(12) UK Patent Application (19) GB (11) 2 168 139 A

(43) Application published 11 Jun 1986

(21) Application No 8428600

(22) Date of filing 13 Nov 1984

(51) INT CL⁴
F28F 3/04

(52) Domestic classification (Edition H):
F4S 4B 4E1A 4E2A

(56) Documents cited
GB A 2132748 GB A 2071838 GB 1433379

(58) Field of search
F4S
Selected US specifications from IPC sub-class F28F

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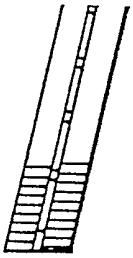
PATENTS ACT 1977

SPECIFICATION NO 2168139A

The following corrections were allowed under Section 117 on 22 July 1986

Front page Heading (71) Applicant
for Heat Transfer Technology
read Heat Transfer Technology Limited

THE PATENT OFFICE
30 July 1986



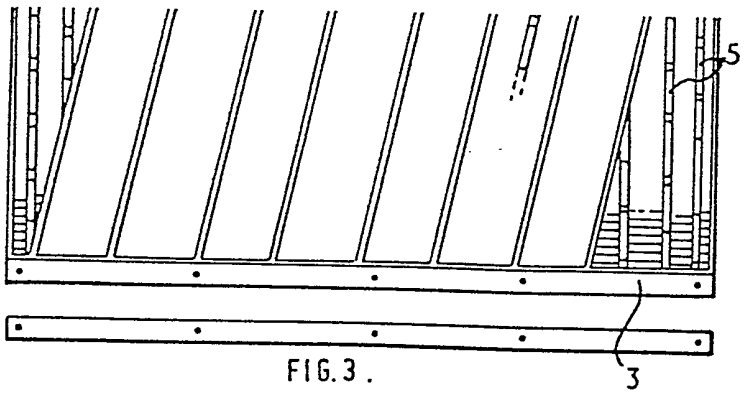


FIG.3.

GB 2 168 139 A

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(54) Improvements relating to plate type heat exchangers

(57) A heat exchanger is of the kind in which fluid flow passages are formed between adjacent parallel opposed corrugated plates and the fluids between which heat is to be exchanged are caused to flow, usually in opposite directions to one another, in alternate flow passages formed between the plates. The invention mainly proposes that at least the inlet and outlet sections of the heat exchanger plates should have corrugated portions which are offset relative to one another laterally of the direction of fluid, these sections being separated by rows of interventing transversely slotted (5) portions with the slotted portions in one row offset laterally, in relation to the direction of fluid flow, from the slotted (5) portions in each adjacent row.

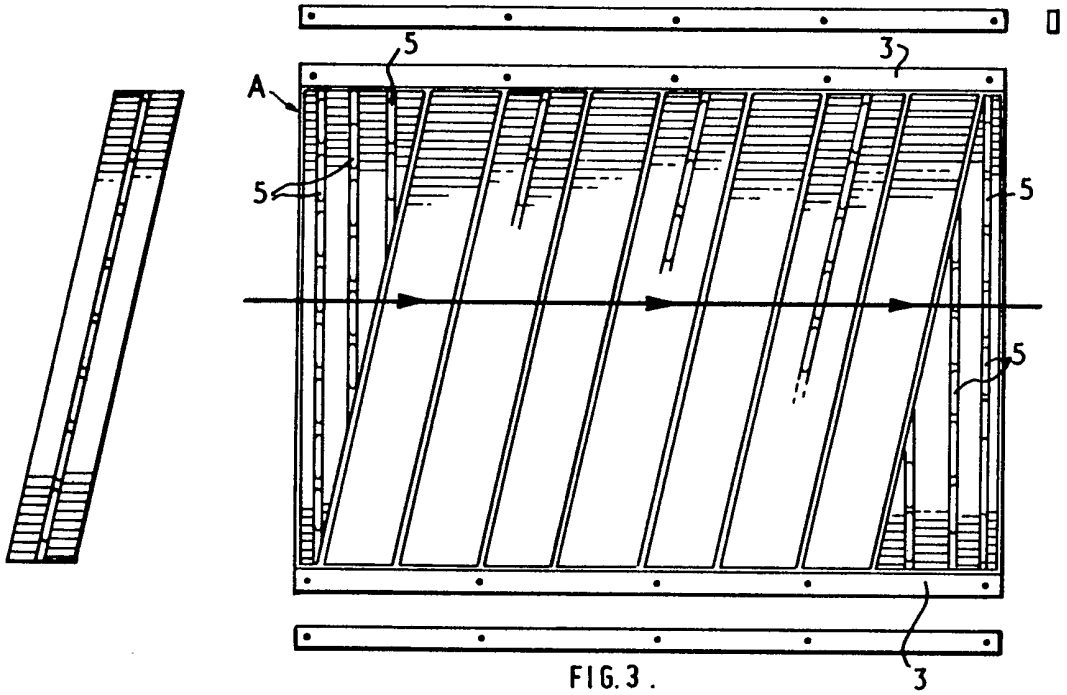

FIG. 3.

GB 2 168 139 A

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

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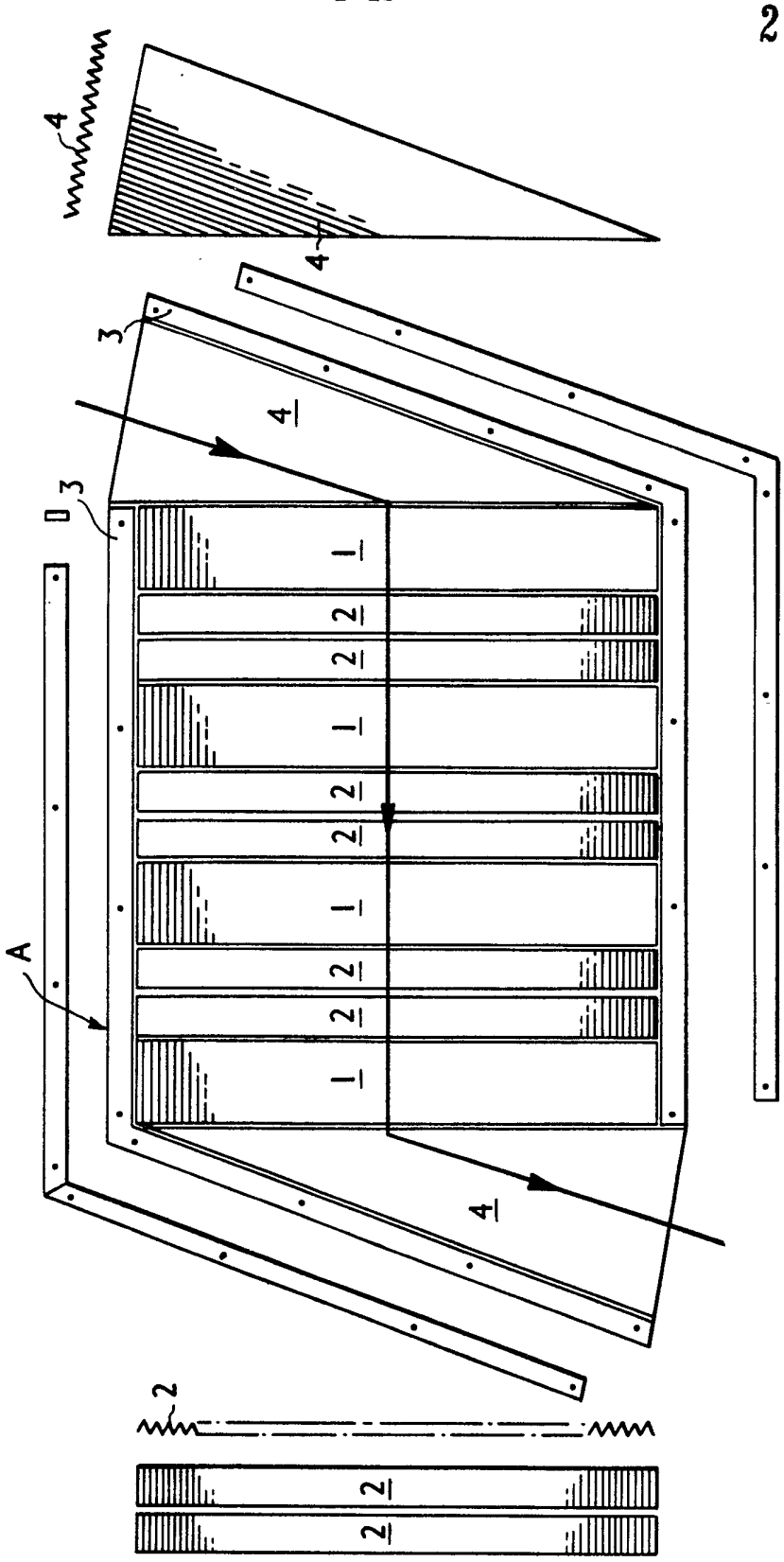

FIG.1.

