Nov. 11, 1952 G. JENDRASSIK 2,617,634

HEAT EXCHANGER

Filed Feb. 28, 1948 3 Sheets-Sheet 1

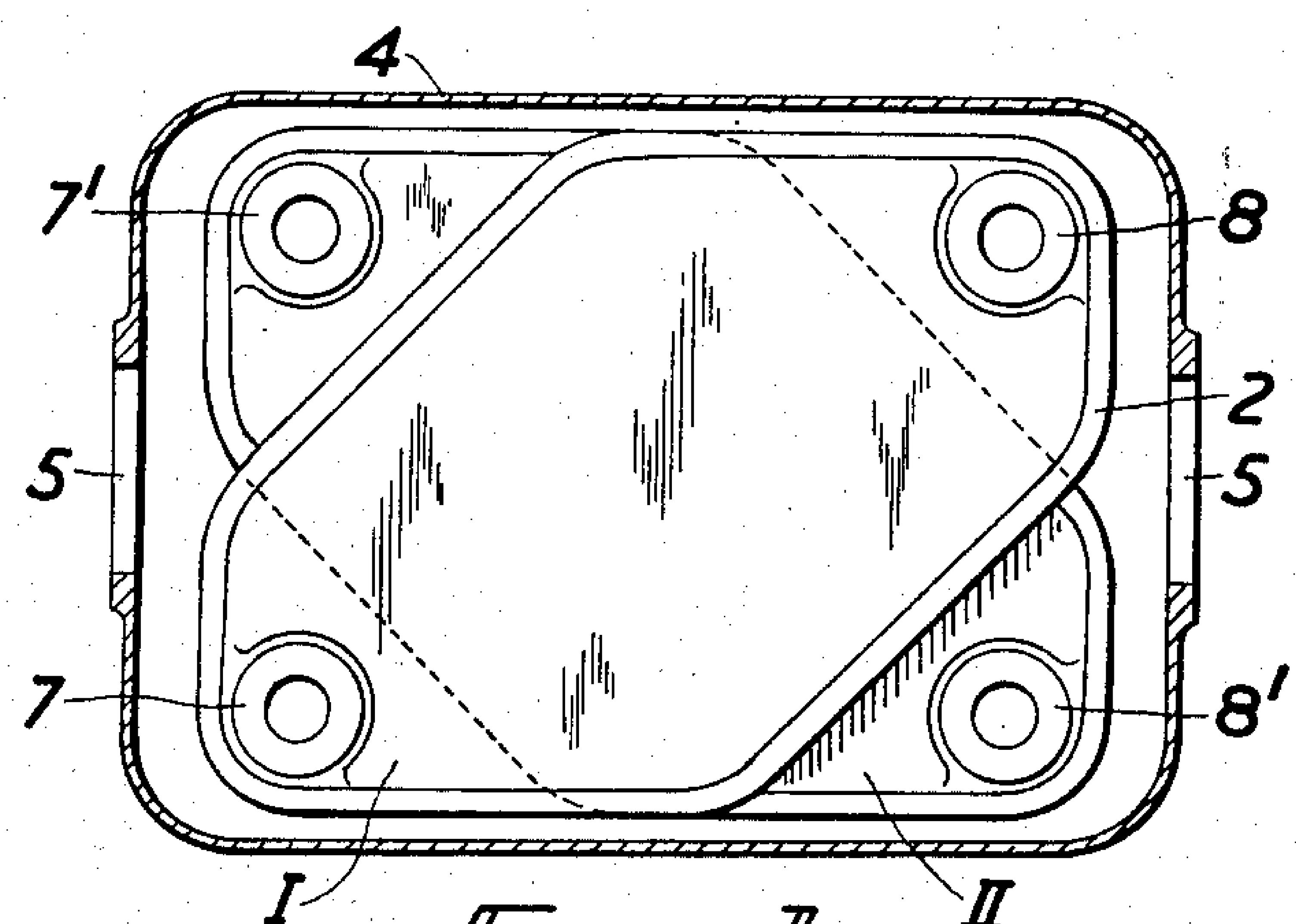

FIG. 1.

