(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 232 231**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 87830043.3

(22) Date of filing: 02.02.87

(51) Int. Cl.³: F 28 F 3/08
F 28 F 3/10

(30) Priority: 07.02.86 IT 1242386

(43) Date of publication of application:
12.08.87 Bulletin 87/33

(84) Designated Contracting States:
BE DE ES FR GB GR NL

(71) Applicant: FONDERIE E OFFICINE SAN GIORGIO PRA S.P.A.
Via G. Ratto 27
I-16157 GENOVA PRA(IT)

(72) Inventor: Orsi, Armando
Via Laviosa 5B/15
I-16156 Genoa Pegli(IT)

(74) Representative: Galletti di San Cataldo, Vettor, Dr.
Via XX Settembre 36
I-16121 Genova(IT)

(54) **Heat exchanger particularly suitable for use for recovery of heat fron wet gases.**

(57) The subject-matter of this invention is a heat exchanger consisting of a series of pressed metal plates (10), fixed together between a pair of rigid end-plates (20). Each plate (10) has a pair of opposed openings surrounded by closed impressions (31) used to accommodate sealing gaskets (41). Each plate (10) is also equipped with a further closed impression (32) which follows the outer contour of the plate (10), and which is used to accommodate another corresponding closed peripheral gasket (42).

Each pair of contiguous plates (10) is separated, alternately, by a pair of gaskets (41) located around the the opening (11, 12), in one case, and in the other by the peripheral closed gasket (42).

Each plate (10) also has diagonal impressions (14), the purpose of which is to create the required turbulence in the current of fluids flowing in contact with the surfaces of the plates (10) in question (figure 1).

EP 0 232 231 A1

./...

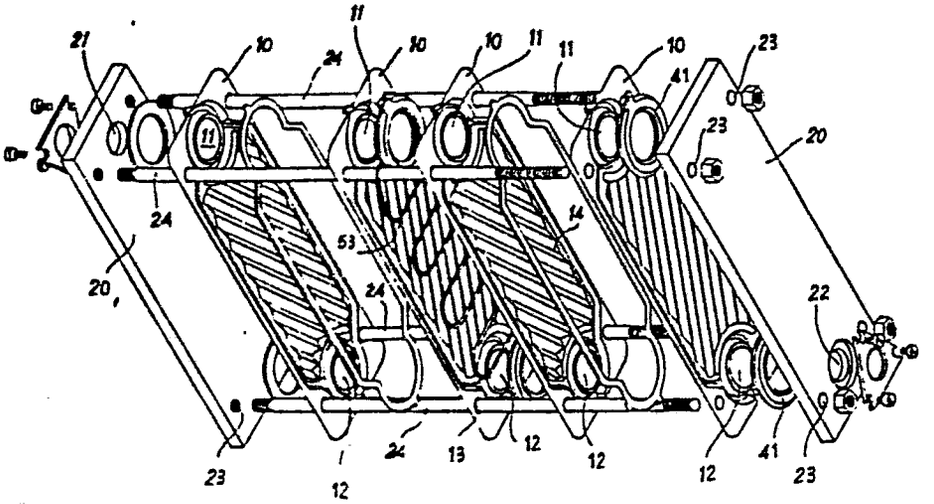
11
21
10
24
10
10
11
11
10
23
41
23
20
24
53
14
20
24
22
23
1
24
13
12
12
12
12
41
23

Fig 1

Heat exchanger particularly suitable for use for recovery of heat from wet gases

The subject-matter of this invention consists of a heat exchanger particularly well-suited for use in recovering heat from wet gasses.

In its preferred use as a thermal recuperator, the exchanger according to the invention is particularly well-suited for use in boilers for domestic heating purposes : in this case the heat is recovered from the fumes, in the form of sensitive heat and latent heat, at temperature levels at which in traditional boilers it is normally lost.

The heat exchanger according to the invention consists of a series of pressed metal plates, having a limited thickness, clamped against one another by means of stay-bolts, and equipped with a pair of end openings.

Once the series of plates forming the exchanger has been assembled, the openings are aligned and form the two distribution and collection headers of the water to be heated, and which forms the secondary fluid.

Each plate is lapped on one side by the primary fluid (wet gasses) and on the other side by the secondary fluid (water to be heated).

Each pair of adjacent plates is separated by suitable spacers which allow the formation of a meatus through

which one or the other of the fluids passes.

The two opposing faces of each pair of adjacent plates defining the meatus for the passage of the fumes are separated from one another by suitable spacers and by a pair of circular gaskets located around the above mentioned openings.