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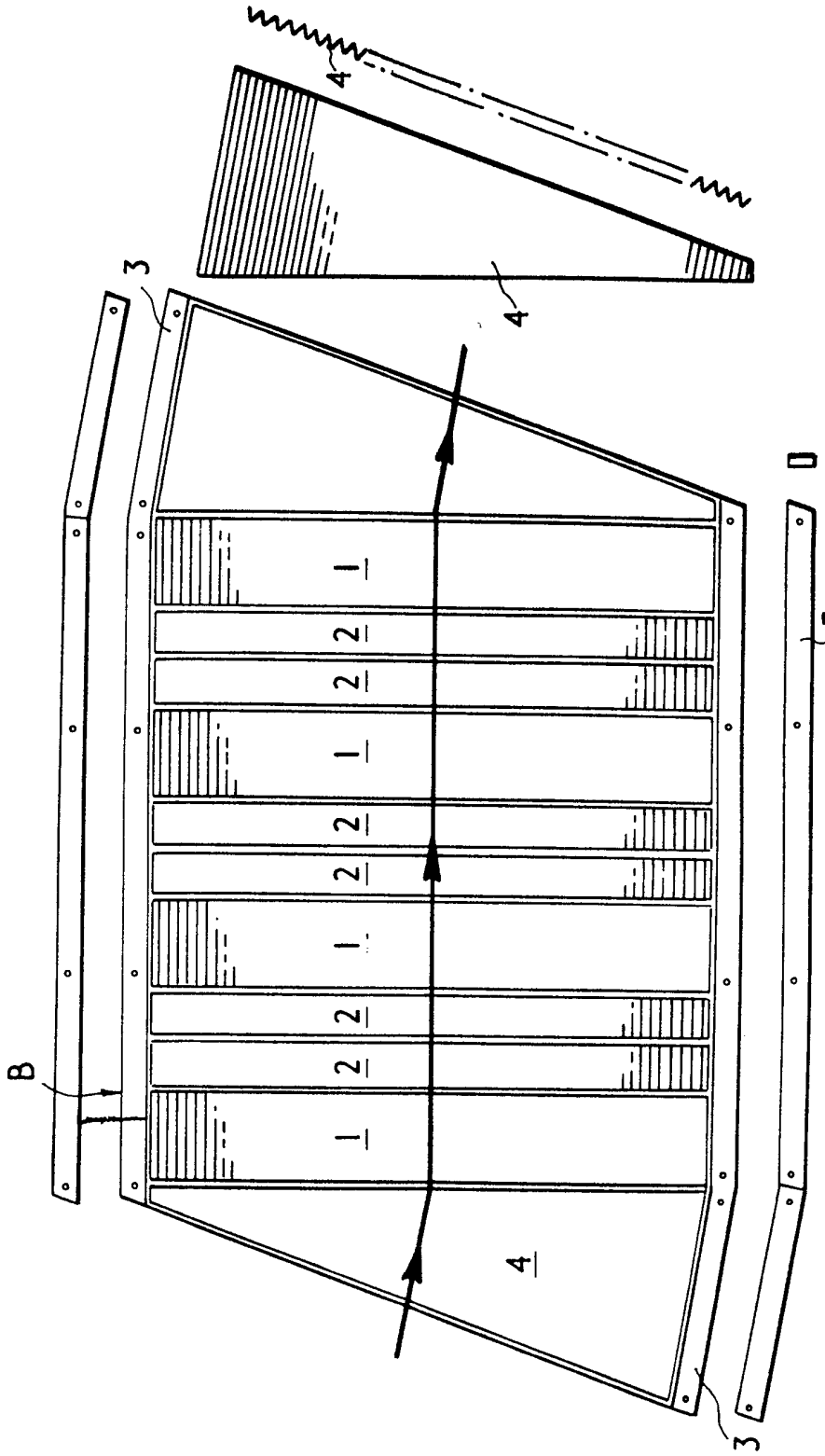


FIG.2.

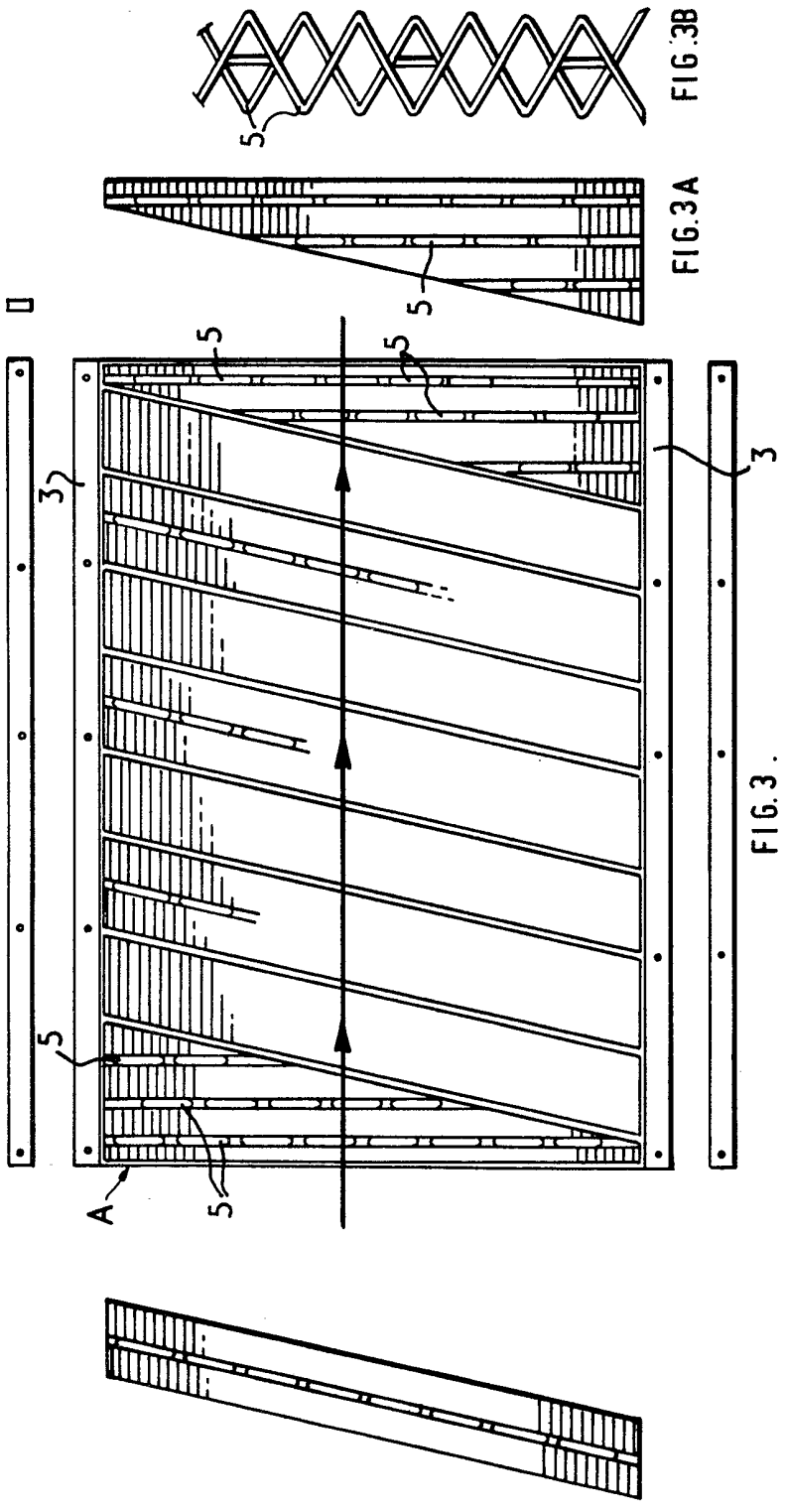


FIG.3B

FIG.3A

FIG.3.

