Figure 1 is a plan of one example;

Figure 2 is an isometric view showing a portion of an end surface of one of the heat exchanger cores shown in Figure 1; and,

Figure 3 is an enlarged partial view, similar to Figure 2, of a core of a second example.

Figure 1 shows a self-purging heat exchanger 10 having first, second and third cores 20,25,30 arranged in a zig zag or "V" patterns as viewed from the top. Air flow direction is as indicated by unnumbered arrows.

Each of the cores 20, 25, 30 is formed (see Figure 2) of a plurality of fins 40 having peripheral edges 45 and at least one cooling water tube 50 of elongate cross-section which extends through the fins 40. Referring once agains to Figure 1, each of the cores, 20, 25, 30 has an air inlet surface 60, an outlet surface 65, and first and second end surfaces 70, 75, all of which are defined by the peripheral edges 45.

The tubes 50 are spaced from the inlet surface 60. The cores 20,25, are angularly oriented to each other in a generally "V" configuration with an included angle of generally between 20° and 80° for efficient cooling and space utilization. In this configuration, the inlet surface 60 of each core 20,25 is positioned generally at an angle between 10° and 40° with the flow of air approaching the inlet surface. The first end surfaces 70 of the cores 20 and 25 are adjacent to one another. A small gap 90 will generally be present between the first end surfaces 70 of the cores 20,25 . The gap 90 is generally sized to allow debris, but not too much air, to flow therethrough. Where there is an end core such as the third core 30, a gap 90' will generally be present between the frame member 95 and the first end surface 70 of the core 30. Moreover, gap 90' will generally have a size approximately equal to that of the gap 90.

Each core 20,25,30 has a pair of covers 80,85 which are substantially parallel to the tubes 50 and are connected over the edges 45 of the fins 40 which define the respective first 70 and second 75 end surfaces of the respective cores 20,25,30. In each of the cores 20,25,30, the leading edge of each tube 50 and the covers 80,85 are spaced from the inlet surface 60 substantially the same distance in order to provide efficient cooling without excessive turbulence and also to facilitate sliding and rolling of debris toward the bottom of the 'V'. Moreover, the covers, for example 80 (see FIG. 2), generally have a dimension "D2" approximately equal to the dimension "D1" of each tube 50.

Preferably, there are a plurality of generally equally spaced tubes 50 and the spacing, between each of the outermost tubes 50 and adjacent covers 80,85 is substantially equal to half the spacing between adjacent parallel tubes 50. In such a situation, the outermost tubes 50 are cooled substantially to the same degree as are any of the other tubes 50. It is also preferred that the tubes 50 and the covers 80,85 are spaced substantially the same distance from the outlet surface 65 in each of the respective cores 20,25,30 to provide efficient cooling.

Turning to Figure 3, there is partially shown therein a core 20' of an alternate embodiment of the present invention. Each core has a pair of covers, one of which 80' is shown, formed of a plurality of tabs 88. The tabs 88 form extensions of the fins beyond the respective first and second end surfaces 70,75 of the respective cores. Moreover, each tab 88 is bent over in the same direction and generally parallel to the respective tubes 50. Each of the tabs 88 generally has a tab dimension "D3" approximately equal to the dimension "D1" of each tube 50 and the spacings of the tabs 88 from the inlet surface 60 is substantially equal to the spacing of the tube 50 from the inlet surface 60. The covers of this example function substantially the same as the above described covers 80, 85.

During operation, air approaches the heat exchanger 10 from the direction shown by the arrows in Figure 1. The air then passes through inlet surfaces 60, through air ducts formed between adjacent tubes 50 and adjacent fins 40, and then out the outlet surfaces 65. Air passing via inlet surfaces 60 adjacent the first and second end surfaces 70,75 passes through air ducts formed between respective covers 80,85, a nearest tube 50, and adjacent fins 40 and out the outlet surfaces 65.

