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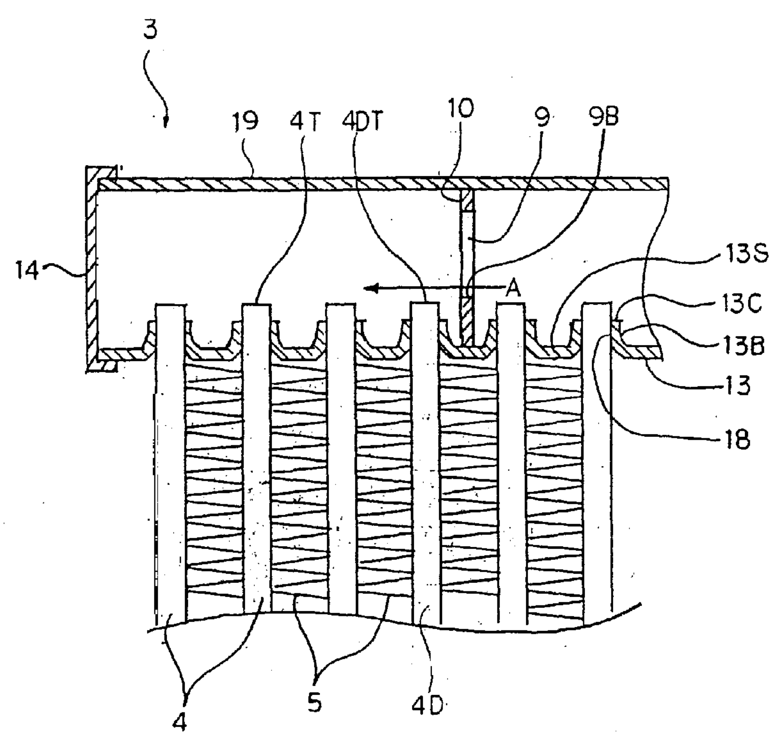
(54) **Heat exchanger**

(57) A heat exchanger has tubes (4) protruding into a tank (3) containing a flow reducing plate (10) which has a constricting hole (9). In order to minimise noise at a critical flow velocity the position of the hole is related to the maximum protrusion of the tubes so that flow passing through the hole does not impinge directly on the tubes.

Fig . 5



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Description

The present invention relates to a heat exchanger primarily for use in a vehicle, more particularly to the internal structure of a tank of a heat exchanger, which can prevent noise which would occur when the heat medium is flowing within it at a certain velocity.

In Fig. 1 and Fig. 2, a heat exchanger of a so-called multi-tube type, to which the techniques of both the conventional art and the present invention are applied, is shown. With reference to Fig. 1, the heat exchanger 1 essentially comprises a pair of tanks 2, 3, a plurality of heat transfer tubes 4 interconnecting the tanks 2, 3, and a plurality of corrugated fins 5 stacked alternately with the heat transfer tubes 4.

With reference to Fig. 2, the tank 2 comprises a tank member 12, a plate 13, and a pair of caps 14, 15. In the plate 13, a plurality of slots 18 each with burring are provided, in which the heat transfer tubes 4 are inserted. The chamber within the tank 2 is divided into two hermetically sealed chambers by a partition plate 8 which is provided about midway along the tank 2. In the tank member 12 at one chamber side, a hole 16 is formed and is attached to an inlet pipe 6. In the tank member 12 at the other chamber side, another hole 17 is formed and is attached to an outlet pipe 7. To the inlet pipe 6 and the outlet pipe 7, the external circulation circuit for a heat medium is connected.

The tank 3 comprises a tank member 19, a plate 13, and a pair of caps 14, 15. In the plate 13, a plurality of slots 18 each with burring are provided, in which the heat transfer tubes 4 are inserted. Within the tank 3, about one quarter of the way along the tank from the cap 14, a plate 10' with a hole 9' is provided. In this specification, we shall hereafter call the hole 9' a flow reducing hole, and the plate 10' as a flow reducing plate.

All of the above parts, i.e. the tank members 12, 19, plates 13, caps 14, 15, partition plate 8, flow reducing plate 10', heat transfer tubes 4, corrugated fins 5, inlet pipe 6, and outlet pipe 7 are brazed in a furnace so as to be fixed with each other.