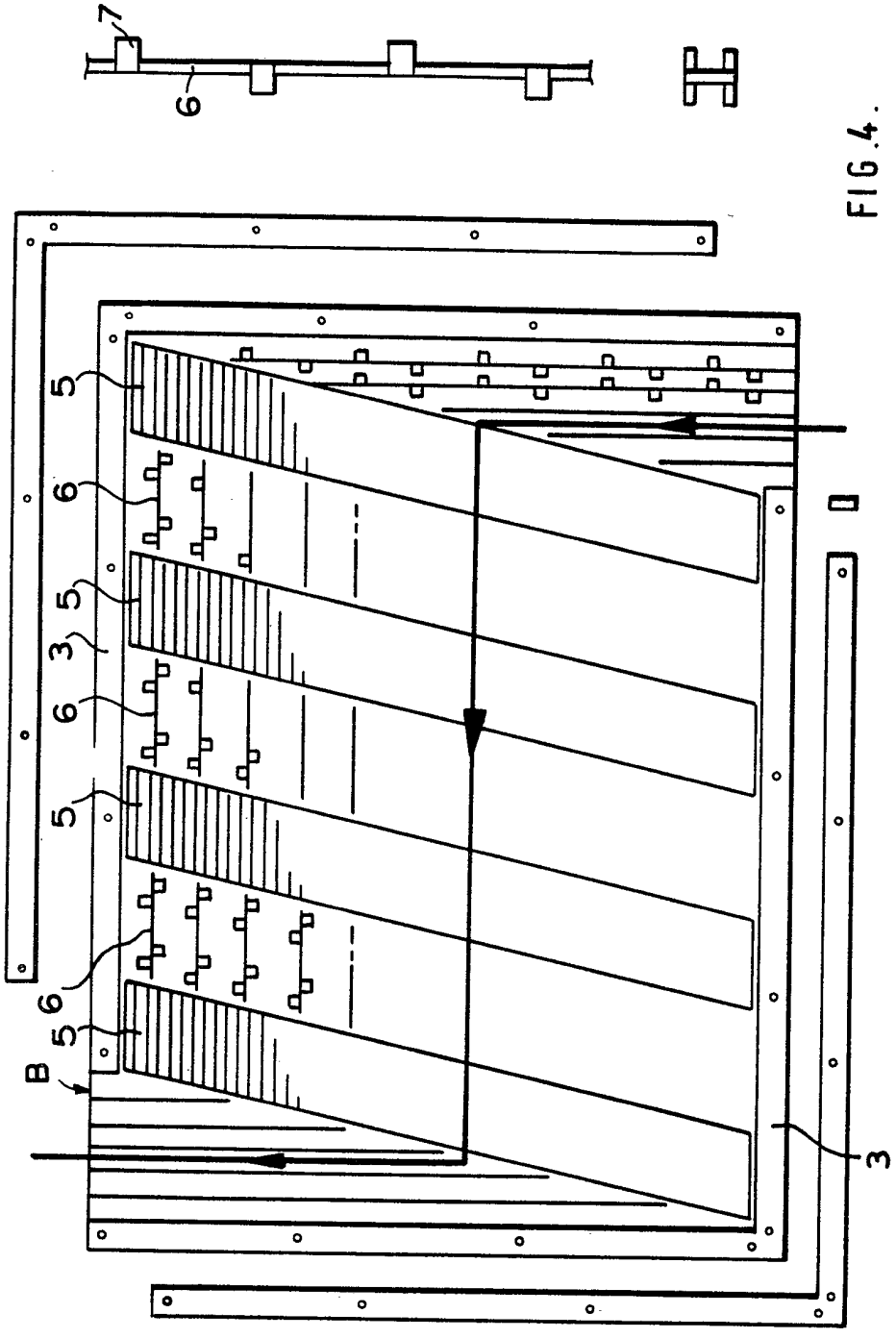


FIG.4.

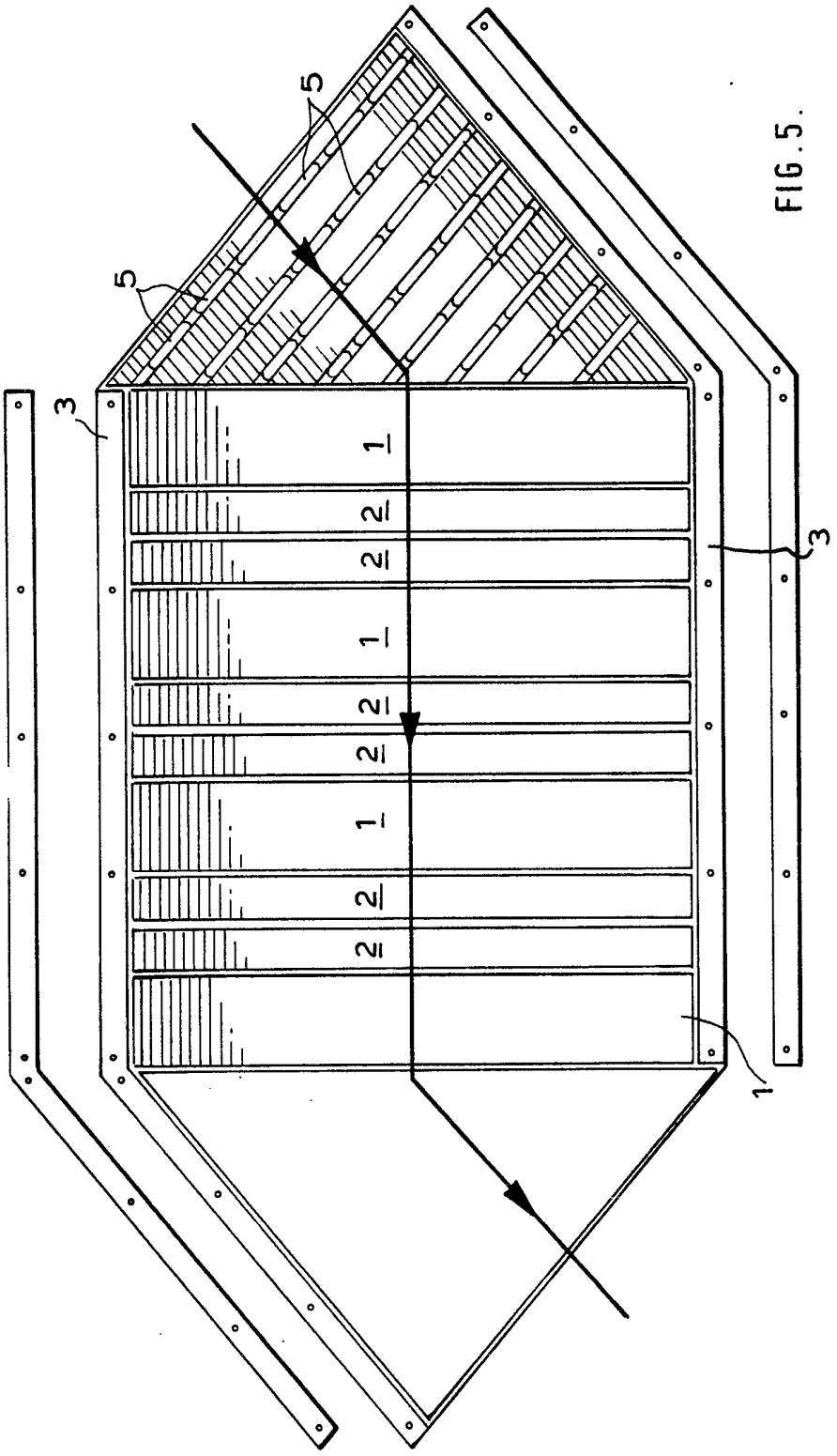


FIG.5.