The two opposing faces of the subsequent pair of adjacent plates are, on the other hand, separated by gaskets which follow the perimeter of the plates so as to form a sealed compartment which communicates only with the two headers formed by the succession of the openings mentioned above.

Naturally, the water to be heated runs through this compartment.

Each plate is suitably equipped with V shaped grooves, positioned diagonally.

The V shaped grooves of one plate are crossed with those of the next plate, so as to favour the turbulence of the fluids which come into contact with these plates.

The main characteristics of the invention are summarized and schematically described in the claims, and the subject-matter and advantages thereof are also explained in the following description referred to forms of embodiment chosen by way of example only, with par-

ticular reference to the attached drawings, in which :

- figure 1 is an exploded view of the exchanger according to the invention, in a preferred form of embodiment;
- figure 2 shows a front view, schematic and partial, with some parts omitted, of the exchanger shown in figure 1;
- figure 3 shows an enlarged section, on a secant plane parallel to the plane of projection of figure 2, passing through the plane of symmetry of the exchanger and limited to its lower part; for the sake of simplicity only four plates according to the invention are shown in figure 3, as this is the smallest number possible to implement the exchanger, although in practice this number will always comprise a few dozen;
- figure 4 is a front view of a plate of the exchanger according to the invention; this front view is projected on a plane perpendicular to the plane of projection of the front view of the whole exchanger as per figure 2;
- figures 5 to 8 are cross-sections of the common plate as per figure 4, on the secant plants V-V up to VIII-VIII of the same figure 4;
- figure 9 is a front view similar to that illustrated in figure 4, but it concerns a different form of em-

bodiment referring to a plate fitted with spacers;

- figures 10 and 12 are sections on planes X-X to XII-XII of figure 9.

With specific reference to figure 1, the heat exchanger according to the invention is formed by a series of adjacent plates 10 made by pressing thin metal sheeting. The exchanger is also equipped with two very thick and stiff end-plates 20.

The series of pressed metal plates 10 and two end-plates 20 is held together by four stay-bolts 24 which pass through corresponding holes 13 and 23 made respectively in the printed metal plates 10 and in the two end-plates 20.

Each printed metal plate 10 has an approximately rectangular shape, and near to its two short sides it has two large holes 11 and 12, which serve as openings for the passage of the water to be heated. Each of the two end plates 20 is fitted with one further hole only, numbered respectively 21 and 22, located in positions corresponding to holes 11 and 12 respectively of the pressed metal plates 10.

Each printed metal plate 10 has a continuous impression 30, with a practically V shaped transverse cross-section, which surrounds uninterruptedly both the two holes 11 and 12 and the outer contour of the plates 10.

This impression 30 is therefore formed by a pair of circular impressions 31 surrounding the two holes 11 and 12 and two elongated impressions 32 which join said two circular impressions 31.

The impression 30 gives rise to a rib on one face of the plate, and to a corresponding groove on the other face : the impression 30 is of course obtained by pressing.

In assembling the series of pressed metal plates 10, the impressions are all made to face in the same direction, as shown in figure 3, so that the impressions of adjacent plates fit partly into one another.

The impressions 31 are made so that circular gaskets 41 fit into them, gaskets which create between the openings 11 and 12, the headers through which the water to be heated passes.

These circular gaskets 41 are alternately positioned between pairs of adjacent plates 10 : that is to say between the first and second, between the third and fourth, between the fifth and sixth plates and so on.

More closed gaskets 42 occupy the impressions 32 and the outer edge of the impressions 31, following approximately the contours of the plates 10.

These gaskets 42 are alternated with the gaskets 41 and are therefore positioned between the second and third,

between the fourth and fifth plates and so on, as shown in figures 1 and 3.

Between the pairs of plates separated from one another by means of the circular gaskets 41 a meatus 51 is thus created, in which a current of fumes to be cooled can pass.

On the other hand, the water passing through the openings 11 and 12 is free to circulate between the pairs of plates 10 separated instead by the perimetrical gaskets 42.

There is therefore a cross-flow of the primary fluid consisting of the fumes to be cooled and the secondary fluid consisting of the water to be heated.

In order to increase the turbulence of the flow of the two fluids coming into contact with the surfaces of the plates 10, these have on them parallel diagonal impressions having a substantially triangular shape, identified by number 14.

These diagonal impressions or folds 14 are suitably inclined by about 45° as compared to the plane of symmetry of the exchanger and these impressions lie in opposite directions on contiguous plates, as shown in figure 1.

In order to achieve a condition of even compression for the whole development of the perimetrical gaskets 42,

it is necessary to insert spacers in the meatus 51 in which the current of fumes to be cooled passes.