With reference to Fig. 1 again, the heat medium from the external circulation circuit (not shown) enters the cap 15 side chamber in the tank 2 through the inlet pipe 6. Thence the heat medium passes through the heat transfer tubes 4 that are connected to the cap 15 side chamber of tank 2, to enter the tank 3. When passing through the heat transfer tubes 4, the heat medium exchanges its heat contents with the air passing transversely through the heat exchanger 1. Within the tank 3, the heat medium flows upwards as seen in Fig. 1. Then, the heat medium passes through the remaining heat transfer tubes 4 to enter the cap 14 side chamber of tank 2. When passing through the heat transfer tubes 4, the heat medium exchanges its heat contents with the air passing through the heat exchanger 1, at this time also. Finally, the heat medium is collected within the cap 14 side chamber of the tank 2, and flows out to the external circulation circuit through the outlet pipe 7.

In Fig. 3, a vertical cross section of the tank 3 including the flow reducing plate 10' is shown. The flows of the heat medium flowing into the heat transfer tubes 4, are indicated by arrows C in the figure. The flow reducing plate 10' functions to reduce the amount of heat medium that flows into the heat transfer tubes 4 located to the cap 14 side within the tank 3. If were it not for the flow reducing plate 10', the heat medium flowing from the right side in Fig. 3 would concentrate at the cap 14 side within the tank 3 due to its inertia. In such a situation, the amounts of heat medium flowing in the heat transfer tubes 4 of cap 14 side will be greater than the ones flowing in the heat transfer tubes 4 that are relatively remote from the cap 14. The occurrence of differences between the amounts of heat medium flowing in each of heat transfer tubes 4 lowers the total heat exchange efficiency of the heat exchanger 1 as a whole. In order to suppress this phenomenon, the flow reducing plate 10' is provided. That is, the flow reducing hole 9' in the flow reducing plate 10' restricts the excess amount of heat medium which would reach the cap 14. In this way, the amounts of heat medium flowing into all of the heat transfer tubes 4 are equalised to approximately one value, by the function of the flow reducing plate 10'.

However, the following problem occurs for the conventional structure of the flow reducing plate 10'. Here, we refer to the heat transfer tube 4 that is immediately downstream the flow reducing plate 10' as 4D, and its end as 4DT. Each of heat transfer tubes 4, 4D is inserted into the slots 18 in the plate 13. All of slots 18 are provided with the burring 13B which protrude to the inner space within the tank 3. Further, the ends 4T, 4DT of the heat transfer tubes 4, 4D protrude from the top 13C of burring 13B by a certain amount. Consequently, the bottom (as seen in Fig. 4) 9B' of the flow reducing hole 9' of the flow reducing plate 10' will be located below the ends 4T, 4DT of the heat transfer tubes 4, 4D in the figure. Accordingly, the heat medium passing near the bottom 9B' of the flow reducing hole 9' impinges particularly upon the end 4DT of the heat transfer tube 4D immediately downstream of the flow reducing plate 10', as indicated by the arrow A'.

As a result, when, for example, the rotational speed of a compressor in a refrigerant circuit of a vehicular air conditioning system changes (owing to the change in the rotational speed of the vehicle engine), and the flow velocity of the heat medium within the tank 3 reaches a certain value, a noise, of which the intensity is so big as to be recognized by the driver, occurs. So, when accelerating the vehicle from low to high velocity, or decelerating from high to low velocity, the flow velocity of the heat medium within the tank 3 certainly traverses this particular value to cause noise for a while.

Here, the relative position of the flow reducing hole 9' and the end 4DT of the heat transfer tube 4D viewed along the direction of flow of the heat medium within the tank 3, is depicted in Fig. 4. The thickness t of the plate

13 is typically about 1 mm. The amount of the protrusion B of the burring 13B must be about 2t to 3t. Furthermore, the heat transfer tube 4D is inserted to the extent that its end 4DT protrudes from the top 13C of the burring 13B by an amount S which equals to about 2 mm. The reason why the protrusion amount S is needed is to avoid the intrusion of the brazing material from the ends 4T, 4DT into the heat transfer tubes 4, 4D when brazing. As a consequence, the ends 4T, 4DT of the heat transfer tubes 4, 4D protrude from the inner surface 13S of the plate 13 by B+S= 4 mm to 5 mm. In the figure, a part of the end 4DT of the heat transfer tube 4D can be seen through the flow reducing hole 9'. Upon this part, a portion of the heat medium that has passed through the flow reducing hole 9', impinges and causes a noise.