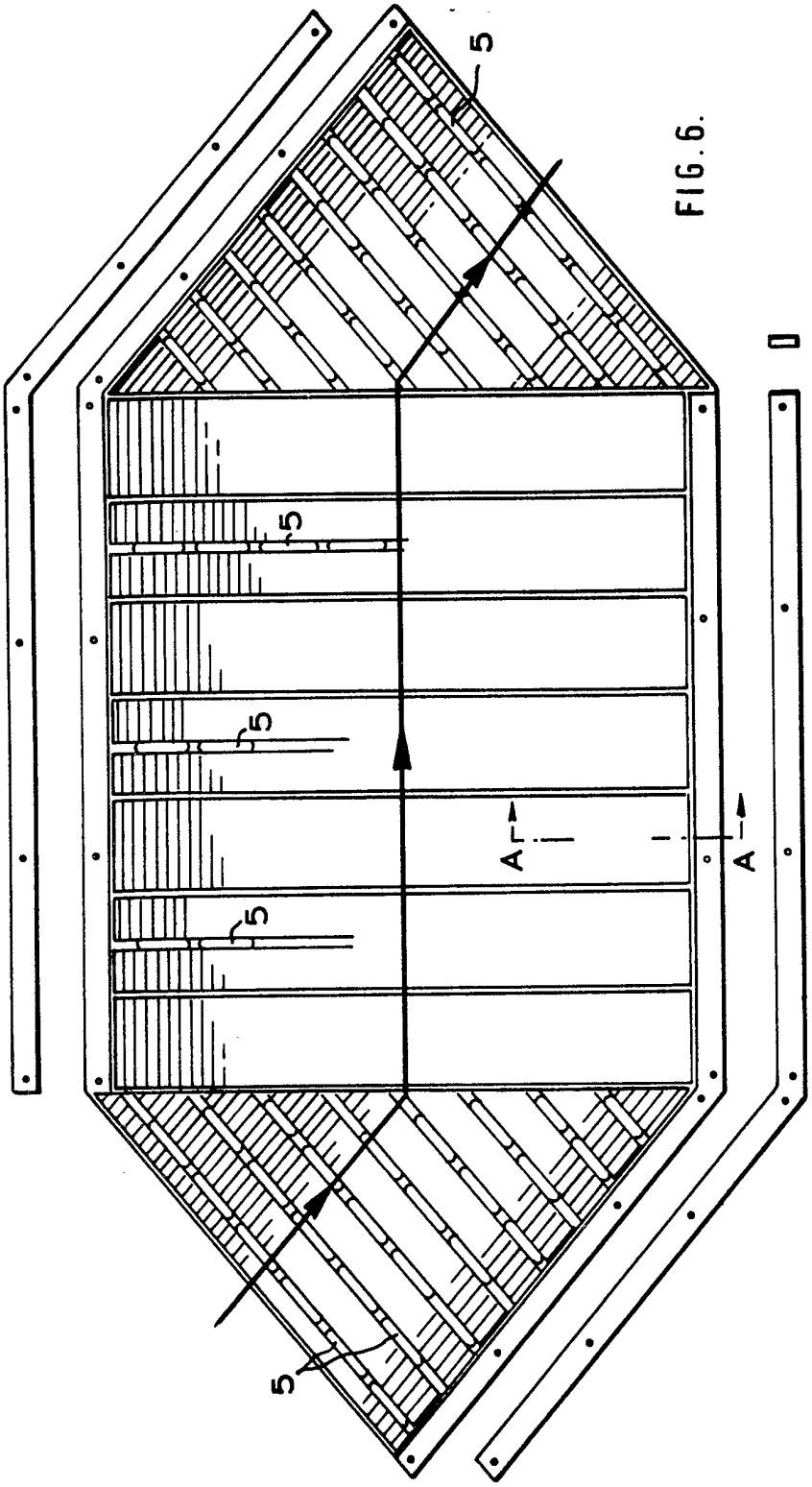


FIG.6.

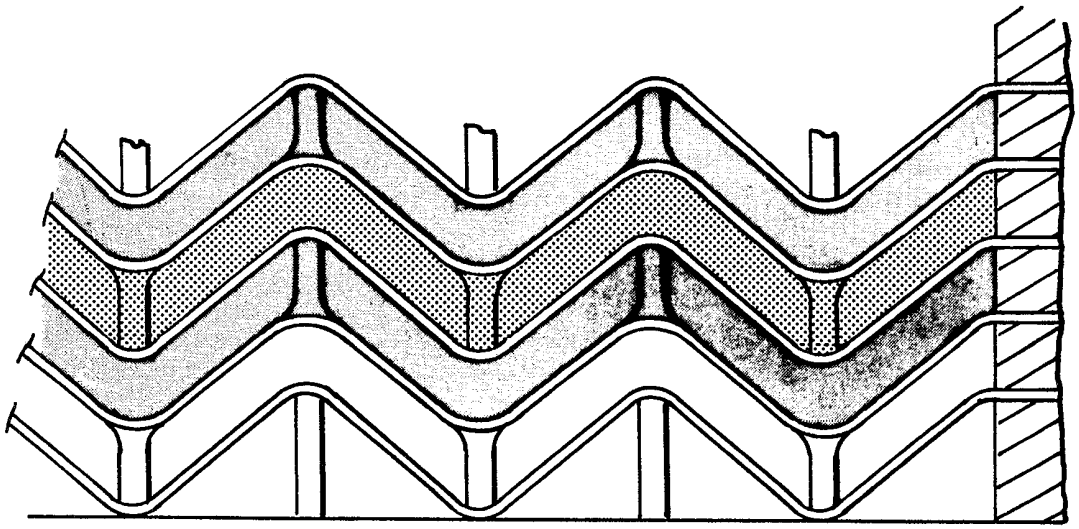


FIG.7.

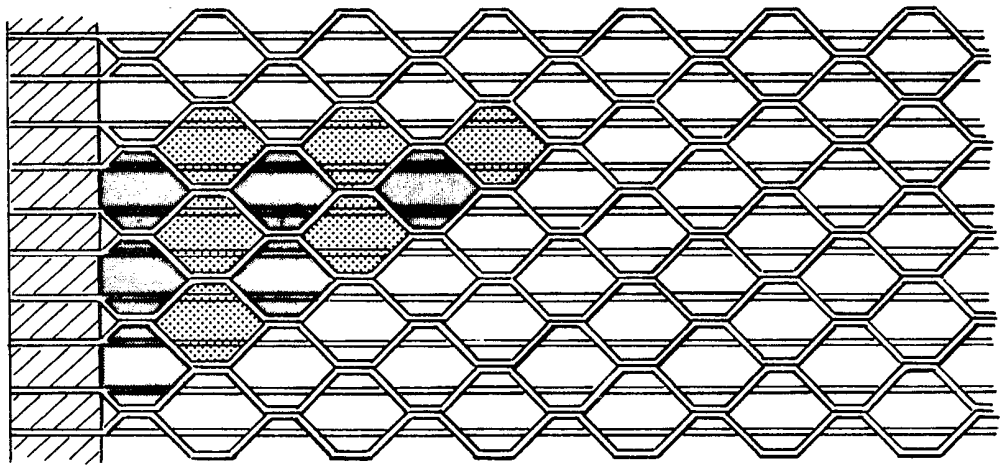
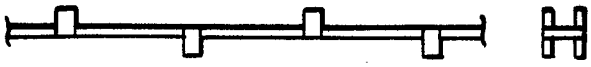


FIG.8.