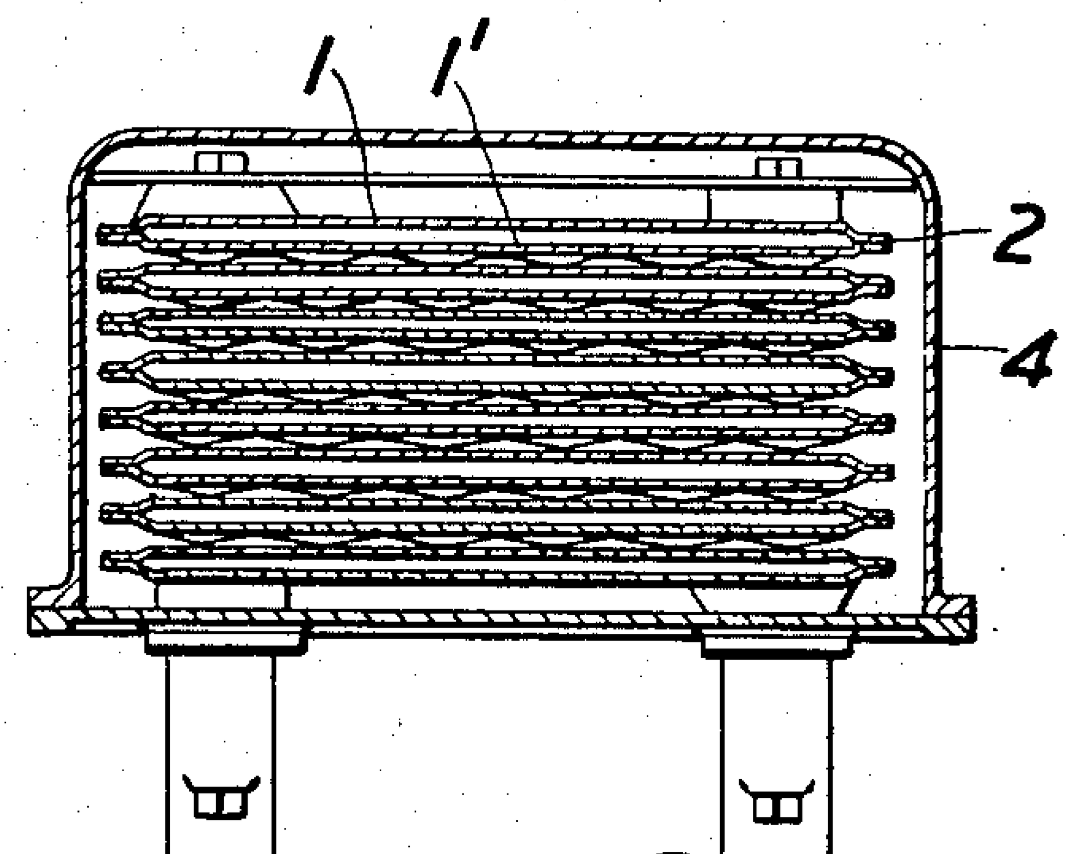

FIG. 2.

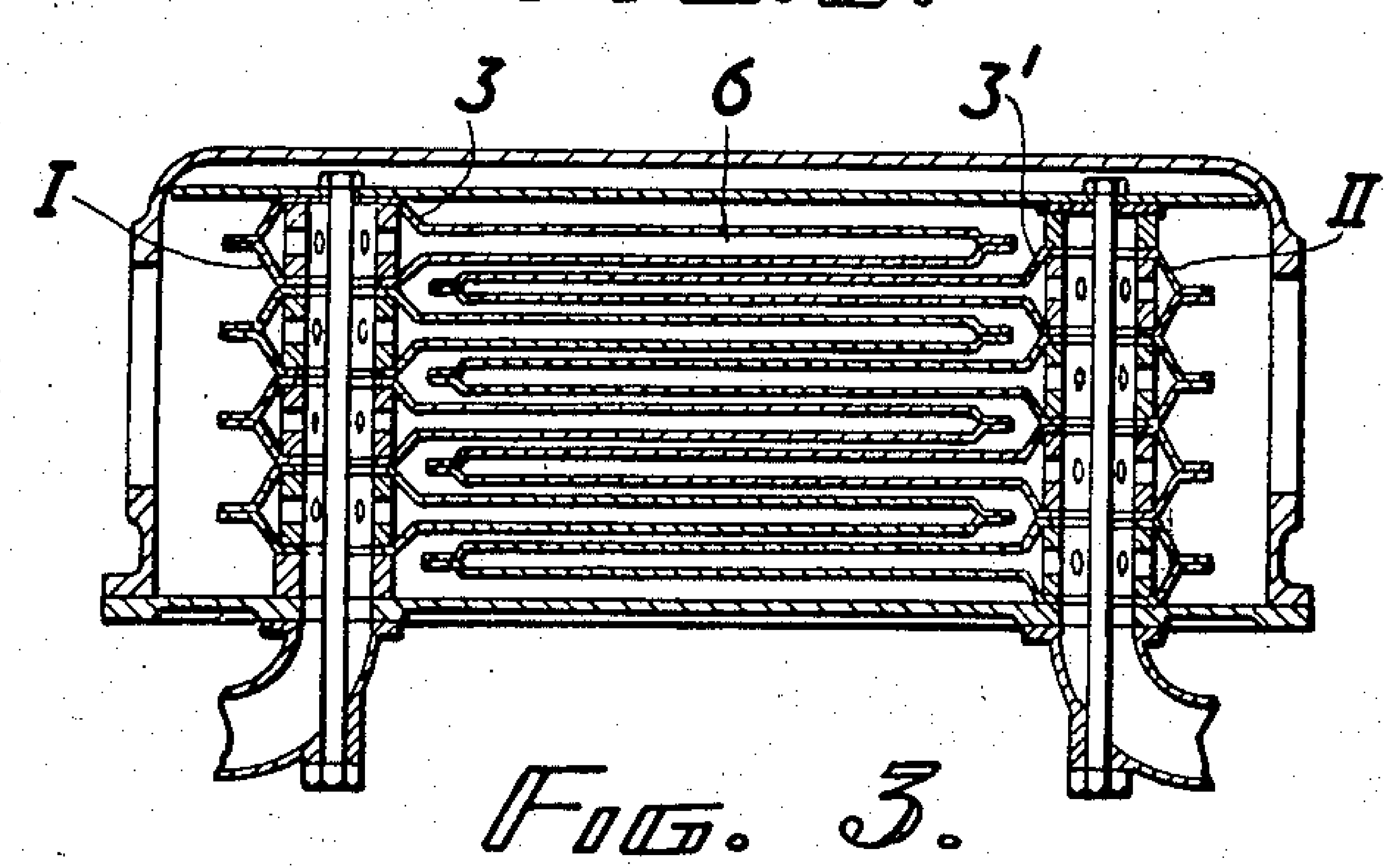

FIG. 3.