Improved heat exchanger cores provide much improved cooling of the tubes nearest the end surfaces of the core. This, in turn, provides a larger (approximately 5% in one example) cooling capacity for the entire heat exchanger assembly. By spacing cover 85 from the inlet surface, cover 85 does not block air flow to the adjacent tube 50. By spacing cover 80 from the inlet surface, any debris passing through the gap 90 does not hang up thereon and is readily purged from the radiator. When, in accordance with one embodiment of the invention, there are a pair of the cores in a "V" configuration, and when there is a gap 90 between the pair of cores, debris is readily purged from the assembly.

Such heat exchanger cores as are disclosed herein are useful as cores for radiators such as those used in vehicles, particularly earthmoving vehicles.

CLAIMS

1. A heat exchanger core (20) comprising a plurality of closely spaced fins (40) having peripheral edges (45) defining an air inlet surface (60), an air outlet surface (65), and first and second end surfaces (70,75); and at least one tube (50) extending through the fins (40) spaced from the air inlet surface (60), characterised in that one of the first and second core end surfaces (70, 75) is provided with a first cover (80, 85), the cover being spaced from the air inlet surface (60).

2. A heat exchanger core (20) according to claim 1, characterised in that the core (20) is positioned with the inlet surface oriented at between 10° and 40° to the direction of incident air flow in use, with the first and second end surfaces offset in the air flow direction.

3. A heat exchanger core (20) according to claim 1 or claim 2, characterised in that the other of the first and second end surfaces (70, 75) is provided with a second cover (85,80), the second cover being spaced from the air inlet surface (60).

4. A heat exchanger core (20) according to any of claims 1 to 3, characterised in that the or each cover (80, 85) is spaced from the air inlet surface (60) a distance substantially equal to the spacing of the

tube (50) from the inlet surface (60).

5. A heat exchanger core (20) according to any of the preceding claims, characterised in that the or each tube (50) is spaced from the air outlet surface (65), the or each cover (80,85) being spaced from the air outlet surface (65) a distance substantially equal to the spacing of the tube (50) from the outlet surface (65).

6. A heat exchanger core (20) according to any of the preceding claims, characterised in that there are a plurality of substantially parallel tubes (50); and in that the spacing between the or each cover (80,85) and a nearest one of the tubes (50) is substantially equal to half the spacing between adjacent tubes (50).

7. A heat exchanger core (20) according to any of the preceding claims, characterised in that the or each cover (80,85) has a width (D2) substantially equal to the elongate dimension (D1) of the cross-section of the or each tube (50), the or each cover (80,85) being substantially parallel to a respective adjacent tube (50).

8. A heat exchanger core (20) according to any of the preceding claims characterised in that the or each cover (80') is formed of a plurality of tabs (88) which are formed by extensions of the fins beyond the peripheral edges (45) at the respective first and second end surfaces (70, 75) of the core and which are bent over into a plane substantially parallel to a respective adjacent tube (50).

9. A heat exchanger core (20) according to any of the preceding claims, characterised in that the or each tube (50) has an elongate cross-section, the tube being positioned with the elongate dimension extending generally between the air inlet and the air outlet surface.

10. A heat exchanger core according to claim 8 and claim 9, characterised in that each tab has a dimension

(D3) substantially equal to the elongate dimension (D1) of the cross-section of the or each tube.

11. A heat exchanger (10) comprising first (20) and second (25) heat exchanger cores according to any of the preceding claims, the cores (20,25) being mounted in a generally "V" configuration with the first end surfaces of the cores at the apex of the "V".

12. A heat exchanger (10) according to claim 8, wherein the heat exchanger has three or more heat exchanger cores mounted in a zig-zag arrangement with alternately first end surfaces (70) and second end surfaces (75) of adjacent cores adjacent one another.

13. A heat exchanger (10) according to claim 11 or claim 12, characterised by a gap (90) between adjacent first end surfaces (70) of adjacent cores (20,25).