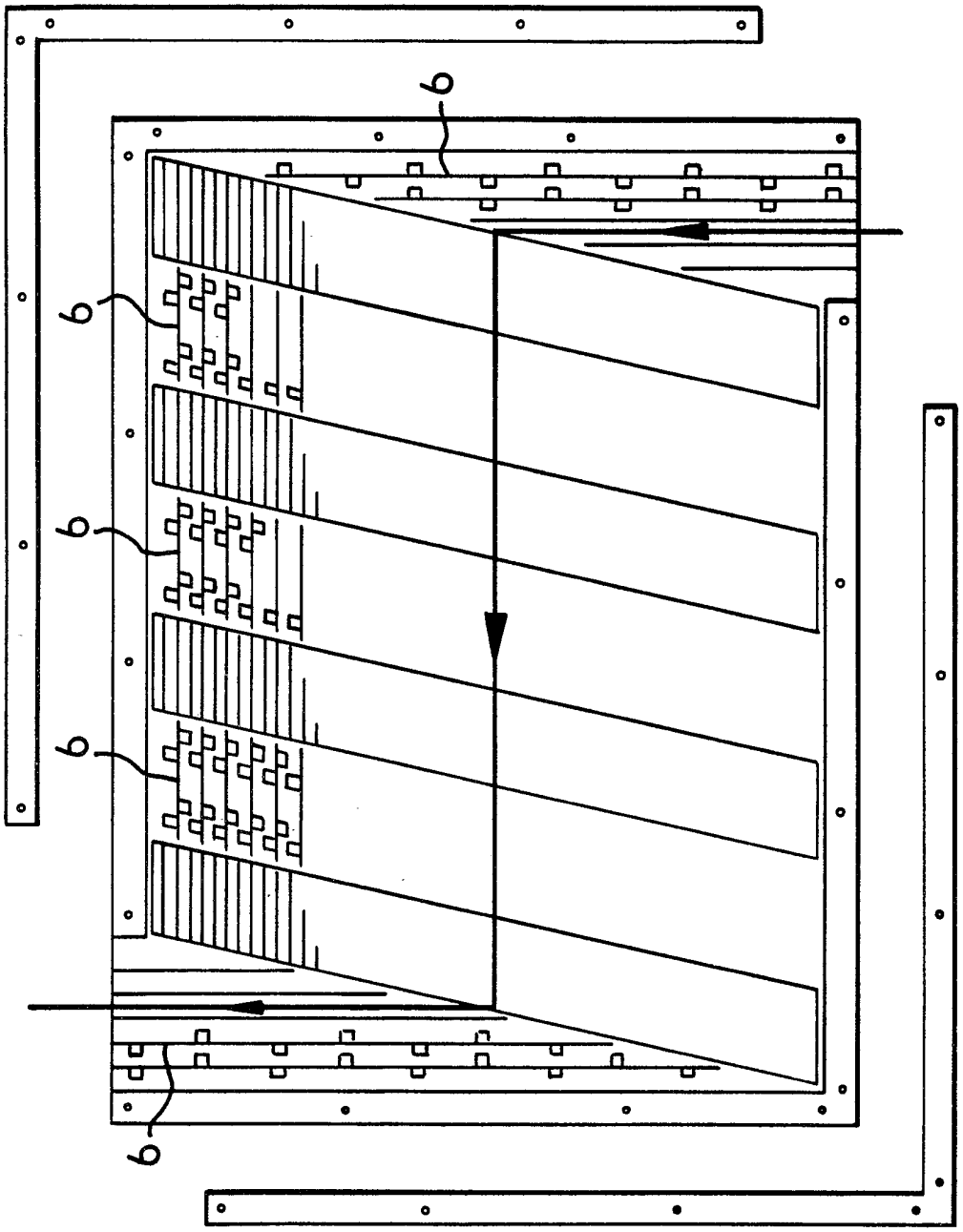
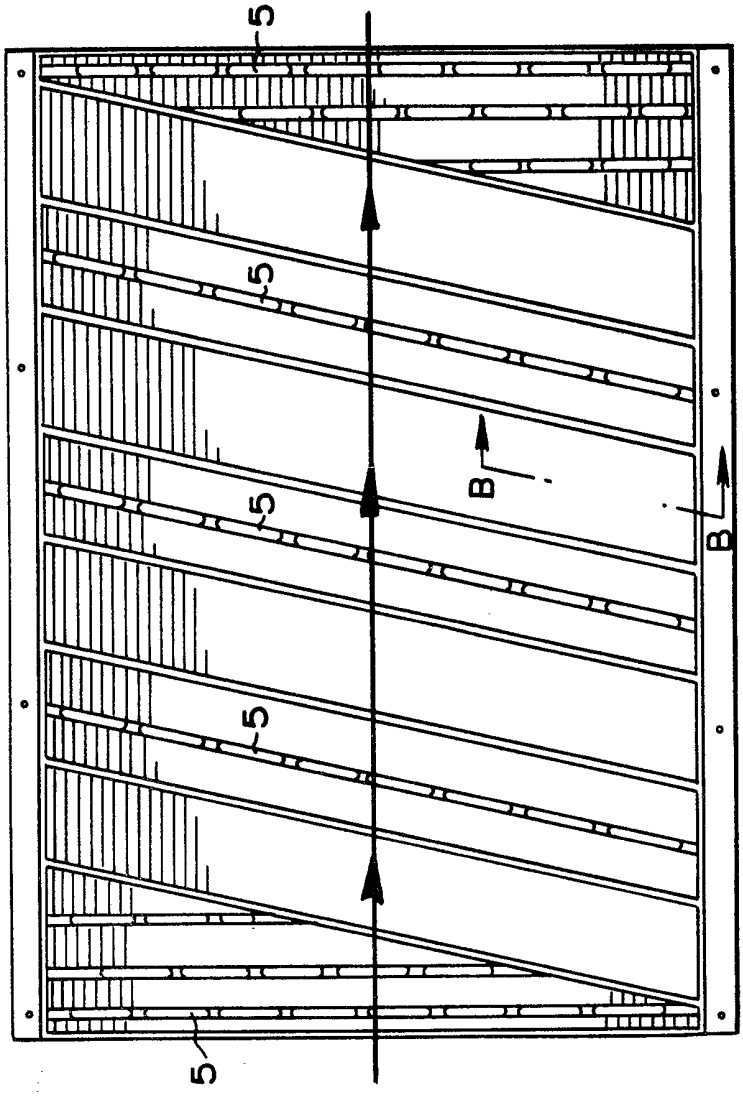


FIG. 9.

FIG.10.



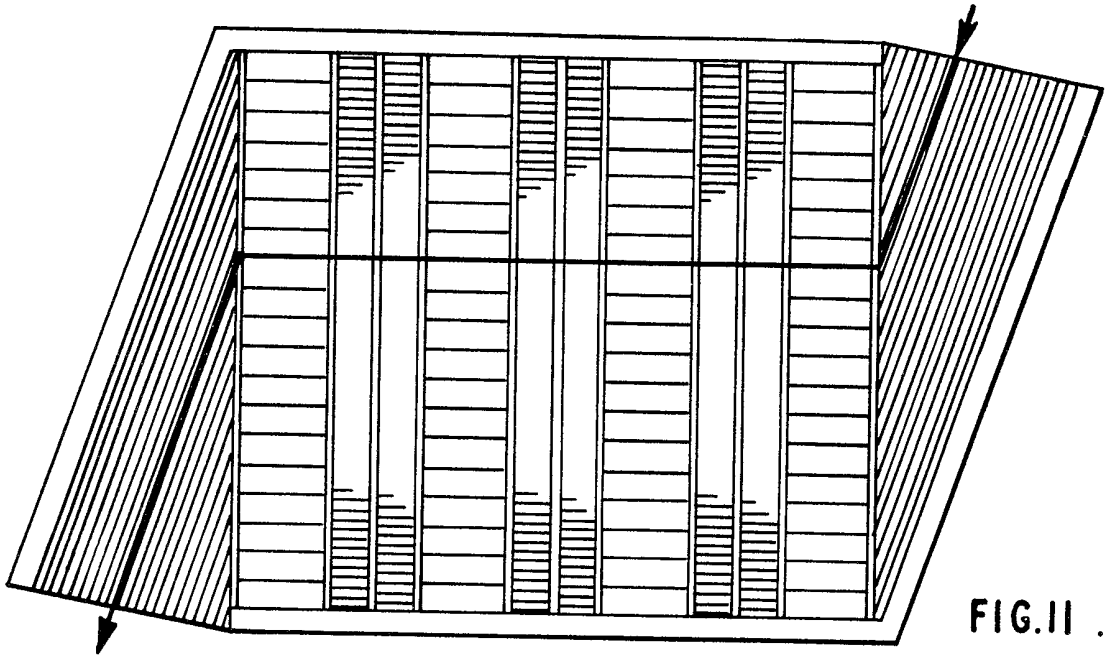


FIG.11.