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3 Sheets-Sheet 2

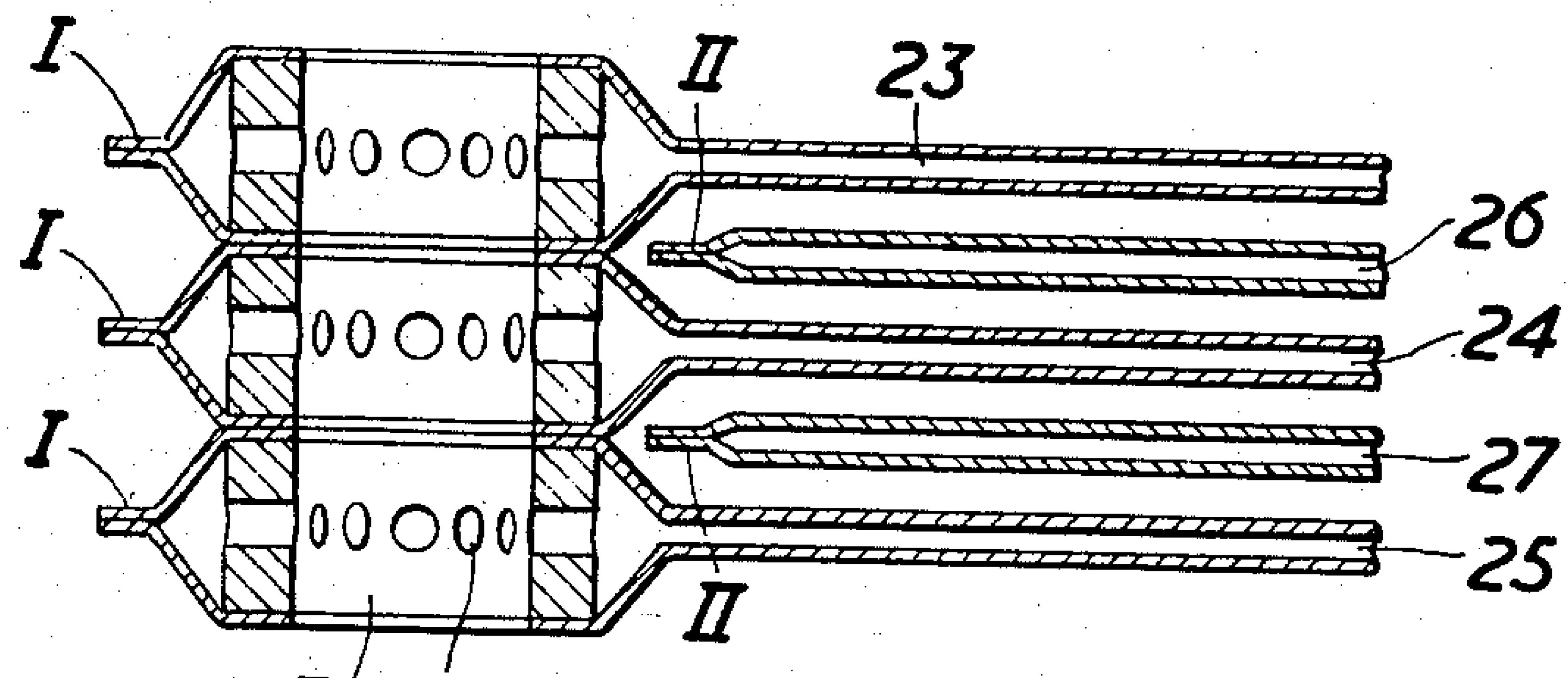

FIG. 4.

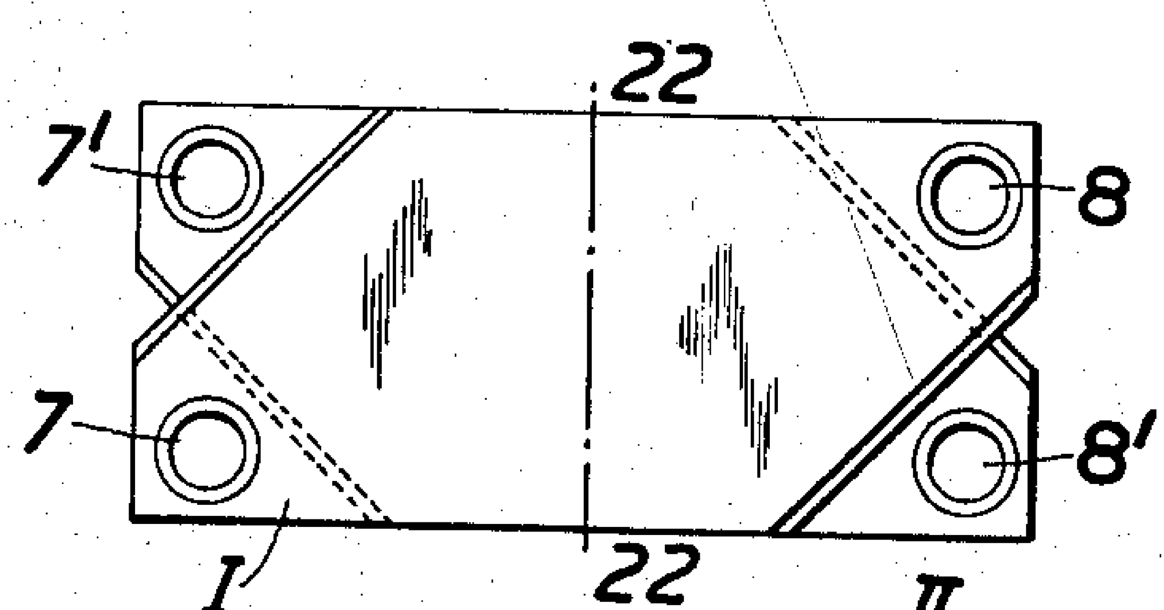

FIG. 5.