It has been long desired to improve the structure of the heat exchanger so as to prevent noise which would occur when operating at certain flow velocity of heat medium. In other words, it has long been desired to improve the structure of the flow reducing hole part.

Accordingly, it is an object of the present invention to provide a heat exchanger which can suppress the noise heard from near the flow reducing plate when the heat medium flows at a certain velocity within the tank. The other object of the present invention is to provide a heat exchanger which can resolve the above noise problem without increment in the size of the heat exchanger.

According to the present invention, there is provided a heat exchanger comprising a pair of tanks; a plurality of heat transfer tubes interconnecting the pair of tanks; a plurality of fins disposed between the plurality of heat transfer tubes; a partition plate provided within one tank and separating an inlet and an outlet; and a flow reducing plate with a flow reducing hole provided partway along within the second tank for equalising the amount of heat medium flowing within the heat transfer tubes; characterised in that at least the heat transfer tubes downstream of the flow reducing plate protrude from the inner surface of the second tank by an amount (S+B), which is less than the closest spacing of the flow reducing hole from the inner surface of the second tank.

With this arrangement, the flow reducing hole is formed at a position such that no part of the end of the heat transfer tube can be seen through the hole when viewed along the direction of the flow of the heat medium within the second tank.

The flow reducing hole may be circular, or elongate (e.g. oval or rectangular), with a longer side closest to the inner surface of the tank. By positioning the flow reducing hole appropriately and making the shape of the flow reducing hole elongate, a necessary passage area in the flow reducing plate for the heat medium can be maintained without any increment in the size of the heat exchanger itself, while the noise problem can be resolved.

In the accompanying drawings:

Fig. 1 is a perspective view of a heat exchanger to which both the conventional art and the present invention can be applied.

Fig. 2 is an exploded perspective view of the heat exchanger shown in Fig. 1.

Fig. 3 is a partial cross sectional view of the conventional art cut along the line III-III' in Fig. 1.

Fig. 4 is a partial cross sectional view of the conventional art cut along the line IV-IV' in Fig. 1.

Fig. 5 is a partial cross sectional view illustrating the principle of the present invention cut along the line III-III' in Fig. 1.

Fig. 6 is a partial cross sectional view of a first embodiment of the present invention cut along the line IV-IV' in Fig. 1.

Fig. 7 is a partial cross sectional view of a second embodiment of the present invention cut along the line IV-IV' in Fig. 1.

Fig. 8 is a partial cross sectional view of a third embodiment of the present invention cut along the line IV-IV' in Fig. 1.

The heat exchanger according to the present invention differs from the conventional heat exchanger only in the position of the flow reducing hole and its shape. So the perspective view and exploded view of the heat exchanger according to the present invention are the same as shown in Figs. 1 and 2. Because the constitutional parts are almost the same as in the conventional art, explanations of them are omitted.

In Fig. 5, a cross sectional view of the tank 3 illustrating the principle of the present invention is depicted. To each of the slots 18 in the plate 13 are provided burring 13B, as with the conventional structure. Further, the ends 4T, 4DT of the heat transfer tubes 4, 4D protrude from the top 13C of the burring 13B by a certain amount, also as with the conventional structure. However, the position of the flow reducing hole 9 is designed such that its bottom (as seen in Fig. 5) 9B is higher than the end 4T, 4DT of the heat transfer tubes 4, 4D when measured from the inner surface 13S of the plate 13. By this structure, no portion of the heat medium that has passed through the flow reducing hole 9 impinges directly upon the ends 4DT of the heat transfer tubes 4D, as indicated by an arrow A. As a result, the heat exchanger according to the present invention can prevent the occurrence of the noise.

In Fig. 6, a cross sectional view of the flow reducing plate 10 portion of the first embodiment of the present invention is shown. As can be understood from this figure, the flow reducing hole 9 is made at such a position that the ends 4DT cannot be seen through it, when viewed along the direction of the heat medium flowing within the tank 3. In other words, when measured from the plate 13, the bottom (as seen in Fig. 6) 9B of the flow reducing hole 9 is higher than the end 4DT of the heat transfer tube 4D. By such a positioning of the flow reducing hole 9, the noise problem can be resolved.