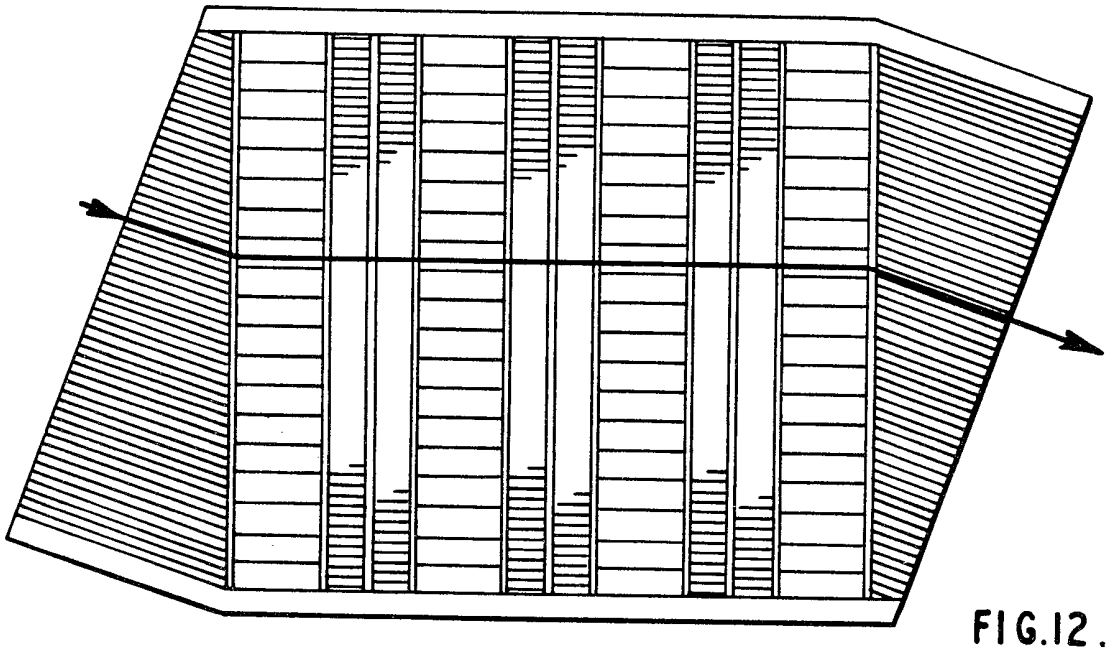


FIG.12.

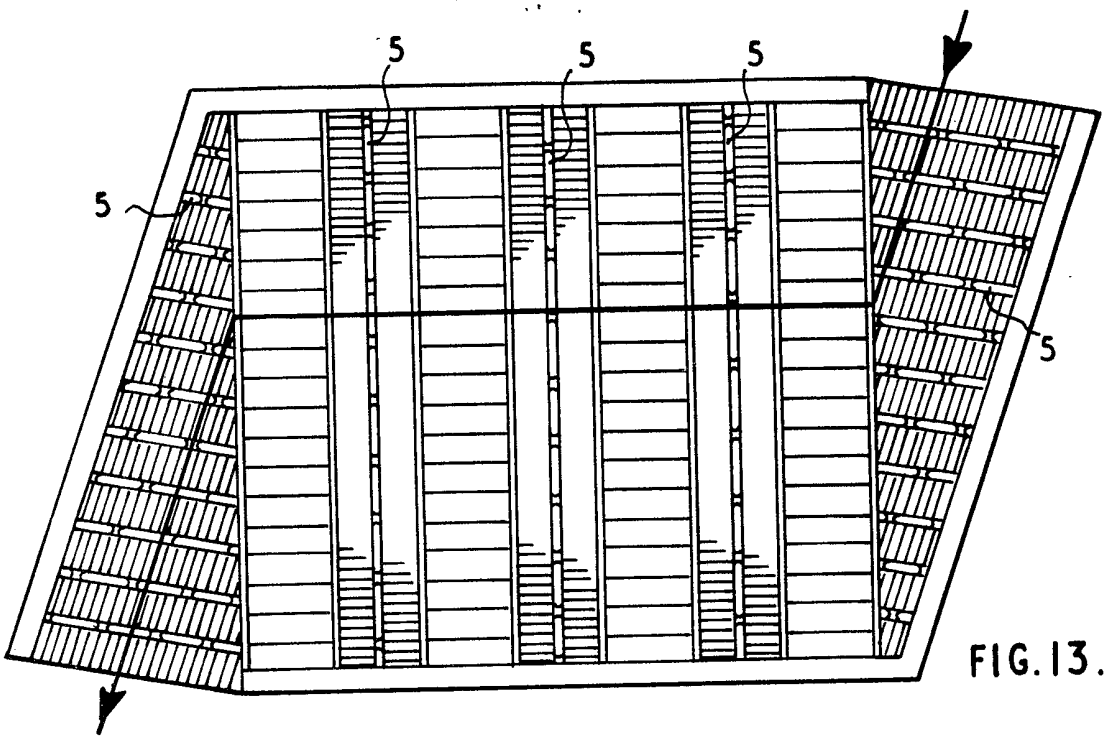


FIG.13.

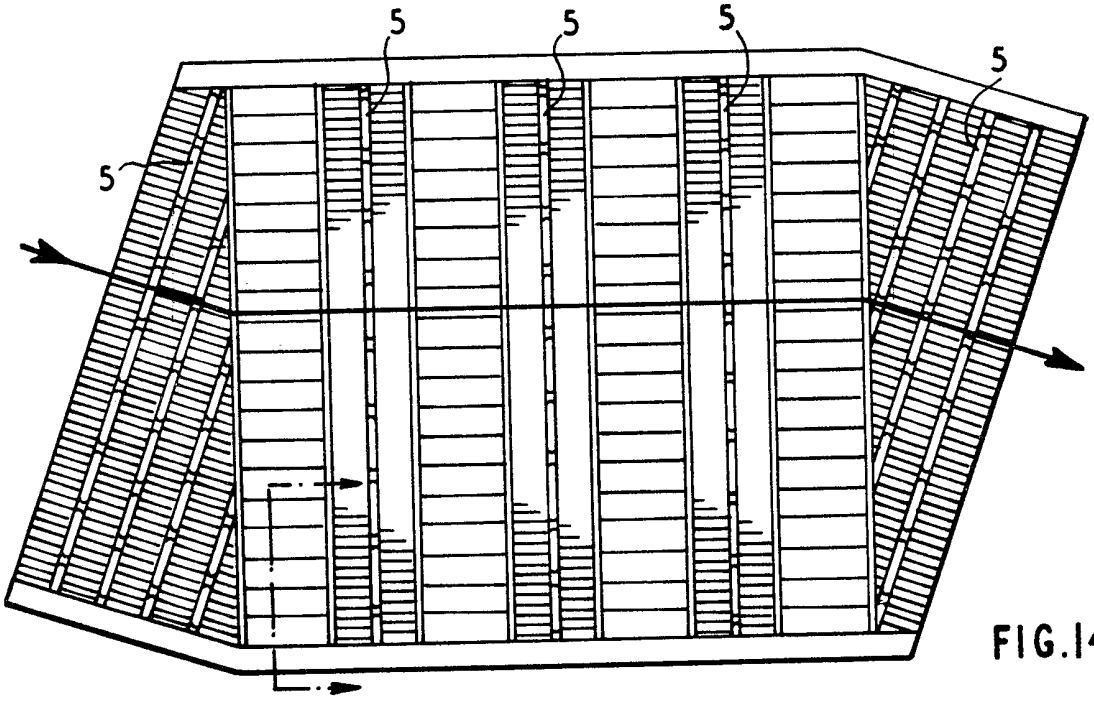


FIG.14.