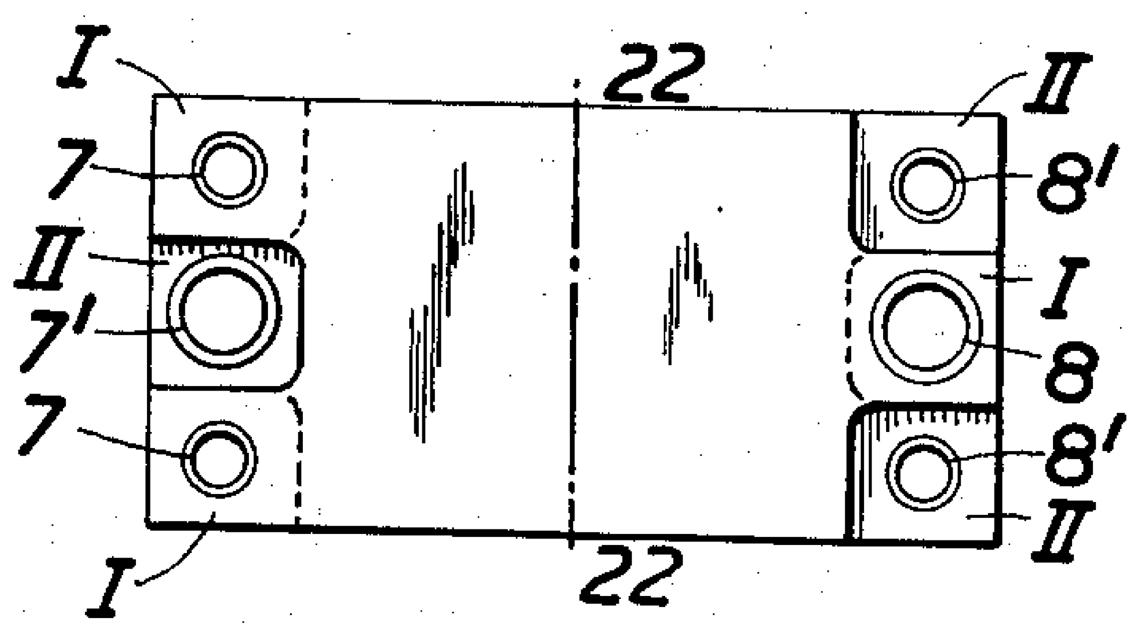

FIG. 7.

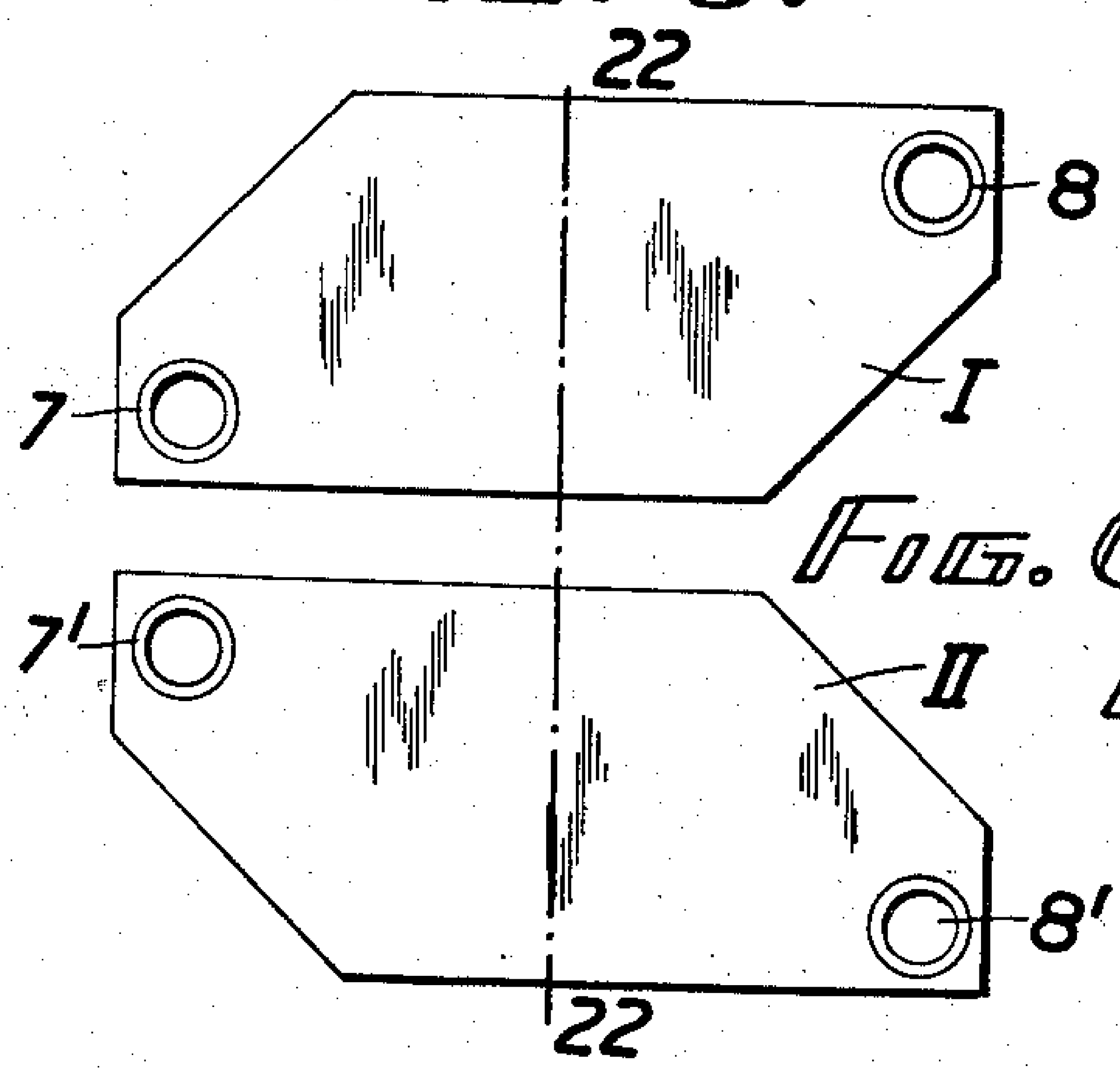

FIG. 6.

