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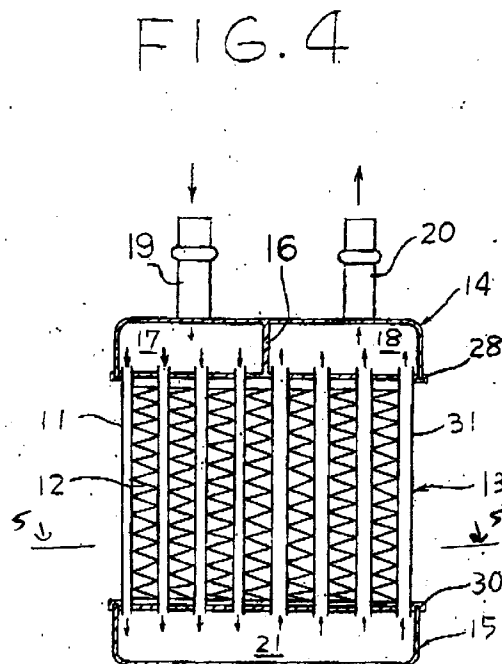
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(54) **Heat exchanger.**

(57) A heat exchanger includes a pair of tanks (14,15) and a heat exchanger core comprising a plurality of upstream and downstream heat-transfer tubes (11,31,41) and fin units (12). The downstream tubes have a cross sectional area which is greater than that of the upstream tubes for preventing the downstream heat-transfer tubes from becoming clogged by corrosion products which are grown in the upstream tubes. Further, a filter device (24) may be disposed in the tank for filtering out corrosion products before they enter the downstream tubes.



This invention relates to a heat exchanger for use as an automotive heat exchanger such as radiators, heaters and condensers and more particularly to an improvement in a structure of tubes and filter which is resistant to corrosion.

The conventional fin and tube exchanger, such as for a motor vehicle engine radiator, is well known in the prior art. For example, US-A-4,645,000 discloses a basic construction of a heat exchanger.

Generally, automotive heat exchangers typically comprise an assembly of cooling medium conduit pipes, and interposed cooling fins. The cooling medium flows into and out from the heat exchanger core through inlet and outlet pipes.

Referring to Figures 1 and 2 of the accompanying drawings, upper tank 14 is partitioned into two chambers, such as inlet chamber 17 and outlet chamber 18 by wall portion 16 of upper tank 14. Inlet chamber 17 and outlet chamber 18 are respectively provided with inlet pipe 19 and outlet pipe 20 by which the radiator is connected in the engine cooling system. Heat exchanger core 13 comprises a plurality of parallel flat shaped tubes 11 which are joined at their opposite ends to headers 28 and 30 which in turn join heat exchanger 13 to upper tank 14 and lower tank 15. Lower tank 15 includes chamber 21 therein. By a flat tube is meant a tube having a cross section which is elongate and which has substantially parallel longer sides. A plurality of corrugated fin units 12 are provided to alternate with the tubes 11 such that each corrugated fin unit 12 is positioned between two tubes 11. Corrugated fin units 12 are brazed to flat tubes 11 for permanent assembly.

The cooling medium is introduced from inlet pipe 19 into inlet chamber 17 of upper tank 14, and flows through heat exchanger core 13, down through the upstream tubes 11, and reaches chamber 21 of lower tank 15, from where it flows back to the outlet pipe 20 up through downstream tubes 11 and outlet chamber 18 of upper tank 14. When the cooling medium is transferred through heat exchanger core 13, the heat energy of the cooling medium is exchanged with air which flows from front to rear through heat exchanger core 13 in accordance with air flow Q. The cooling medium, which has performed heat-exchange with air flow Q, flows into the outlet chamber 18 of tank 14 and is reintroduced into the engine coolant circuit. The tubes 11 and fin units 12 are made of high heat conductivity material, such as aluminum alloy. Also, upper tank 14 and lower tank 15 are made of aluminum or aluminum alloy.