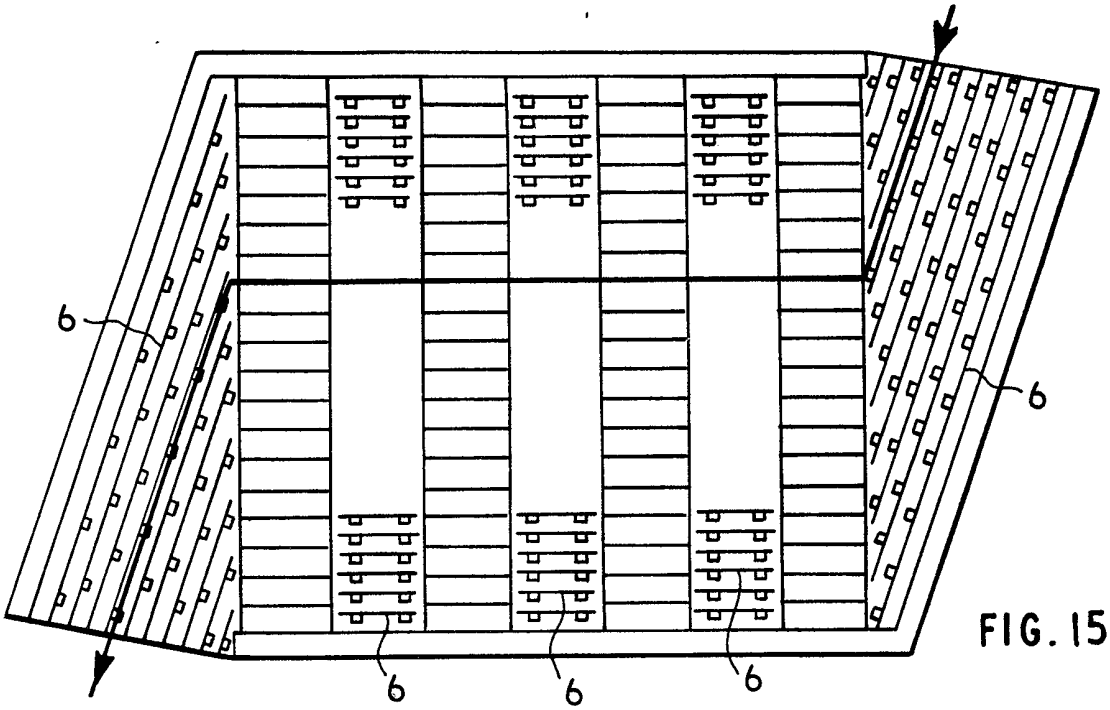


FIG. 15.

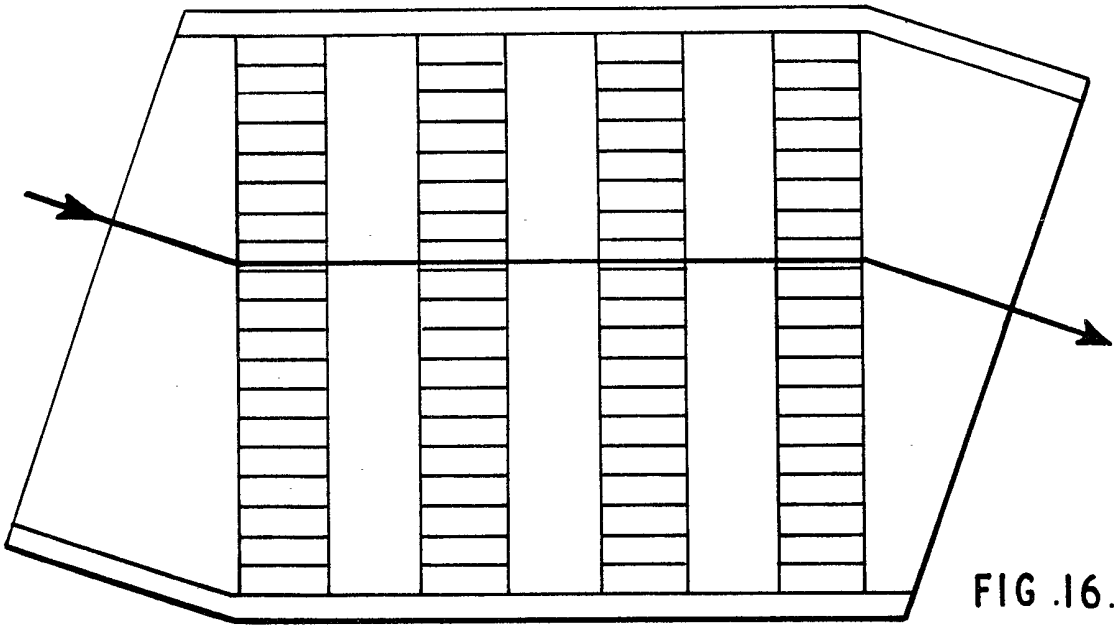


FIG. 16.

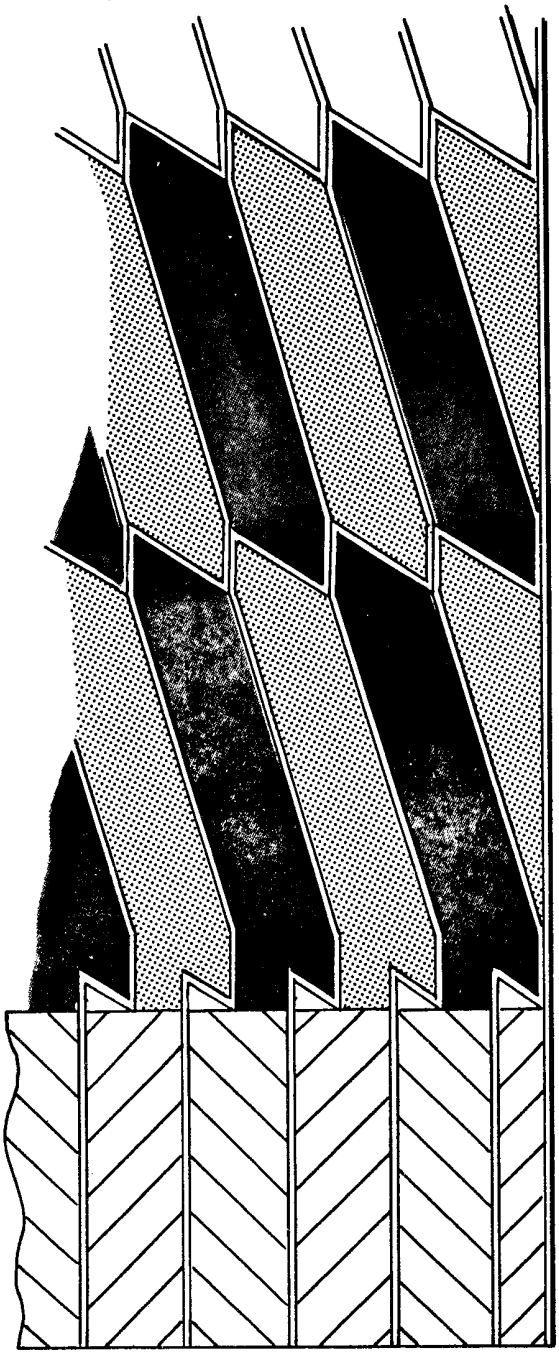


FIG.17.