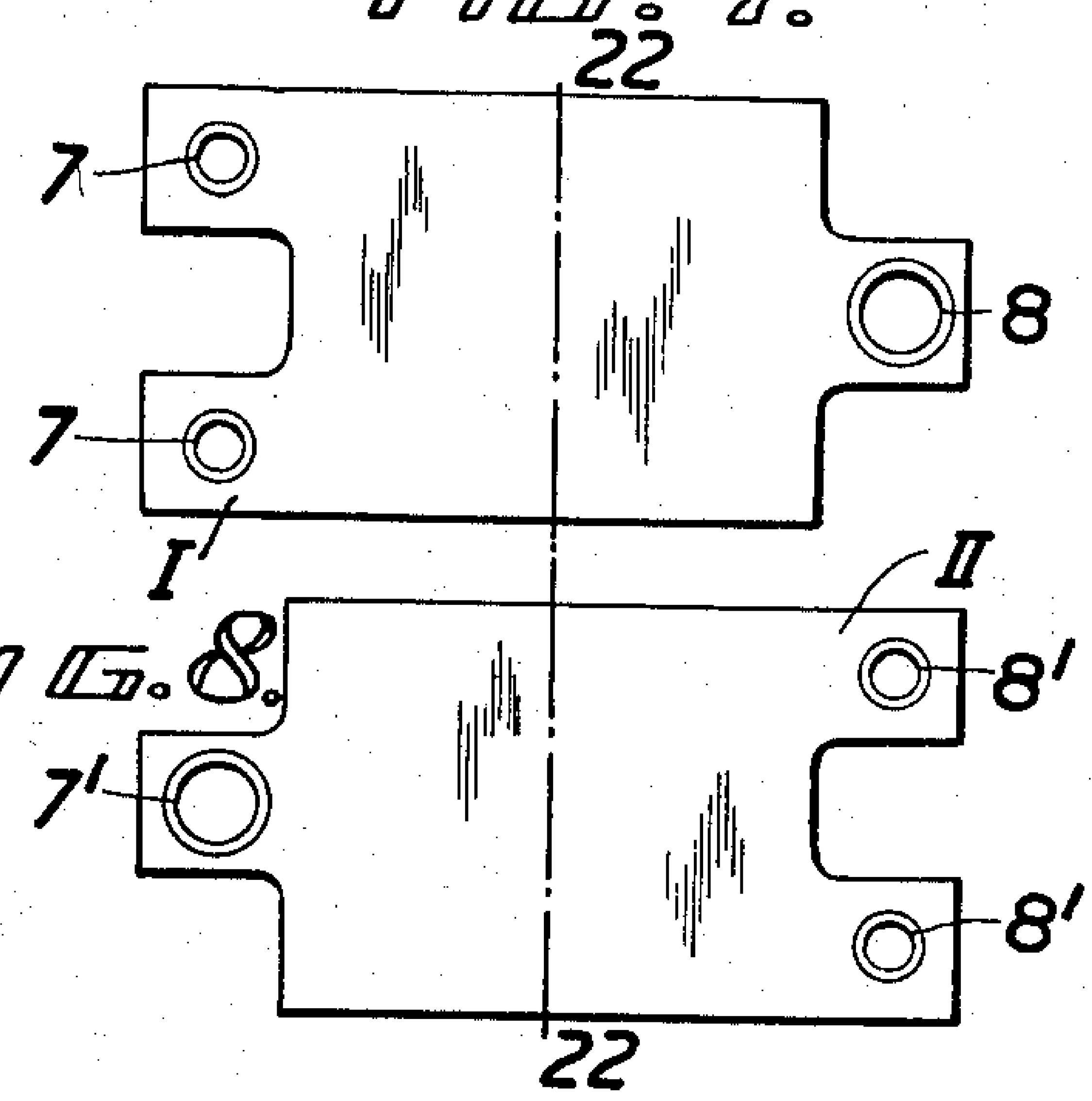

FIG. 8.

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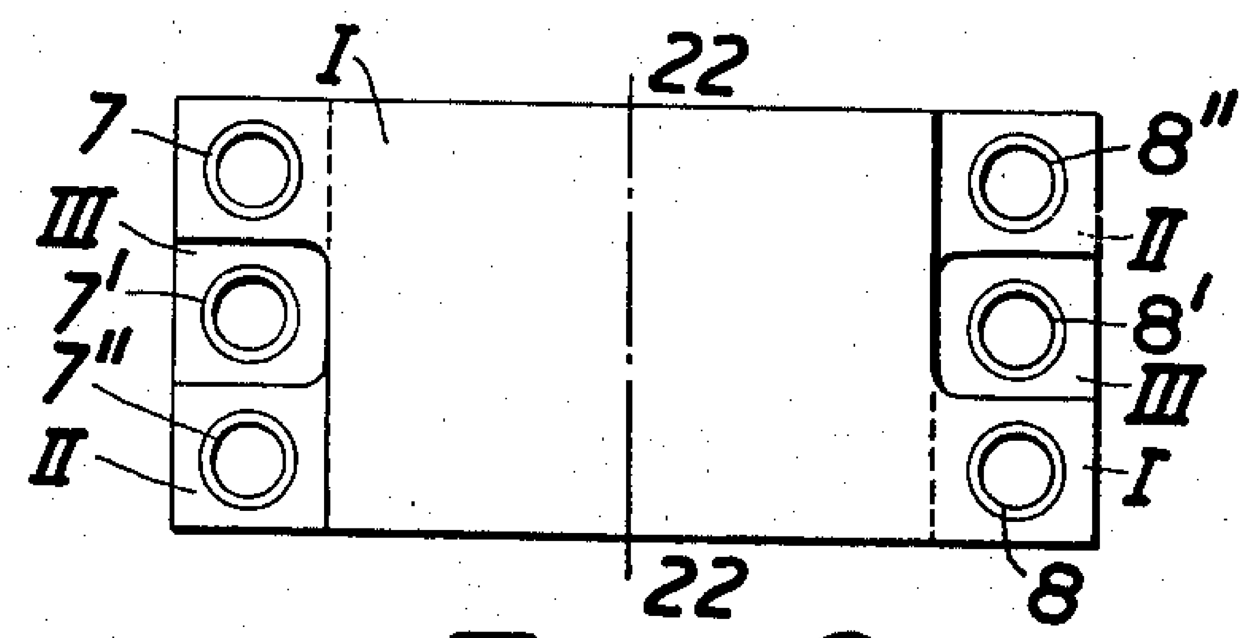

FIG. 9.