Generally, inner surfaces of tubes 11 are not corroded by a refrigerant, but easily corroded by a cooling medium such as water and the corrosion products are easily formed therein. Particularly, the cooling medium causes pits to form on the inner surface of tubes 11. Within a short period of time, these pits quickly grow and eventually cause holes or cracks to

form in the inner surface of tubes 11 leading to leakage of the cooling medium. In order to prevent coolant leakage caused by such a pit formation, tubes 11 have a metal core 11a which is made of A1-Zn alloy such as AA3003 with cladding linings 11b such as of JIS A7072 (A1-1%Zn) or A1-Ca Alloy or A1-Sn Alloy for preventing the pitting of flat tubes 11, such that the JIS A7072 functions as sacrificial metal.

Thus, in this arrangement, the corrosion products gradually accumulate on the inner surfaces of flat tubes 11, particularly in the portions of downstream flat tubes 11 which lead to the outlet chamber 18 of upper tank 14. According to circumstances, the corrosion products clog the tube 11. As a result, it is hard for the cooling medium to pass through the tubes 11, and the efficiency of the heat exchange is decreased.

It is an object of the invention to provide a heat exchanger which can maintain a high efficiency of heat exchange in long use by avoiding clogged tubes.

According to the invention, a heat exchanger comprising first and second tanks, the first tank including a partition therein for dividing the first tank into a first chamber and a second chamber, the first chamber including an inlet pipe fitting for providing a path of ingress of a heat transfer medium, and the second chamber including an outlet pipe fitting for providing a path of egress of a heat transfer medium; a plurality of first tubes each connected at one end to the first chamber of the first tank and at the other end to the second tank, a plurality of second tubes each connected at one end to the second chamber of the first tank and at the other end to the second tank; and a plurality of corrugated fin units attached to and positioned between the tubes; is characterised by preventing means disposed in the heat exchanger for preventing the second tubes from becoming clogged by corrosion products which grow, in use, in the heat exchanger.

The preventing means may be provided by the second tubes having an internal passage cross sectional area which is larger than that of the first tubes.

Alternatively or in addition, a filter device may be disposed in the second tank for filtering out corrosion products which grow, in use, in the first tubes.

Therefore, even if the corrosion products are grown in the first tubes and flow into the second tubes through the second tank and accumulate on inner surfaces of the second tubes, the second tubes are difficult to clog. As a result, the efficiency of heat exchanging is not decreased in long service.

In the accompanying drawings:

Figure 1 is a perspective view of a heat exchanger in accordance with the prior art;

Figure 2 is a sectional view of the heat exchanger of Figure 1;

Figure 3 is a partial cross-sectional view taken on the line 3-3 in Figure 2;

Figure 4 is a sectional view of a heat exchanger

in accordance with a first embodiment of the invention;

Figure 5 is a partial cross sectional view taken on the line 5-5 in Figure 4;

Figure 5(a) and 5(b) are a various cross sectional views in accordance with modifications of the Figure 5 embodiment;

Figure 6 is a partial cross sectional view similar to Figure 5 but in accordance with a second embodiment;

Figure 6(a) and 6(b) are a various cross sectional views in accordance with modifications of the Figure 6 embodiment;

Figure 7 is a sectional view of a heat exchanger in accordance with a third embodiment;

Figure 8 is a perspective view of a filter device of the Figure 7 embodiment;

Figure 9 is a sectional view of a heat exchanger in accordance with a forth embodiment; and,

Figure 10 is a perspective view of a filter device of the Figure 9 embodiment.

Embodiments of the present invention as applied to a heat exchanger for use with a vehicle engine are illustrated in Figures 4-10. The same numerals are used in Figures 4-10 to denote the corresponding elements shown Figure 1, 2 and 3 in the prior art. The explanations of those elements are omitted.

Figure 4 and 5 illustrate a first embodiment of the invention. A plurality of parallel flat tubes 11 and a plurality of parallel flat tube 31 are disposed between upper tank 14 and lower tank 15. The upstream flat tubes 11 are connected in fluid communication with inlet chamber 17 of upper tank 14, and the downstream flat tubes 31 are connected in fluid communication with outlet chamber 18 of upper tank 14. Corrugated fin units 12 are respectively positioned between two flat tubes 11 and two flat tubes 31. Each flat tubes 31 has a metal core 31a which is made of aluminium alloy with cladding linings 31 for preventing the pitting of flat tubes 31 such that cladding 31 functions as sacrificial metal for the core metal.