In Fig. 7, a cross sectional view of the flow reducing plate 10 portion of the second embodiment of the present invention is shown. As can be understood from the figure, the elongate flow reducing hole 9L earns the necessary passage area for heat medium by being elongate, as well as being made at such a position that the ends 4DT can not be seen through it, when viewed along the direction of the heat medium flowing within the tank 3. In other words, when measured from the plate 13, the bottom (as seen in Fig. 7) 9B' of the flow reducing hole 9L is higher than the end 4DT of the heat transfer tube 4D. By this positioning and shaping of the flow reducing hole 9L, the noise problem can be resolved and at the same time any increment in the size of the heat exchanger can be avoided.

In Fig. 8, a cross sectional view of the flow reducing plate 10 portion of the third embodiment of the present invention is shown. As can be understood from the figure, the rectangular flow reducing hole 9R earns the necessary passage area for heat medium by being elongate longer in the lateral direction, as well as being at such a position that the ends 4DT cannot be seen through it, when viewed along the direction of the heat medium flowing within the tank 3. In other words, when measured from the plate 13, the bottom (as seen in Fig. 8) 9B" of the flow reducing hole 9R is higher than the end 4DT of the heat transfer tube 4D. By this positioning and shaping of the flow reducing hole 9R, the noise problem can be resolved and at the same time any increment in the size of the heat exchanger can be avoided.

With reference to Fig. 6-8, principally the gap between the bottom 9B of the flow reducing hole 9 and the end 4DT of the heat transfer tube 4D, or the corresponding gap in Fig. 7 or in Fig. 8, has to be greater than zero, and in practice, the gap is preferably greater than 2 mm. Although in the above explanations it has been assumed that both of the upstream side and the downstream side heat transfer tubes 4, with regard to the flow reducing plate 10, protruding into the tank 3 have the same height measured from the inner surface 13S of the tank 3, the purpose of the present invention can also be attained even if the heat transfer tubes 4, 4D that have ends 4T, 4DT lower than the bottom 9B, 9B', 9B" of the hole in the flow reducing plate 10, are confined only to the downstream side heat transfer tubes 4, 4D.

Claims

1. A heat exchanger (1) comprising a pair of tanks (2,3); a plurality of heat transfer tubes (4, 4D) interconnecting the pair of tanks (2,3); a plurality of fins (5) disposed between the plurality of heat transfer tubes (4, 4D); a partition plate (8) provided within one tank (2) and separating an inlet and an outlet (6,7); and a flow reducing plate (10) with a flow reducing hole (9) provided partway along within the second tank (3) for equalising the amount of heat medium flowing within the heat transfer tubes (4, 4D); characterised in that at least the heat transfer tubes (4, 4D) downstream of the flow reducing plate (10) protrude from the inner surface (13S) of the second tank (3) by an amount (S+B), which is less than the closest spacing of the flow reducing hole (9) from the inner surface (13S) of the second tank (3).

2. A heat exchanger according to claim 1, wherein the flow reducing hole (9) is circular.

3. A heat exchanger according to claim 1, wherein the flow reducing hole (9L) is oval with a longer side closest to the inner surface (13S).

4. A heat exchanger according to claim 1, wherein the flow reducing hole (9R) is rectangular with a longer side closest to the inner surface (13S).

5. A heat exchanger according to any one of the preceding clams, wherein the closest spacing of the flow reducing hole (9, 9L, 9R) from the inner surface of the second tank (3) is at least 2 mm greater than the amount of the protrusion of the heat transfer tubes (4, 4D) from the inner surface of the tank (3).