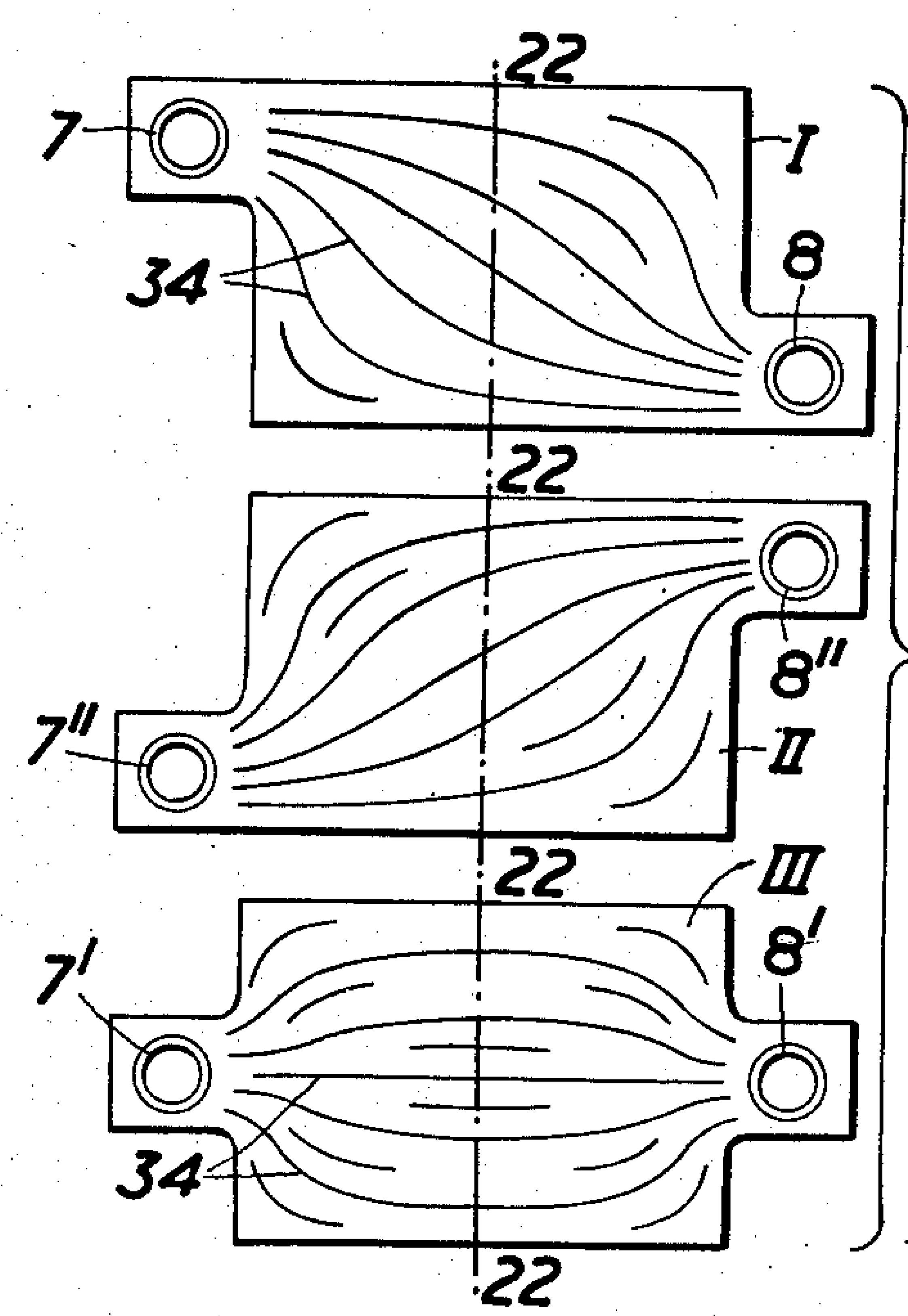

FIG. 10.

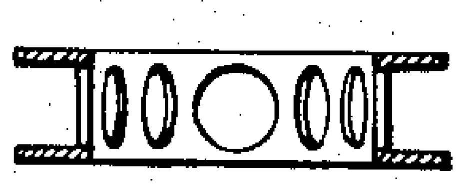

FIG. 11.

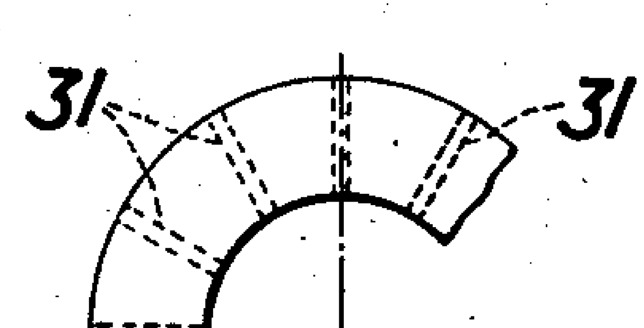

FIG. 12.

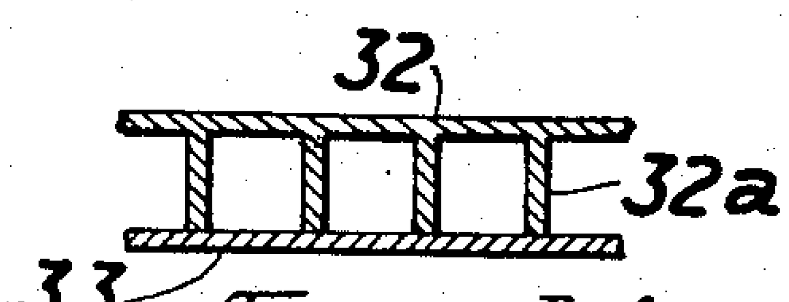

FIG. 14.

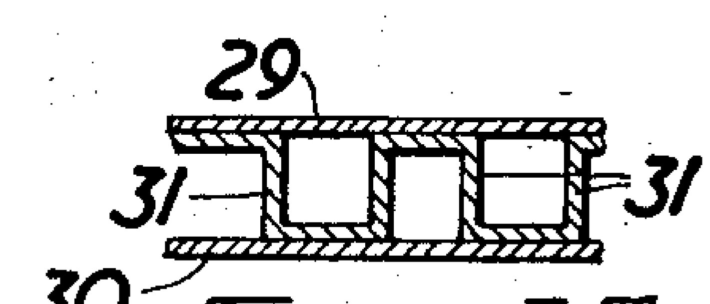

FIG. 13.