As a rule these spacers are not necessary in the meatus 52 sealed by the perimetrical gaskets 42 and in which the water to be heated circulated.

These spacers may be made in different ways. According to the form of embodiment illustrated in figure 1, same may consist of thin metal wires 53 bent into coils.

According to the form of embodiment illustrated in figure 3 and in figures 9 to 12, these spacers may consist of transverse impressions 54, positioned alternately on the plates 10.

The above descriptions and illustrations provide a practical and efficient condenser, particularly simple to build and assemble.

Although for descriptive reasons this invention is based on the above descriptions and illustrations, by way of example only, with particular reference to the attached drawings, many modifications and variations may be brought about in the embodiment of the invention; any such modifications and variations shall, however, be deemed to be based on the following claims:

CLAIMS

1) Heat exchanger, particularly well-suited to be used for the recovery of heat from wet gasses, characterized by the fact that it provides a series of pressed metal plates suitably spaced and secured together by means of stay-bolts between two stiff end-plates, and in which each of these metal plates has two opposing openings, each surrounded by a corresponding closed impression; a further closed impression which follows the perimeter of these plates is also provided, so that each pair of plates is separated alternately by a pair of gaskets positioned in the two impressions which surround the two above mentioned openings in one case, and in the other by a closed perimetrical gasket positioned in the above mentioned closed perimetrical impression.

2) Heat exchanger, according to the preceding claim, characterized by the fact that the pairs of contiguous plates are separated alternately by closed gaskets inserted in the impressions surrounding the above mentioned openings in the first case, and in the second case by a single closed peripheral gasket inserted in the above mentioned peripheral impression.

3) Heat exchanger, according to the preceding claims, characterized in that it has diagonal impressions or folds, which are positioned in opposite directions in

each pair of contiguous plates.

4) Heat exchanger, according to the preceding claims, characterized in that a further mechanical element of separation is inserted in the meatus created between the pairs of adjacent plates separated by the pair of closed gaskets surrounding the openings.

5) Heat exchanger according to claim 4, characterized in that said further mechanical element of separation consists of a metal wire bent into a coil.

6) Heat exchanger, according to claim 4, characterized in that this further mechanical element of separation consists of a series of transverse impressions made in the pressed metal plates.

7) Heat exchanger according to the preceding claims, implemented and put into practice substantially in accordance with the above descriptions and illustrations.