Fig. 1

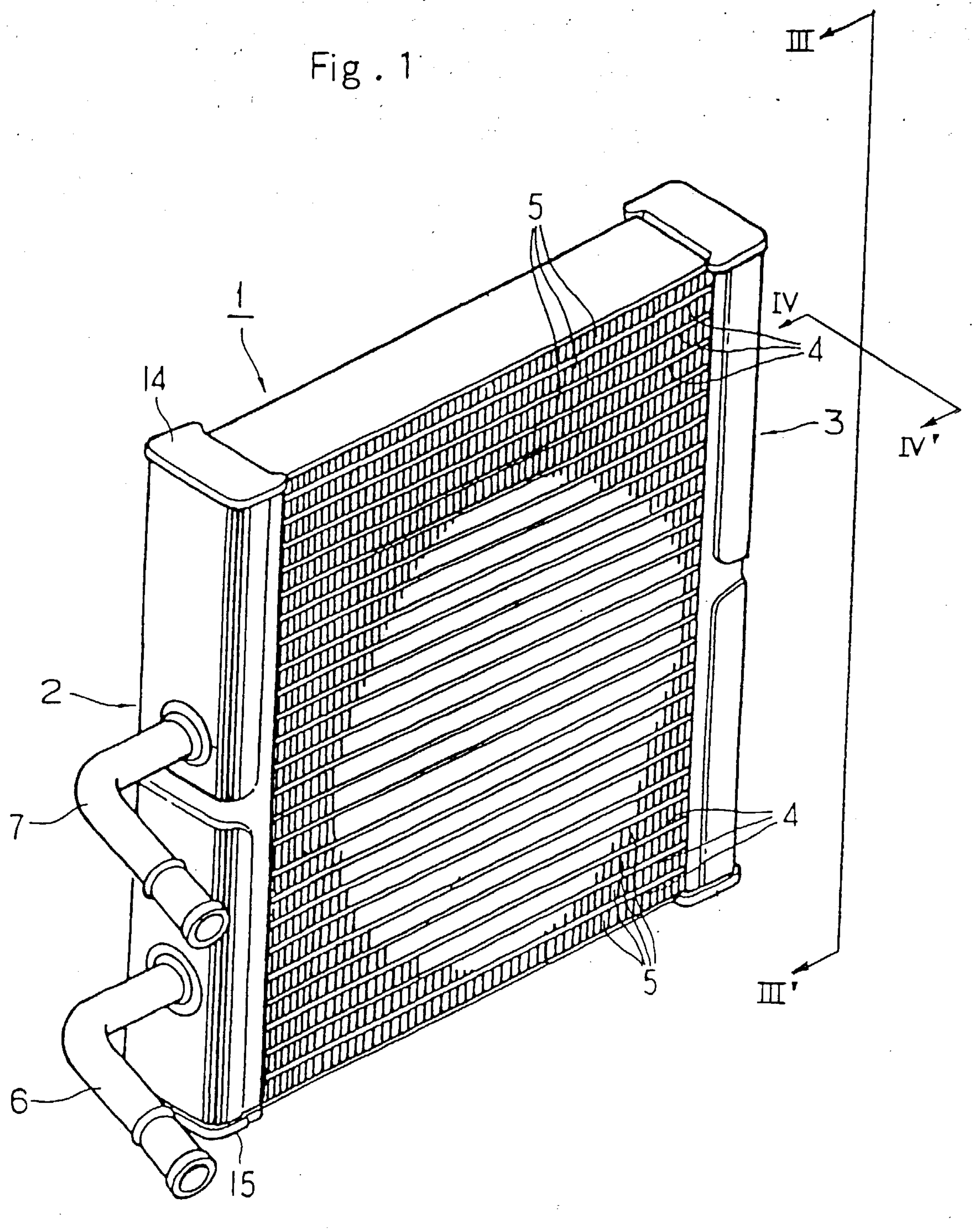

Fig. 2