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UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

George Jendrassik, Budapest, Hungary

Application February 28, 1948, Serial No. 12,102
In Hungary May 22, 1942

Section 1, Public Law 690, August 8, 1946
Patent expires May 22, 1962

5 Claims. (Cl. 257—245)

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This invention relates to heat exchangers.

Heat exchangers are known of the kind which consist of a plurality of sheets of nearly identical shape stacked one above the other. Adjacent sheets of the sheet assembly are secured (e. g. welded) together at their edges in pairs in a fluid-tight manner, so that the closed cells thus formed between the sheets secured together in pairs are suitable for guiding one heat exchange medium. The other heat exchange medium flows outside the individual cells formed by pairs of sheets through a closed casing enclosing the assembled sheets and provided with an inlet and an outlet opening.

In order to enable one heat exchange medium to enter and leave the cells between the pairs of sheets, said assembled sheets communicate with an inlet manifold and an outlet manifold both of which are common to all the assembled pairs of sheets.

One known heat exchanger of this kind which is suitable for use with fluids at substantially different pressures has its sheets each equipped with two apertured dished portions. The inlet and outlet manifolds pass through these dished portions of the separate cells and they are made up of a number of superimposed rings equal in number to the number of cells with which the manifolds are to communicate. The rings are bored peripherally so that the tubular manifold formed by the rings is connected for fluid flow through these bore holes with the cells. Such cells are mounted one upon the other within a casing and the whole assembly of cells is compressed together by rods passing axially through the manifold rings. The manifolds are at opposite ends of the exchanger and the cells are open to corresponding rings of the inlet and outlet manifolds. The higher pressure fluid passes through the exchanger within the cells whilst the lower pressure fluid flows through the casing and outside the cells. Corrugated sheet inserts have been employed between adjacent cells in such constructions and these serve to increase the heat transmitting surface. A drawback of this previously proposed heat exchanger is that the distance between adjacent cells cannot be reduced as much as is desirable. This is because the axial length of the manifold rings cannot be substantially reduced because of the peripheral bore holes through them. Hence, an excessive number of corrugated inserts has had to be used in some instances.

One object of the present invention is to provide a heat exchanger of the kind hereinbefore

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described which is of compact construction and highly efficient in operation.

Another object of the invention is to provide a heat exchanger of the kind hereinbefore described in which the space between the superimposed cells is reduced to a minimum.

A further object of the invention is to provide a compact heat exchanger of the kind hereinbefore described which can be easily dismantled and re-assembled.

Further objects and advantages of the invention will become apparent from the following description taken in conjunction with Figs. 1 to 14 of the accompanying drawings, in which:

Figures 1, 2 and 3 show sectional plan, end and side elevations respectively of a heat exchanger according to the invention having interdigitated cells;

Figure 4 shows in more detail the arrangement of the manifold rings together with the individual sheets of a number of cells;

Figures 5, 7 and 9 are views of three different forms of assembled groups of cells, comprising either two of three cells per group, showing the manner in which the inlet and outlet ducts formed by the manifold rings are arranged at the ends of the cells;

Figures 6, 8 and 10 are views of the individual component sheets making up the groups shown in Figures 5, 7 and 9 respectively;

Figure 11 is a section through one form of manifold insert ring;

Figs. 12 and 13 are respectively a top plan view and a vertical section through part of another form of insert ring; and

Fig. 14 is a section through a further form of insert ring.

In Figures 1, 2 and 3 is shown the general construction of a heat exchanger according to the invention. In this construction there are two sets of interdigitated cells I and II. Each cell is formed of two sheets 1 and 1′ welded or otherwise joined together at their edges 2. Each sheet is of the shape clearly shown in Figure 1 and has at its opposite ends circular flared-out parts 3 and 3′ which parts each have a central aperture (see Figure 3 particularly). Four manifold ducts are provided altogether, each cell communicating with two of them and alternate cells being connected to the same pair of manifolds. The whole assembly is contained within a casing 4 which has openings 5 at its opposite ends for the passage therethrough of the lower pressure fluid. The assembled cells are maintained under compression by bolts as clearly shown. Each manifold duct is built up from a number of separate superimposed rings **7**, **7'**, **8**, **8'** which locate with the appropriate apertures in the flared-out parts **3**, **3'** of the sheets. Between adjacent cells there may be arranged corrugated heat transmitting surfaces such as are indicated in Figure 2. In operation the higher pressure fluid is introduced through one or other of two manifolds, passes through the cells and emerges through the appropriate one of the remaining two manifolds. More detailed description of this and similar heat exchanger constructions will now be given with reference to the remaining figures.

Figure 4 is in effect an enlarged view of a part of Figure 3 and it shows the superimposition of rings making up manifold ducting. Figures 5 and 6 relate to cells of this same embodiment, whilst Figures 7 and 8, and 9 and 10 refer to two different embodiments. For each cell there may be either two or three ducts provided perpendicularly to the sheet planes.

In the most simple arrangement shown in Fig. 5, all pairs of sheets are uniformly shaped, but asymmetrically arranged with reference to the median plane **22—22** of the sheet assembly in such a manner that when stacking the sheet pairs I and II upon each other alternately in mirror image positions (i. e. in positions in which each second sheet pair is turned over around the axis **22—22**), the sheet assembly of the heat exchanger according to the invention will be obtained.

In the case of the sheet assembly shown in Fig. 9, in which each cell is provided with three ducts, it is necessary to provide at least two different forms of sheets as shown in Fig. 10, from which it can be seen that the sheet pair I can, after being turned around the axis **22—22**, be brought into the position II. Thus it is possible to employ the same shape of sheet for both the sheet pairs I and II, whilst sheets of a different shape must be provided for the sheet pair III. Ribs **34** are stamped into the sheets and serve both to support the sheet pairs and also to increase the heat transmitting surface and to ensure the proper conduction and distribution of the working fluid in the flow spaces between the sheets.

Two or more inlet and/or discharge ducts can be provided for each sheet pair. A typical embodiment of this latter kind is shown in Figs. 7 and 8, where the assembly is composed of identical sheet pairs arranged in mirror image fashion.