0232231

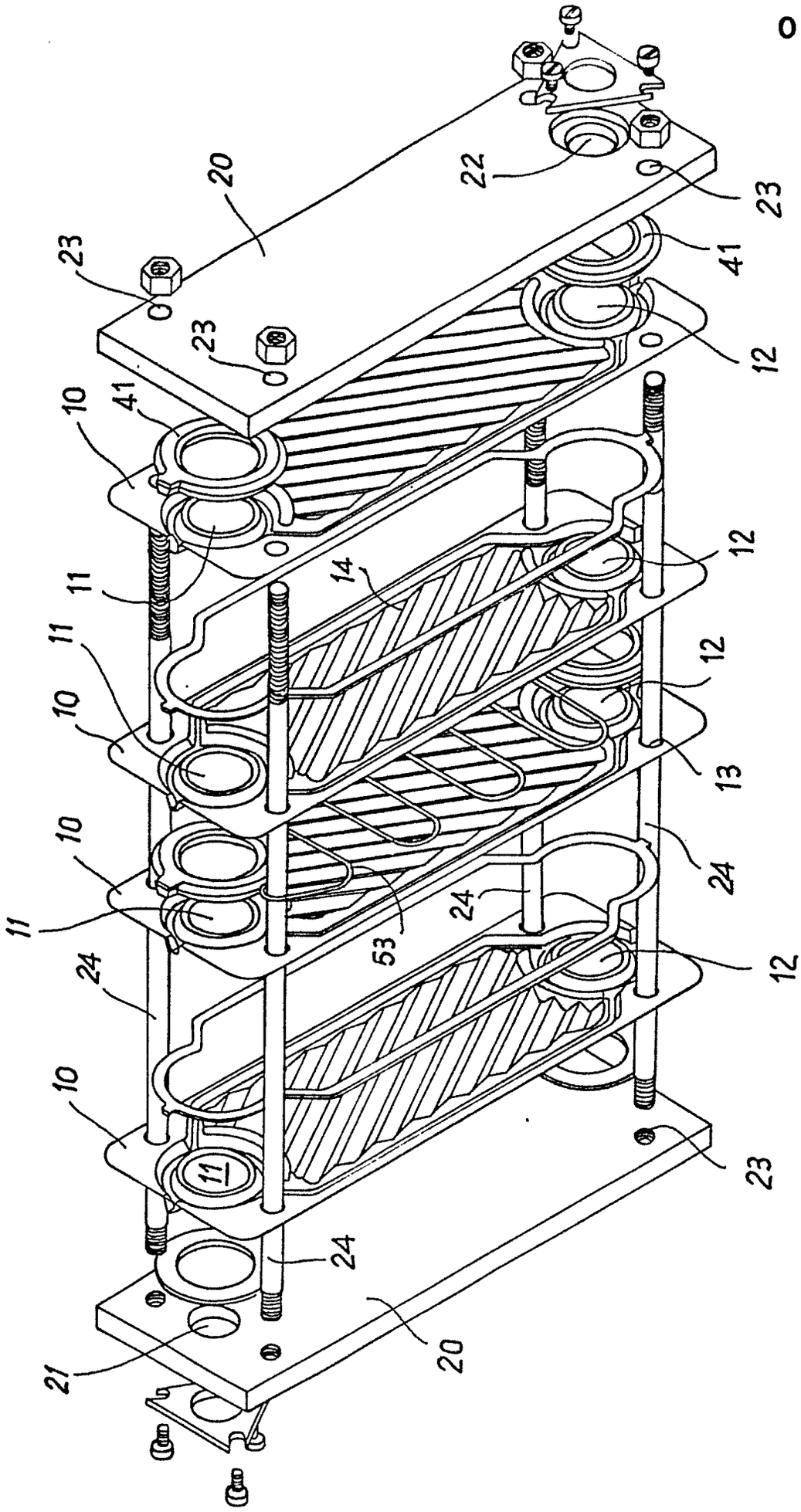

Fig. 1

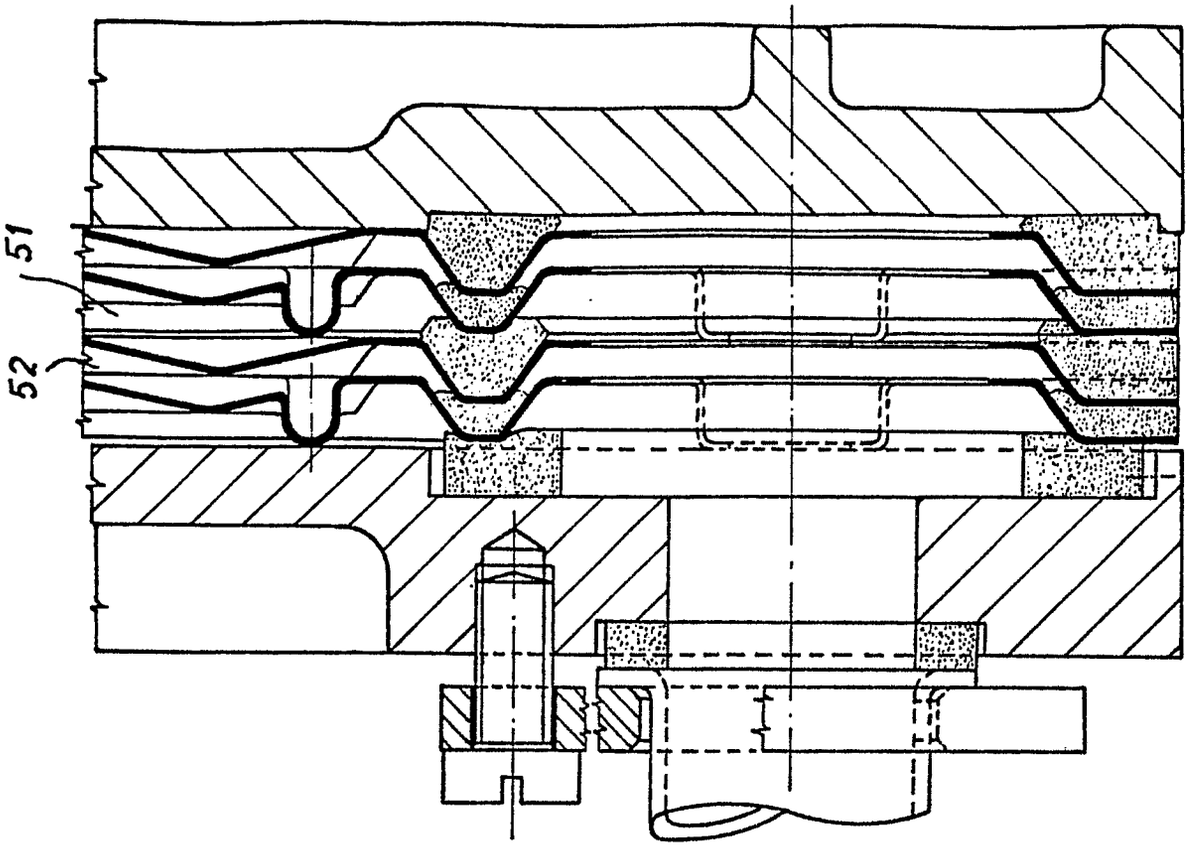

Fig.3

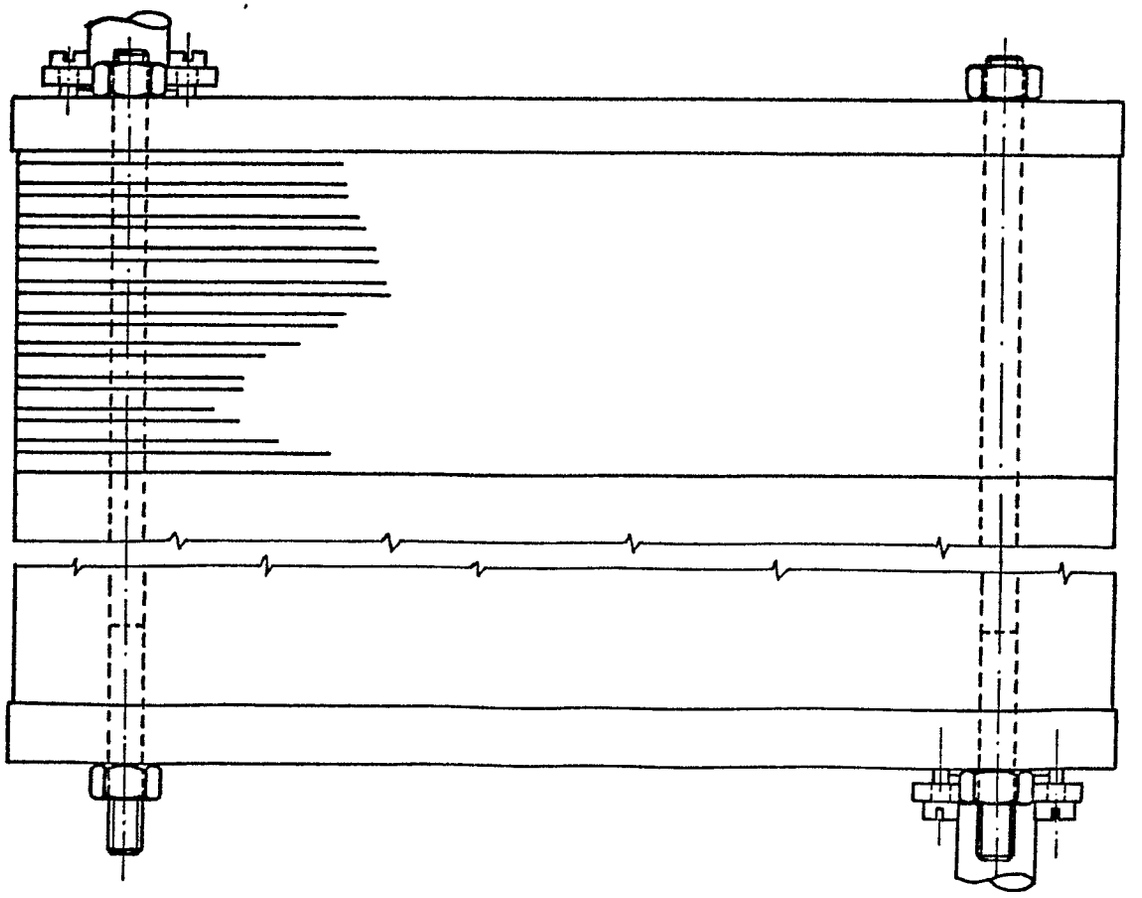

Fig.2

0232231

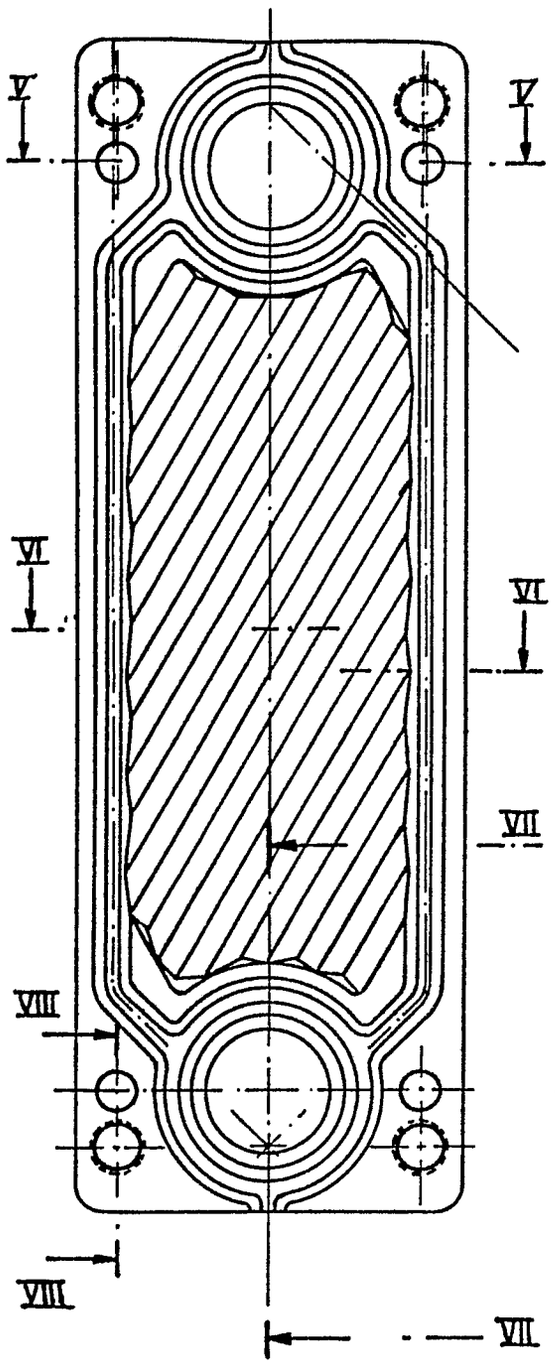

Fig. 4

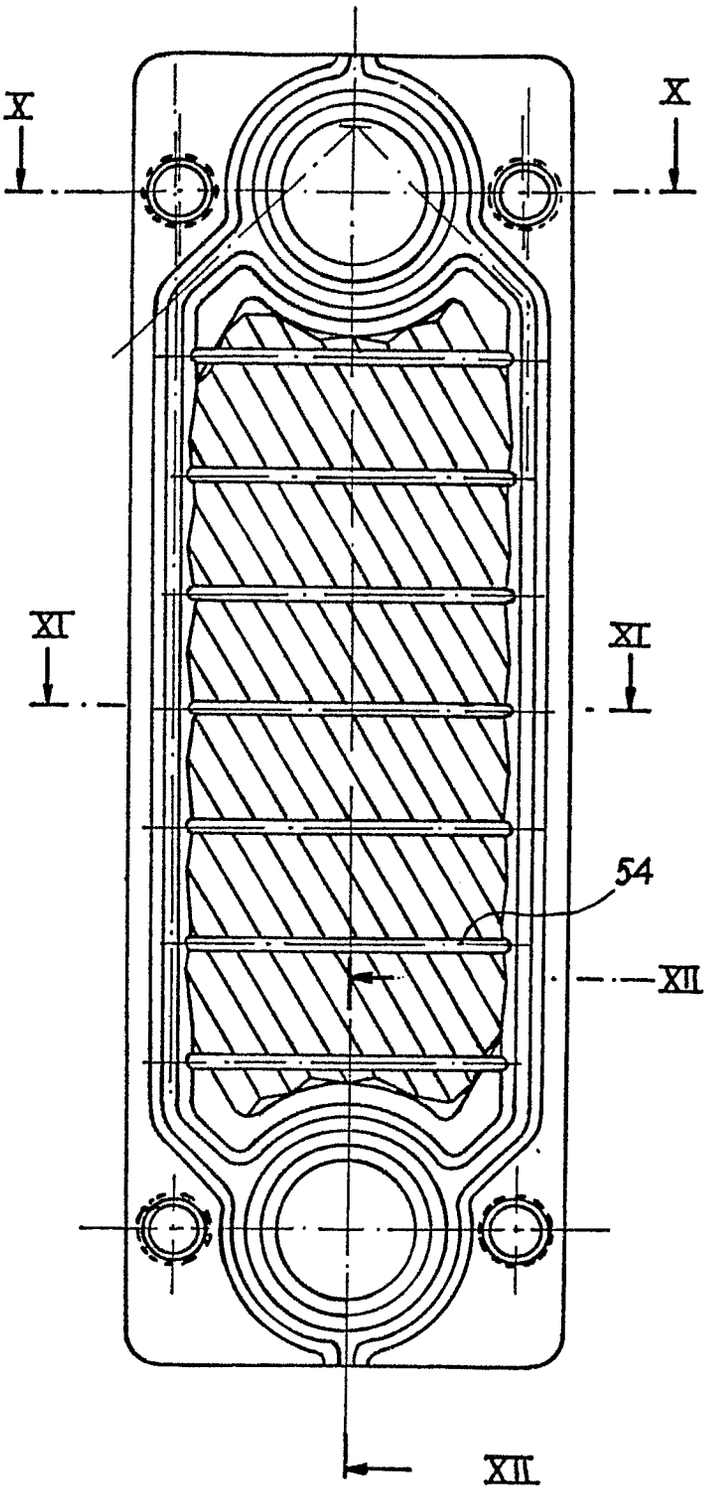

Fig. 9

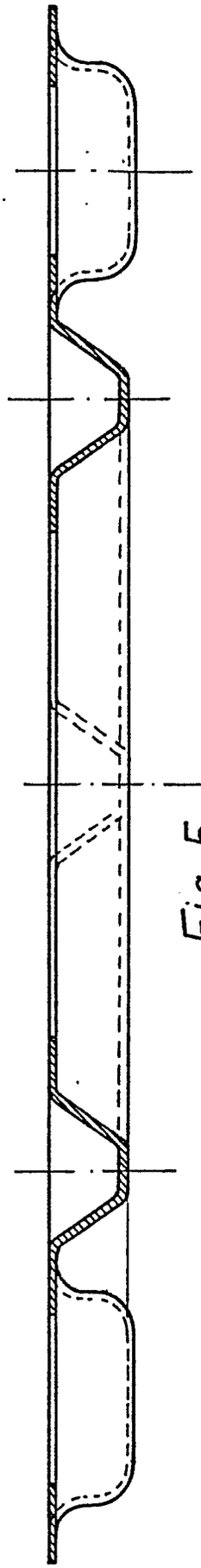

Fig. 5

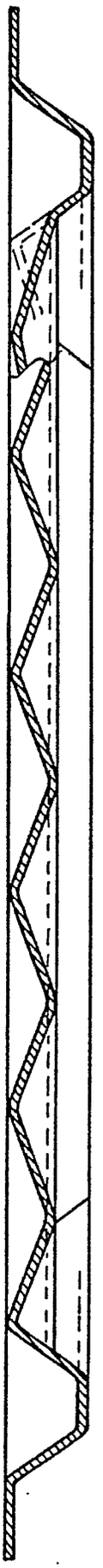

Fig. 6

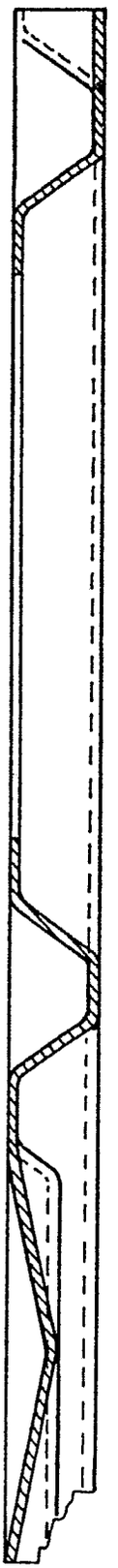