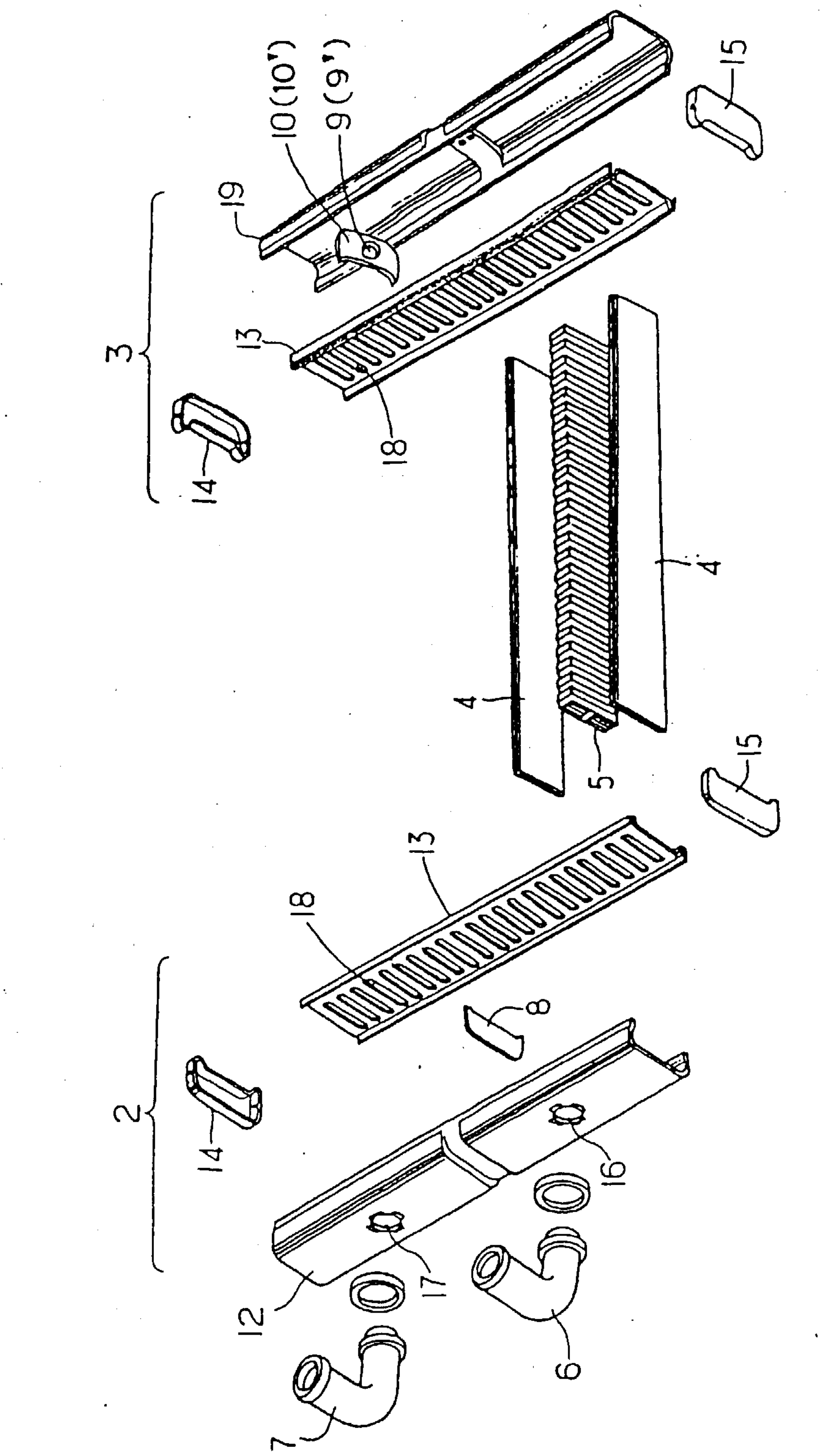

Fig. 3
(PRIOR ART)