Each tube 31 includes at least one fluid passageway therein and has a cross section with a width B which is larger than the width A of each flat tube 11 in the direction of the width of the heat exchange core 13. On the other hand, the depth of each flat tube 31 is identical to that of each flat tube 11. Thereby, the passage cross sectional area of each flat tube 31 is larger than for the flat tubes 11. Even if the corrosion products grow in the flat tubes 11 and flow into the flat tubes 31 through the chamber 21 of lower tank 15 and gradually accumulate on inner surface of flat tubes 31, flat tubes 31 are difficult to clog by the corrosion products. As a result, the heat exchanging efficiency of the heat exchanger is not decreased in long service. As shown in Figure 5(a) and 5(b), the interior space 25 of tube 31 may be divided by a plurality of parallel wall portions 311 into a corresponding plural-

ity of essentially parallel passages through which coolant fluid flows.

Figure 6 illustrates a second embodiment of the invention. Flat tubes 41 have a metal core 41a which is made of aluminum alloy with cladding linings 41 for preventing the pitting of the flat tubes 31, the cladding 41 functioning as sacrificial metal for the core metal. Depth D of flat tubes 41 are larger than depth C of flat tubes 11. However, the thickness of flat tubes 41 are identical to that of flat tubes 11. Therefore, the passage cross sectional area of tubes 41 is larger than that of flat tubes 11 as in the first embodiment. Both the function and effect of this embodiment are almost same as the function and the effects of a first embodiment so that explanations thereof are omitted. As shown in Figure 6(a) and 6(b), the interior space 26 or tube 41 may be divided by a plurality of parallel wall portions 411 into a corresponding plurality of essentially parallel passages through which coolant fluid flows.

Figure 7 and 8 illustrates a third embodiment of the invention. Filter 23 is disposed in the center of chamber 21 of lower tank 15 and mechanically fixed to the inner surface of chamber 21 so that the chamber 21 is substantially partitioned into two chambers by filter 23. Further, filter 23 is made of a porous material, such as metal or plastics, and filters the corrosion products which are grown in upstream flat tubes 11 leading from inlet chamber 17 of upper tank 14 without flowing into downstream flat tubes 11 which lead to outlet chamber 18 of upper tank 14. Thereby, the cooling medium, which does not contain corrosion products, passes through the downstream flat tubes 11 leading to outlet chamber 18 of upper tank 14. Filter 23 may be fixed to the inner surface of chamber 21 so as to be exchangeable. Also, filter 23 may be designed to function, without impairing the heat exchanger until its area is clogged by 50%. Therefore, even if the corrosion products grow in the upstream flat tubes 11 and flow into chamber 21 of lower tank 15, flat tubes 31 will not be clogged by the corrosion products. As a result, the heat exchanging efficiency is not decreased in long service.

Figure 9 and 10 illustrate a fourth embodiment of the invention. Filter 24 includes first filter portion 24a and second filter portion 24b thereof. First filter portion 24a is mechanically connected to the inner surface of chamber 21 of lower tank 15 in parallel with flat tubes 11. Second filter portion 24b is extending from first filter portion 24a in parallel with the bottom surface of lower tank 15 and connected to the side surface of chamber 21 of lower tank 15. In this arrangement, the surface area which can filter the corrosion products is wider than that of the third embodiment. As a result, the filtering ability is increased in comparison with the third embodiment.

## Claims

1. A heat exchanger comprising first (14) and second (15) tanks, the first tank including a partition (16) therein for dividing the first tank into a first chamber (17) and a second chamber (18), the first chamber including an inlet pipe fitting (19) for providing a path of ingress of a heat transfer medium, and the second chamber including an outlet pipe fitting (20) for providing a path of egress of a heat transfer medium; a plurality of first tubes (11) each connected at one end to the first chamber of the first tank and at the other end to the second tank, a plurality of second tubes (11,31,31) each connected at one end to the second chamber of the first tank and at the other end to the second tank; and a plurality of corrugated fin units attached to and positioned between the tubes; characterised by preventing means (31,41,24) disposed in the heat exchanger for preventing the second tubes from becoming clogged by corrosion products which grow, in use, in the heat exchanger.
 