Fig. 1

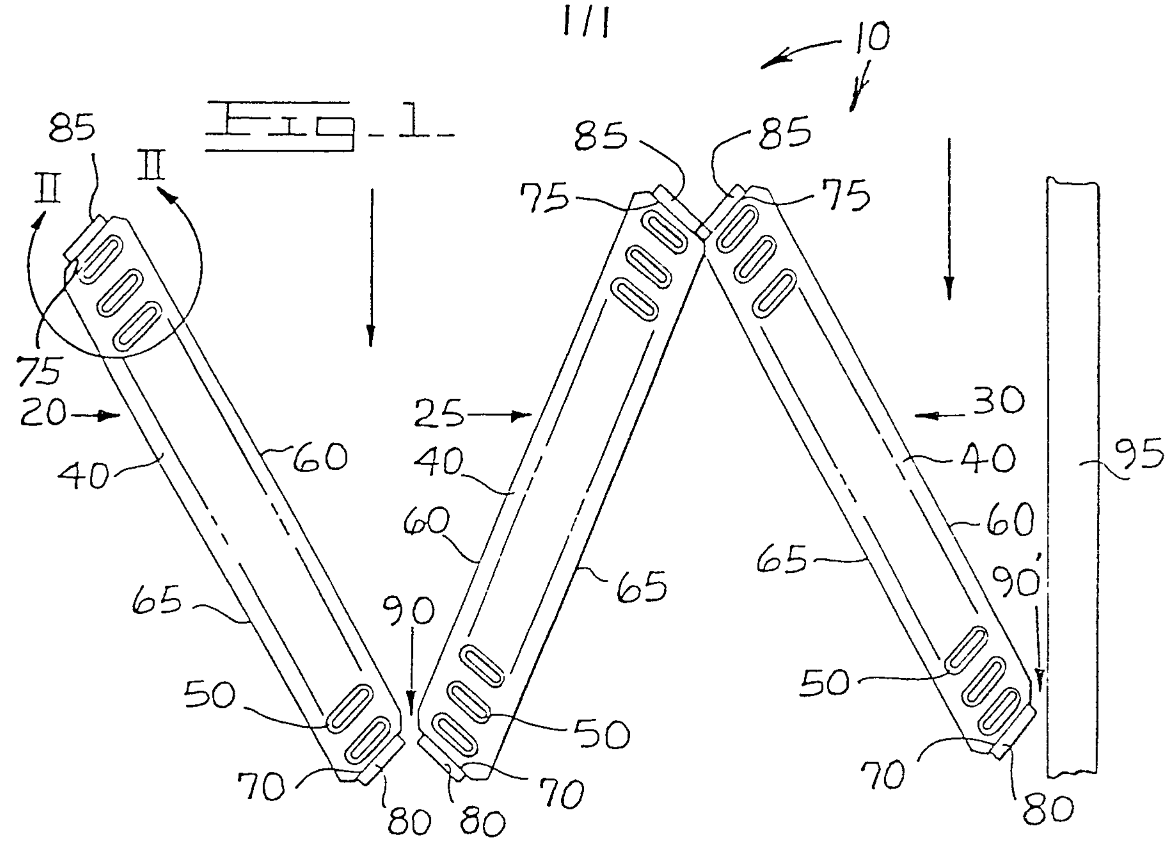


Fig. 2

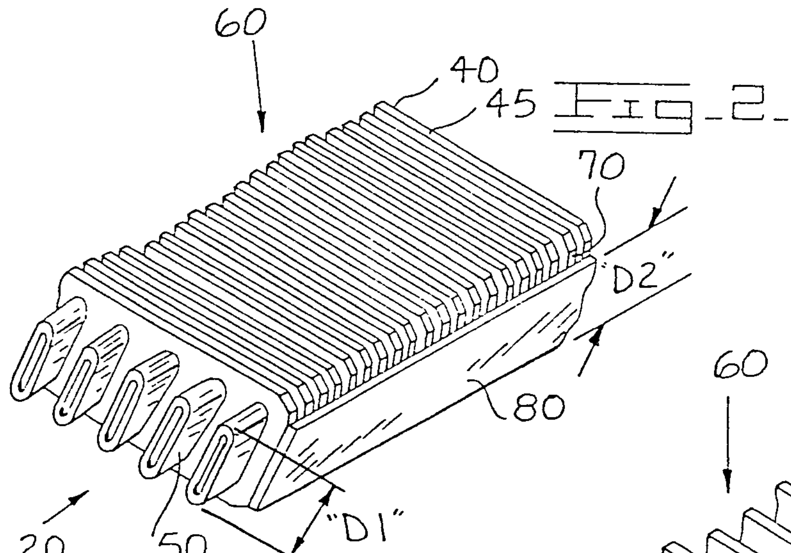
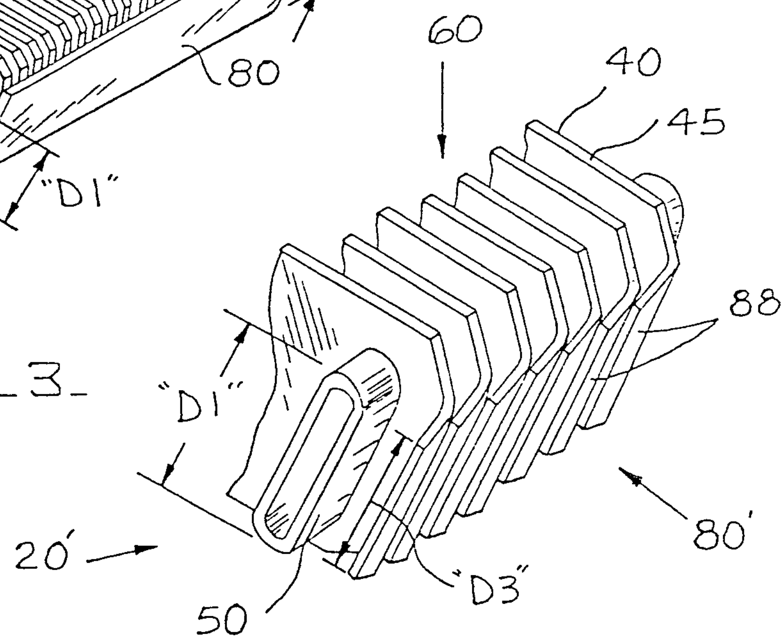


Fig. 3



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EUROPEAN SEARCH REPORT

Application number
EP 80 30 4365

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl.³)
	FR - A - 2 259 341 (VON ROLL) * Page 1, lines 16-24; page 2, lines 3-14; figure 1 *	1,8	F 28 D 1/04
	US - A - 1 921 278 (YOUNG) * Page 1, lines 58-75; figure 3 *	1,3,5, 6,9	
	US - A - 3 907 032 (DEGROOTE) * Column 5, line 40 - column 6, line 4; figure 7 *	1,3,5, 6,9	
	US - A - 2 602 650 (MARCOTTE) * Column 2, lines37-47; figures 1,3,5 *	1,3,5, 6,8	
	US - A - 3 538 984 (KASERMANN) * Column 1, line 62 - column 2, line 16; figures 1,3 *	1,3,4, 5,6,7, 9	
	FR - A - 2 200 888 (PHILIPS) * Page 3, lines 8-16, 25-32; figures *	1,2,3, 6,9, 11,12	
	FR - A - 2 250 089 (PHILIPS) * Page 1, lines 1-10; page 3, line 38 - page 4, line 6; figures 1,2 *	1,2,3, 6,9, 11,12	

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TECHNICAL FIELDS SEARCHED (Int Cl.³)

F 28 D
F 28 F
F 28 B

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons
&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11-03-1981	SCHOUFOUR

European Patent Office

EUROPEAN SEARCH REPORT

Application number
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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
D	US - A - 4 116 265 (STAEBLER) * Column 3, line 18 - column 4, line 51; figures 1,4,5 * --	1,2,3, 5,6, 11,12, 13
P	WO - A - 80/01105 (CATERPILLAR) * Page 4, lines 9-36; page 5, lines 1-19, 33-35; page 6, lines 1,2; figures 1,2,4 * --	1,2,5, 6,9, 11,12, 13
P	WO - A - 80/01104 (CATERPILLAR) * Page 4, line 19 - page 5, line 31; page 6, lines 6-10; figures 1,4 * ----	1,2,5, 6,9, 11,12, 13

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

TECHNICAL FIELDS SEARCHED (Int. Cl. 3)