Fig. 4 representing a section taken at one end of the sheet assembly along the axis of such a duct, shows clearly that on the edges of the cells **26**, **27** there are no parts of sheets which would prevent the contact of the cells **23**, **24**, **25**. Thus, if the duct part shown in Fig. 4 belongs to the duct **7** of the embodiment shown in Fig. 5, the interstices of the cells **26**, **27** join on, in an arrangement corresponding to Fig. 4, to the duct **7'**. In the vicinity of the latter duct the parts of the cells **23**, **24**, **25** which would again prevent contact between the cells **26**, **27** are absent. As can be seen from Fig. 4, the foregoing arrangement enables the height of the insert rings to be made, within certain limits, independent of the distance between the pairs of sheets, thus permitting small intervals between sheets whilst retaining a satisfactory height of insert ring.

In a previously known arrangement, the height of the manifold rings amounts to at least the distance, measured in the middle zone of the sheet bundle, of the outer sheets of a sheet group consisting of three consecutive sheets, whilst according to the present invention rings of the same dimensions can be, when using two ducts (as shown in Figs. 5 and 7) practically twice as large, and, when employing three ducts (as shown in Fig. 9) three times as large as the distance between the sheets or conversely in case of rings of the same height, the gap width between adjacent cells may be in general a half or a third, respectively, of the gap width permissible in the known arrangement.

The reduction of the height of the insert rings below a certain limit is, as may be concluded from the ring cross-section shown in Fig. 4, prevented mainly by the circumstance that the cross-sectional area of the passage bore-holes **28** provided in these rings must also be sufficiently large and, besides, a layer of packing material must be left above and below the bore-holes, which layer must be sufficiently thick to withstand the force applied to pressure-tighten the assembly. The embodiment of ring shown in Fig. 11, illustrates the manner in which the bore-holes are produced.

Another suitable embodiment is shown in Figs. 12 and 13 (of which Fig. 12 is a plan view, and Fig. 13 a cylindrical section, evolved into a plane) of the insert ring. In this embodiment the insert consists of there rings, viz. of two outer smooth rings **29**, **30** and of a corrugated ring **31** arranged therebetween. The corrugations of ring **31** may be produced by stamping. The outer smooth rings **29**, **30** withstand the necessary tightening compression, and are preferably welded to the corrugated ring **31**.

The embodiment shown in Fig. 14 consists of a toothed ring **32** and of a plane tightening ring **33** supported by the teeth of the toothed ring.

The heat exchanger of the present invention is particularly suitable for effecting heat transmission between gaseous working media in counterflow, this being of great importance in connection with gas turbines or other heat engines, operating in conjunction with heat exchangers. In this case it is the high-pressure working medium of lower temperature which flows through the sheet cells, to which working medium, at the available temperature drop, the heat contents of the low-pressure working medium of higher temperature are transmitted.

I claim:

1. A heat exchanger for the transfer of heat between fluids at substantially different pressures comprising a casing, inlet and outlet connections to the casing via which the lower pressure fluid is arranged to flow through the casing in one direction, a number of spatially separated cells supported as a pack within the casing, entry and exit arrangements for the cells via which the higher pressure fluid is arranged to flow in parallel through the different cells in a direction opposite to the lower pressure fluid flow, in which the individual cells are each constructed of a pair of sheets joined together at their edges the sheets both being flared out to corresponding apertures at least in one position adjacent each of the two opposite ends of the cell, in which in every cell a tubular supporting member having circumferentially distributed fluid passages extends between each corresponding pair of apertures, in which the tubular members of adjacent cells are arranged to be offset with respect to one another but coincident and superimposed in tight contact

with the tubular members of non-adjacent cells in the pack and in which said fluid entry and exit arrangements are connected to appropriate superimposed sets of tubular members.

2. A heat exchanger as claimed in claim 1 in which said passages have at least as great a dimension axially of the tubes as the perpendicular distance between the sheets of a cell.

3. A heat exchanger as claimed in claim 1 in which said tubular supporting members are fabricated from two flat annuli and a corrugated ring therebetween.

4. A heat exchanger for the transfer of heat between fluids at substantially different pressures comprising a casing, inlet and outlet connections to the casing via which the lower pressure fluid is arranged to flow through the casing in one direction, a number of spatially separated cells supported as a pack within the casing, entry and exit arrangements for the cells via which the higher pressure fluid is arranged to flow in parallel through the different cells in a direction opposite to the lower pressure fluid flow, in which the individual cells are each constructed of a pair of sheets joined together at their edges the sheets both being flared out to corresponding apertures in two positions adjacent one end of the cell and in another position adjacent the opposite end of the cell, in which in every cell a tubular supporting member having circumferentially distributed fluid passages extends between each corresponding pair of apertures, in which the tubular members of adjacent cells are arranged to be offset with respect to one another but coincident and superimposed in tight contact with the tubular members of non-adjacent cells in the pack and in which said fluid entry and exit arrangements are connected to appropriate superimposed sets of tubular members.

5. A heat exchanger for the transfer of heat between fluids at substantially different pressures comprising a casing, inlet and outlet connections to the casing via which the lower pressure fluid is arranged to flow through the casing in one

direction, a number of spatially separated cells supported as a pack within the casing, entry and exit arrangements for the cells via which the higher pressure fluid is arranged to flow in parallel through the different cells in a direction opposite to the lower pressure fluid flow, in which the individual cells are each constructed of a pair of sheets joined together at their edges the sheets both being flared out to corresponding apertures in one position adjacent each of the two opposite ends of the cell, in which there are two kinds of cells, the first having identical but asymmetrical plan and the second having symmetrical plan, in which any three consecutive cells of the pack consist of two cells of the first kind in mirror-image relation to one another and one cell of the second kind, in which in every cell a tubular supporting member having circumferentially distributed fluid passages extends between each corresponding pair of apertures, in which the tubular members of adjacent cells are arranged to be offset with respect to one another but coincident and superimposed in tight contact with the tubular members of non-adjacent cells in the pack and in which said fluid entry and exit arrangements are connected to appropriate superimposed sets of tubular members.

GEORGE JENDRASSIK.

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