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2. A heat exchanger according to claim 1 wherein the preventing means is provided by the second tubes (31,41) having a width and/or depth which is greater than that of the first tubes (11).
 

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3. A heat exchanger according to claim 1, wherein the preventing means is provided by the second tubes (31,41) having an internal passage sectional area which is greater than that of the first tubes (11).
 

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4. The heat exchanger according to any one of the preceding claims, wherein the preventing means comprises a filter device (24) disposed in the second tank for filtering out the corrosion products which grow, in use, in the first tubes (11).
 

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5. A heat exchanger according to claim 4, wherein the filter device is made of a porous material.
6. A heat exchanger according to any one of the preceding claims, wherein the tubes (11,31,41) are flat tubes.
 

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FIG. 1  
(Prior Art)

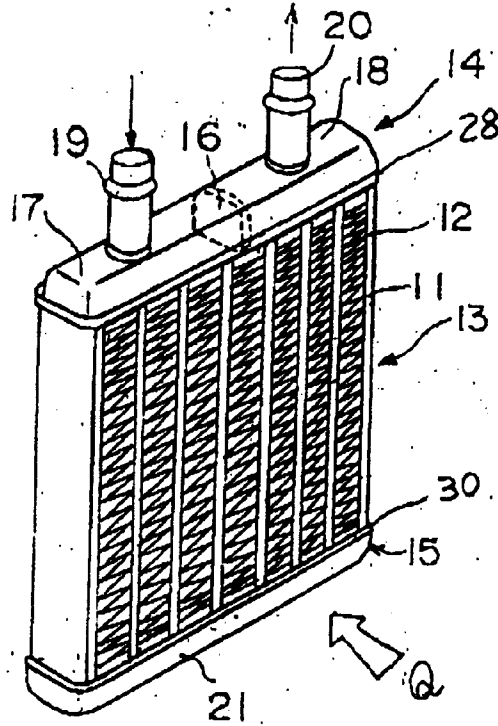


FIG. 2  
(Prior Art)

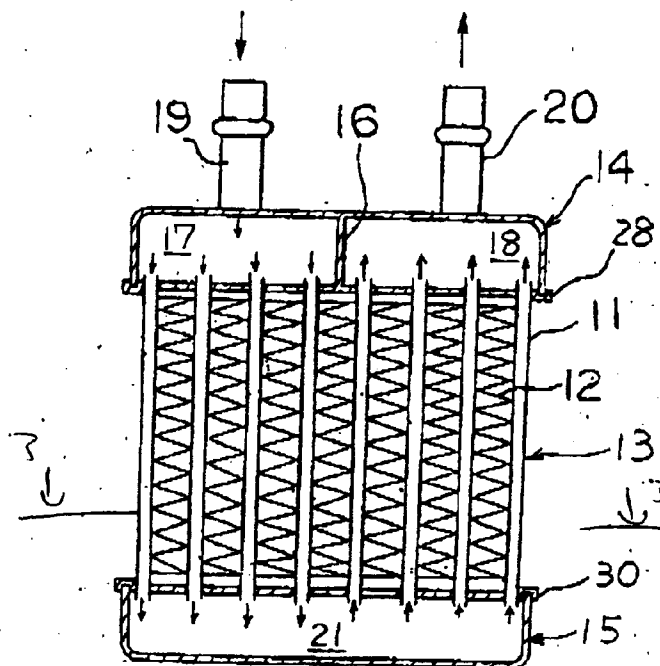


FIG. 3  
(Prior Art)