SPECIFICATION

Improvements relating to plate type heat exchangers

This invention relates to heat exchangers of the kind in which fluid flow passages are formed between adjacent parallel opposed corrugated plates and the fluids between which heat is to be exchanged are caused to flow, usually in opposite directions to one another, in alternate flow passages formed between the plates.

Heat exchangers of this kind have been protected by British Patents 1048122, 1510960 and by co-pending British Patent Application 8236837 published as Specification 2132748.

As a result of experience in the operation of plate type heat exchangers of this kind, it has been realised that their efficiency can be improved firstly by modifying the configuration of the flow passages which lead into and out of the main body of the heat exchanger, secondly by modifying the flow path of liquid flowing across the main body of the heat exchanger, and thirdly by modifying the cross-sectional profile of the flow passages which are defined between adjoining interleaved plates.

In accordance with the first modification, the inlet and outlet sections of the heat exchanger plates have corrugated portions which are offset relative to one another laterally of the direction of fluid flow, these portions being separated by rows of intervening slotted portions with the slotted portions in one row offset laterally from the slotted portions in each adjacent row.

In accordance with the second modification heat exchanger plates across which water or other liquid is caused to flow comprise a series of spaced corrugated sections between which there are disposed a plurality of parallel spaced guide vanes which extend in the direction of liquid flow.

According to the third modification flow passages defined between adjacent plates and the members which separate them are of laterally elongated quadrilateral profile and preferably of parallelogram profile.

The nature of the above mentioned modifications should become more clearly apparent from the following description with reference to the accompanying 17 figures of drawings.

Figs. 1 and 2 relate to a multiple plate type heat exchanger intended to be used for exchanging heat between gas and air in a gas turbine and are based on the disclosure of British Patent Application 8236837 (2132748) which is an improvement on an earlier patent 1048122. Fig. 1 is a schematic drawing to illustrate the components and mode of fabrication of a first plate A with slightly spaced, wide and narrow bands of corrugations 1, 2, spacers 3 and triangular inlet and outlet sections 4 across which air flows in the directions indicated by the three arrows. Fig. 2 is a view comparable to Fig. 1 of a second and similar plate B intended to be opposed to plate A and across which gas is intended to flow in a generally contrary direction to the direction of air flow as again indicated by the three arrows. Plates A and B are interleaved alternately to form a stack.

As can be seen from Figs. 1 and 2 the triangular inlet and outlet sections 4 are of V-shaped corrugated formation and the corrugations are continuous from end to end.

It has however been found that a material improvement in heat transfer efficiency occurs when, as shown for instance in Fig. 3 and Fig. 3A the corrugations are separated along their length by transverse slots 5 and further that the corrugations between successive parallel rows of any two adjacent rows of slots are offset laterally relative to the corrugations between the next adjacent rows of slots. Other examples of this configuration are shown in Figs. 5, 6, 10, 13 and 14.

The width of the slots 5 is equivalent to the hydraulic mean diameter which is much the same as the thickness of the spacer bars which separate the slots. Fig. 3B is an enlarged end elevation of a pair of two superposed thus modified plates viewed in the direction of the three flow indicating arrows in Fig. 3.

Plates A as illustrated in Fig. 3 are alternated with plates B as shown in Fig. 4 in a heat exchanger used as an intercooler in a turbo charged internal combustion engine, and also represent an improvement in the arrangement described in published Specification 2132748. Fig. 4 shows the construction of a plate over which water is intended to flow in the direction indicated by the arrows whilst Fig. 3, which has already been referred to, shows a plate A over which air flows in a straight line as indicated by the arrows.

Fig. 4 illustrates the second modification in accordance with the present invention according to which there is disposed between each spaced corrugated strip 5 a plurality of parallel guide vanes 6 extending in the direction of water flow and each having a plurality of laterally directed attachment lugs 7, the lugs from one side of the vane 6 being offset in relation to the lugs from the other side of the vane. Vanes 6 may however have lugs projecting from one side only as illustrated for instance in Fig. 15. These guide vanes replace the corrugated support or distribution plates which are previously used and which proved to constitute a hindrance to free flow of liquid without any compensating thermal transfer characteristics. It had been thought that it could possibly be advantageous to remove the corrugated plates and allow the free flow of liquid but in fact this was not satisfactory. Firstly, because of lack of support during the

brazing operation, the corrugated supports on the adjacent air or gas plates were not properly brazed to the adjacent surfaces and the fin effect of these was almost completely lost and resulted in a severe drop in performance. Moreover due to the lack of guide vanes not only was the fin effect lost but because of total lack of guidance across the plate it was found that the liquid took a short cut through the unit with the result that almost 50% of the heat transfer surface was inoperative.

By introduction of the guide vanes 6 such as have been described above very good flow characteristics and heat transfer characteristics have been obtained.

Fig. 7 is an enlarged part section on Line A–A of Fig. 6 or line B–B of Fig. 10 showing how alternating plates as illustrated in Figs. 5 and 6 or alternatively Figs. 9 and 10 combine to form chevron-shaped flow passages in accordance with the disclosure of Specification 1510960.

Fig. 8 on the other hand shows a cellular-structure of octagonal form between interleaved plates A, B in accordance with the disclosure of Patent Specification 2132748.

Both of the above mentioned flow passage cross-sections are relatively efficient from the heat transfer point of view but it has now been discovered that improved results can be obtained by modifying the profiles of the interleaved plates so that when placed together they co-operate to form flow passages having an elongated parallelogram profile as illustrated in Fig. 19.

In each of Figs. 7, 8 and 17 hot air or gas flow passages are indicated by darker shading whilst liquid or water passages are indicated by lighter colour shading.

One, two or all three of the modifications which have been mentioned above can be utilised with good effect in a plate type heat exchanger. Figs. 11 and 12 illustrate a known pair of plates intended to be alternately interleaved. Figs. 13 and 14, and 15 and 16 respectively show the first and second above described modifications applied to the plates of Figs. 11 and 12.

By a combination of the three modifications described above to plate type heat exchangers as previously known, there may be constructed an improved heat exchanger which is extremely compact, has a very high thermal transfer surface area and good flow characteristics such a heat exchanger can be constructed to have a large frontal area and may be manufactured using most modern methods.

CLAIMS

1. A heat exchanger of the kind referred to characterised in that inlet and outlet sections of the heat exchanger plates have corrugated portions which are offset relative to one another laterally of the direction of fluid flow, these portions being separated by rows of intervening slotted portions with the slotted portions in one row offset laterally from the slotted portions in each adjacent row.

2. A heat exchanger as claimed in Claim 1, in which the heat exchanger plates across which water or other liquid is intended to flow comprise a series of spaced corrugated sections between which there are disposed a plurality of parallel spaced guide vanes which extend in the direction of liquid flow.

3. A heat exchanger as claimed in Claim 1 or Claim 2 characterised in that flow passages defined between adjacent plates and the members which separate them are of laterally elongated substantially quadrilateral profile.

4. A heat exchanger as claimed in Claim 2 in which said parallel spaced guide vanes have laterally directed attachment lugs projecting from each side, with the lugs from one side being offset in relation to the lugs extending from the other side.

5. A heat exchanger as claimed in Claim 2 in which said parallel guide vanes each have a plurality of laterally directed attachment lugs projecting from one side only of the vanes.

6. A heat exchanger as claimed in Claim 3 in which said flow passages are of substantially parallelogram profile.

7. A heat exchanger of the kind referred to which is constructed substantially as hereinbefore described with reference to and as shown in, any of the accompanying figures of drawings.

Printed in the United Kingdom for
Her Majesty's Stationery Office, Dd 8818935, 1986, 4235.
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London, WC2A 1AY, from which copies may be obtained.