Fig. 7

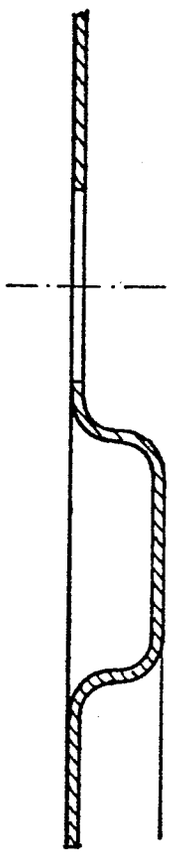

Fig. 8

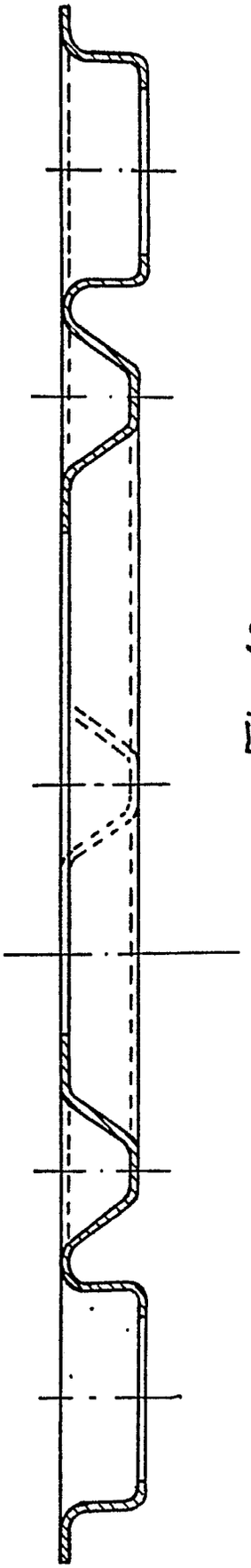

Fig. 10

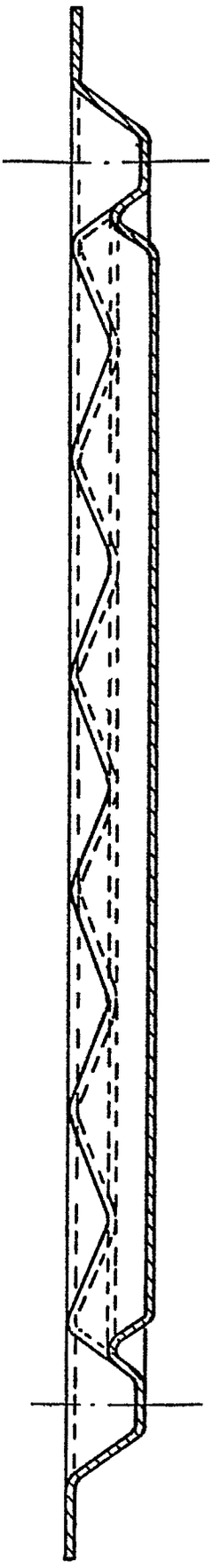

Fig. 11

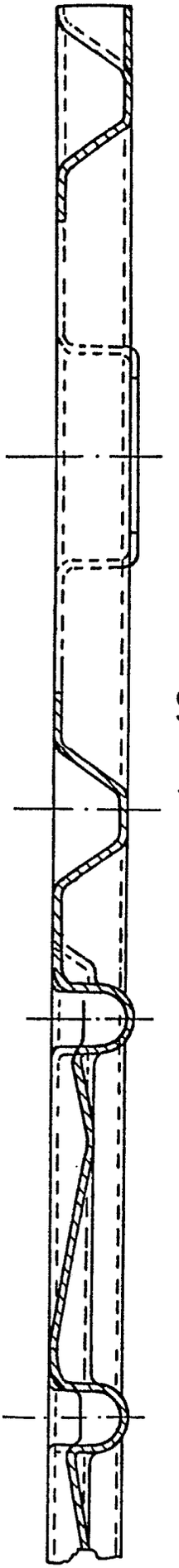

Fig. 12

0232231

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 87 83 0043

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 4)