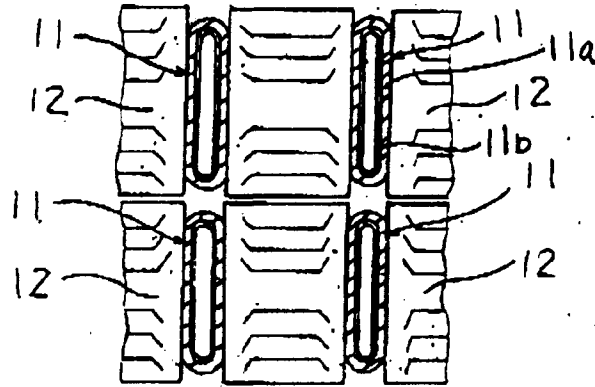


FIG. 4

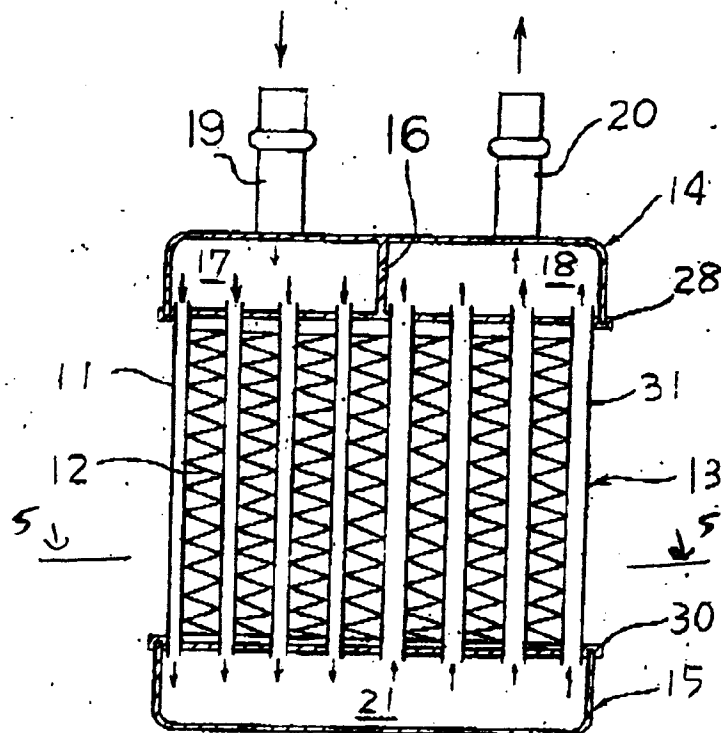


FIG. 5

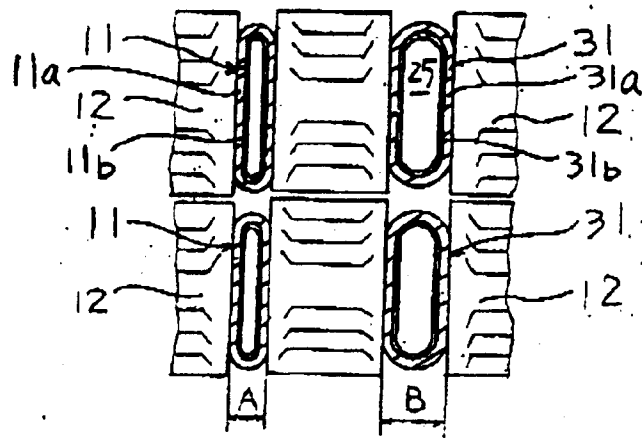


FIG. 5(a)

FIG. 5(b)

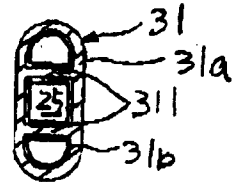
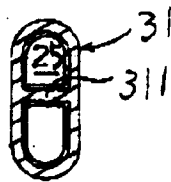


FIG. 6

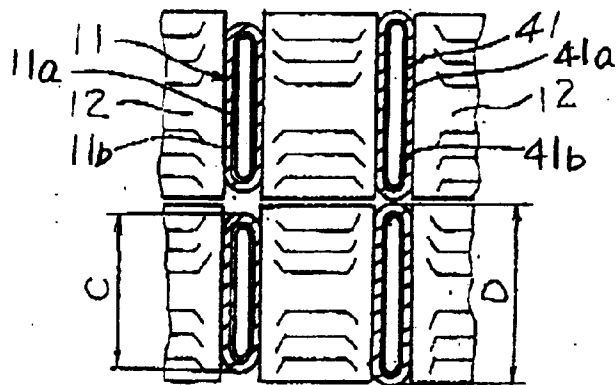


FIG. 6(a)

FIG. 6(b)