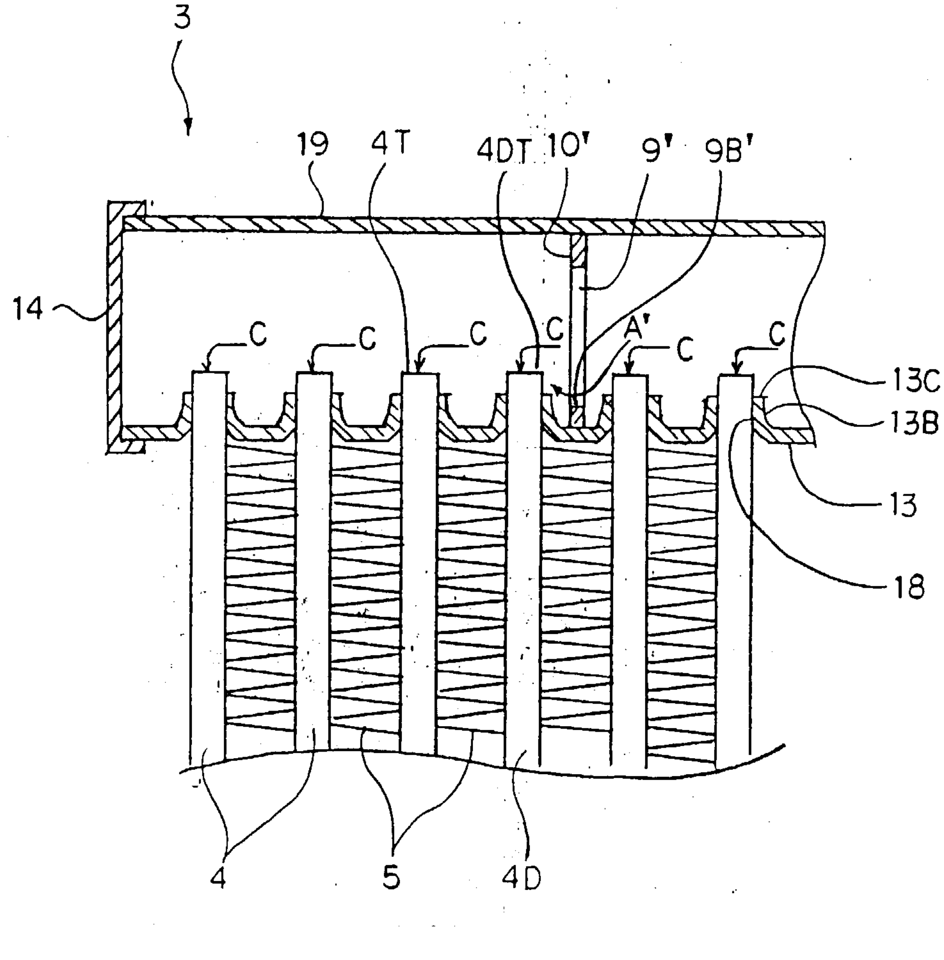

Fig. 4
(PRIOR ART)