Y	FR-A-2 523 287 (LECOMTE et al.) * Page 1, lines 19-38; page 2, lines 1-24; page 3, lines 24-31; page 5, lines 12-38; page 6, lines 1-6; figures 1-3,5,6 *	1-3,7	F 28 F 3/08 F 28 F 3/10
Y	FR-A-1 378 761 (SEPARATOR) * Page 1, column 1, lines 1-31; claim 1; figures 1,2 *	1-3,7	
A	GB-A- 713 683 (CREAMERY PACKAGE) * Page 1, lines 18-24; figures 1,2 *	4	
A	FR-A- 927 384 (LJUNGSTRÖMS ANGTURBIN) * Figures 2-4,9 *	6	
A	DE-B-1 064 539 (SILKEBORG MASKINFABRIK) * Claim 1; figures 1-3 *	1	TECHNICAL FIELDS SEARCHED (Int Cl 4) F 28 D F 28 F
A	US-A-3 195 625 (THOMSON) * Column 2, lines 6-10; figure 1 *	1	
A	CH-A- 332 971 (JENSSEN et al.) * Claim; figures 1-4 *	1,2,4	

-/-

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13-05-1987	HOERNELL, L.H.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO Form 1503 03 82

European Patent Office

0232231

Application number

EP 87 83 0043

EUROPEAN SEARCH REPORT

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.4)
A	GB-A-2 056 652 (GENERAL MOTORS) * Page 1, lines 73-78; figures 1,2 *	1-4	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13-05-1987	HOERNELL, L.H.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO Form 1503 03 82