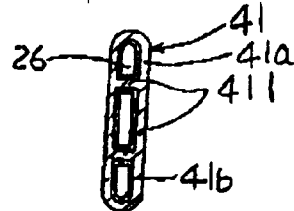
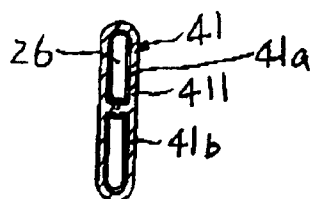


FIG. 7

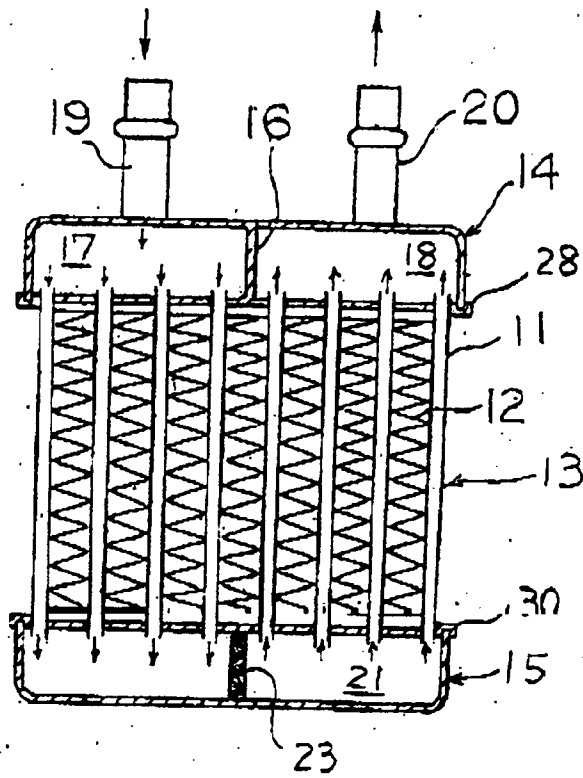


FIG. 8

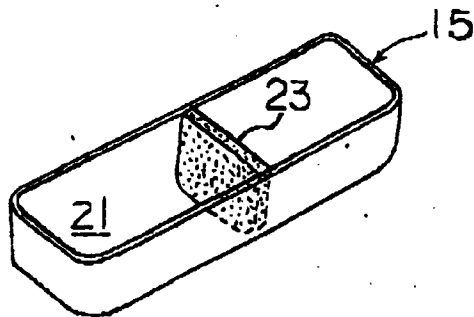


FIG. 9

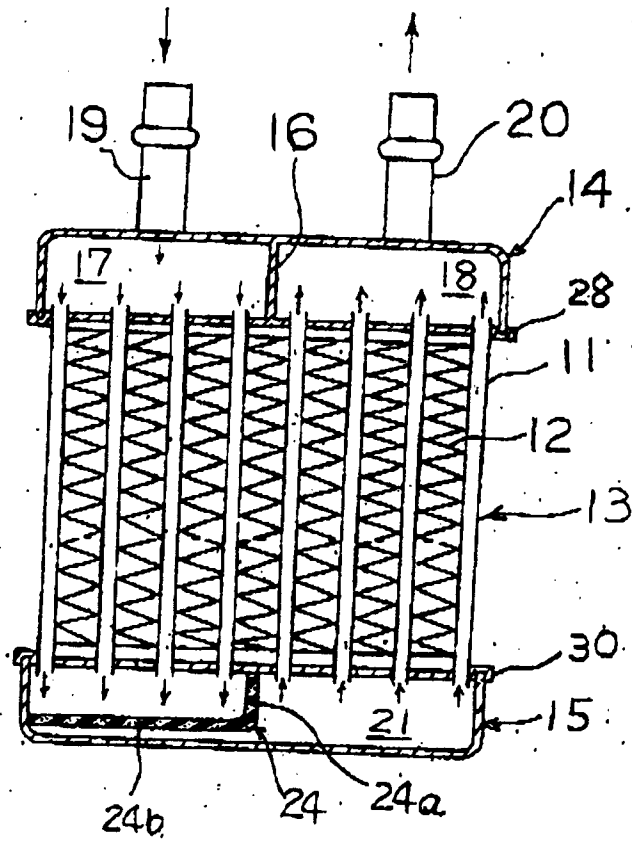


FIG. 10