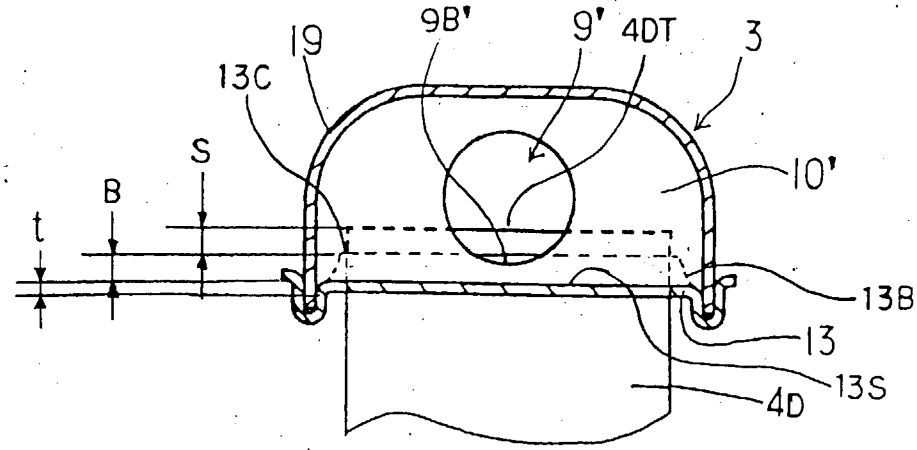

Fig . 5

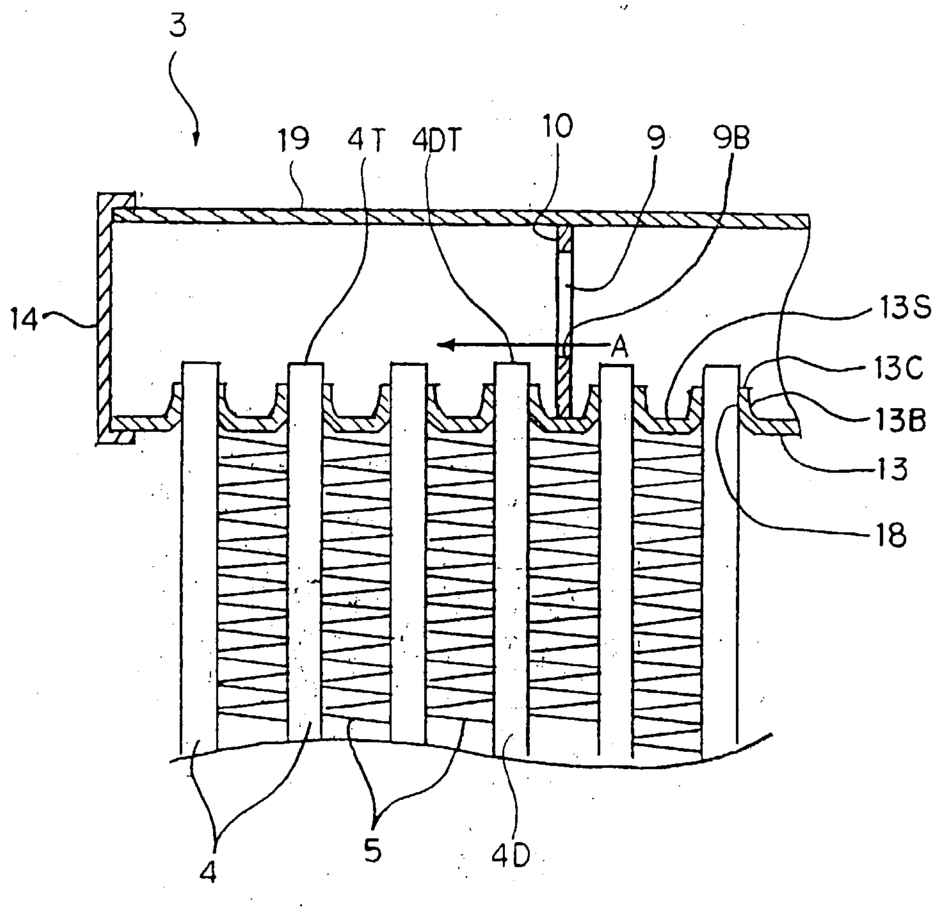

Fig. 6

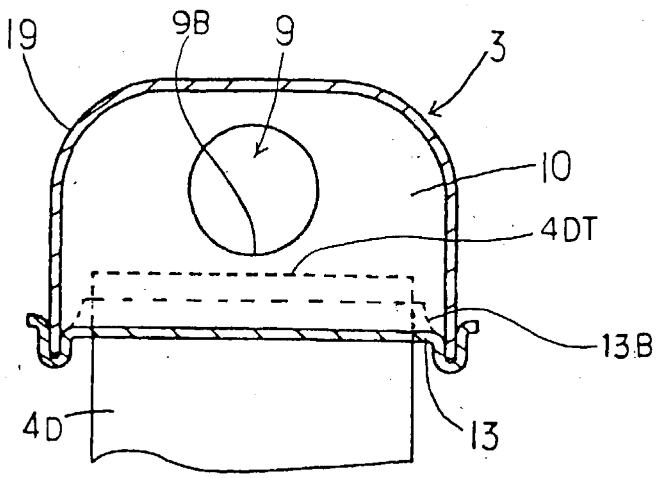

Fig. 7

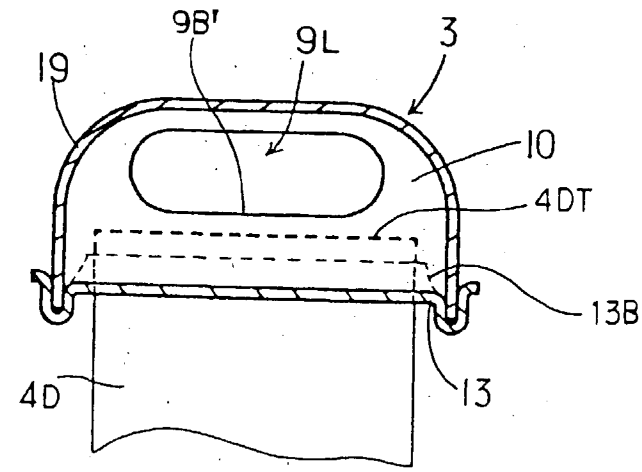

Fig. 8