

1,409,967.

E. PRAT.
HEAT EXCHANGER.
APPLICATION FILED OCT. 29, 1920.

Patented Mar. 21, 1922.

4 SHEETS—SHEET 1.

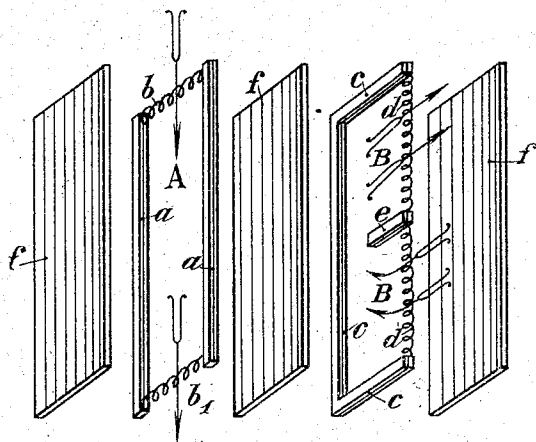


Fig. 1

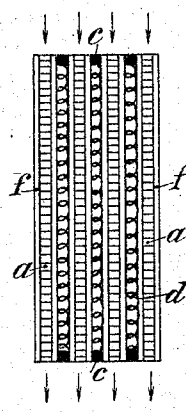


Fig. 2

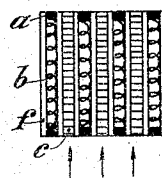


Fig. 3

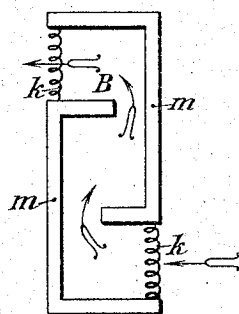


Fig. 5

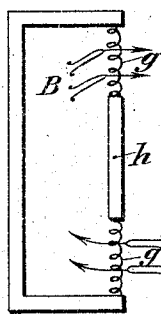


Fig. 4

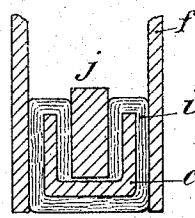


Fig. 6

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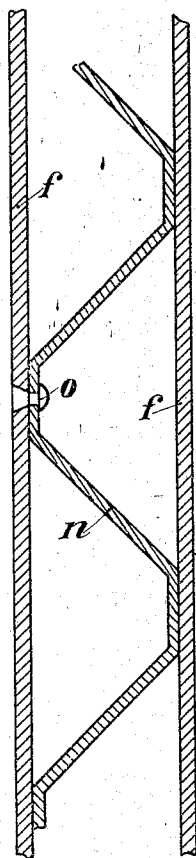


Fig. 7

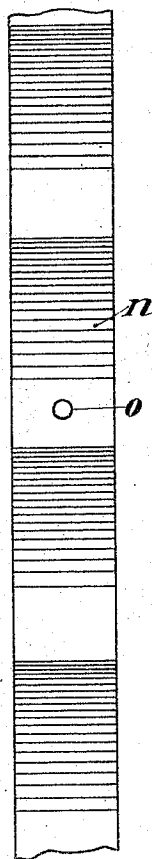


Fig. 8

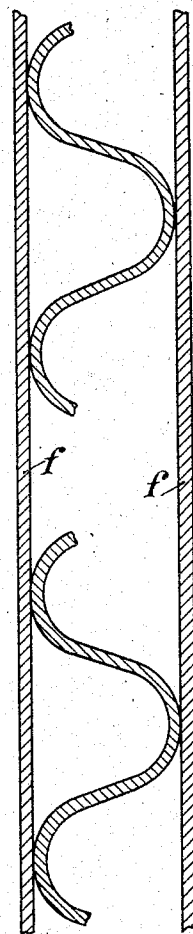


Fig. 9

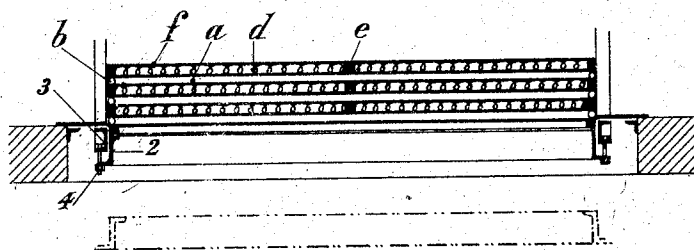


Fig. 11

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4 SHEETS—SHEET 3.

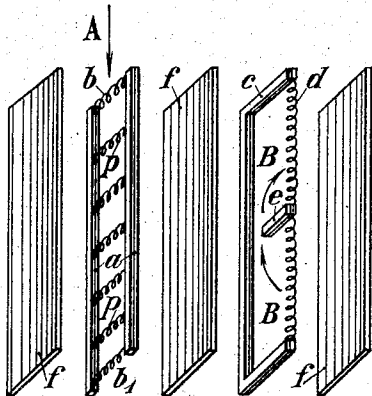


Fig. 10

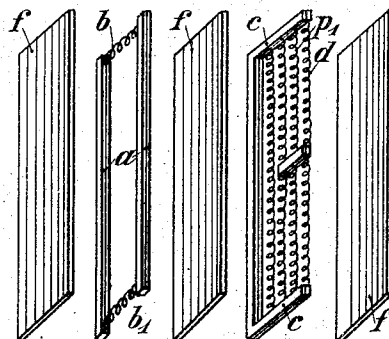


Fig. 11

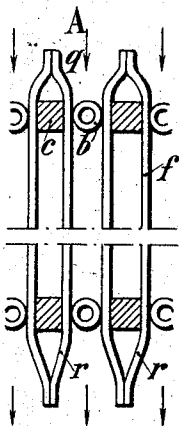


Fig. 12

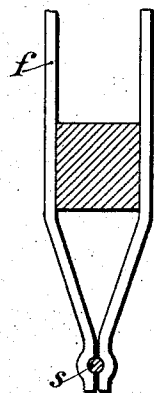


Fig. 13

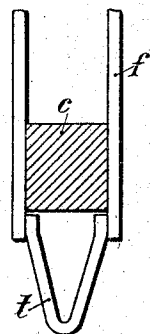


Fig. 14

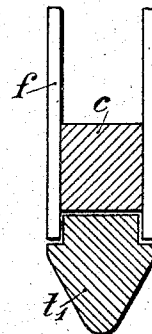


Fig. 15

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4 SHEETS—SHEET 4.

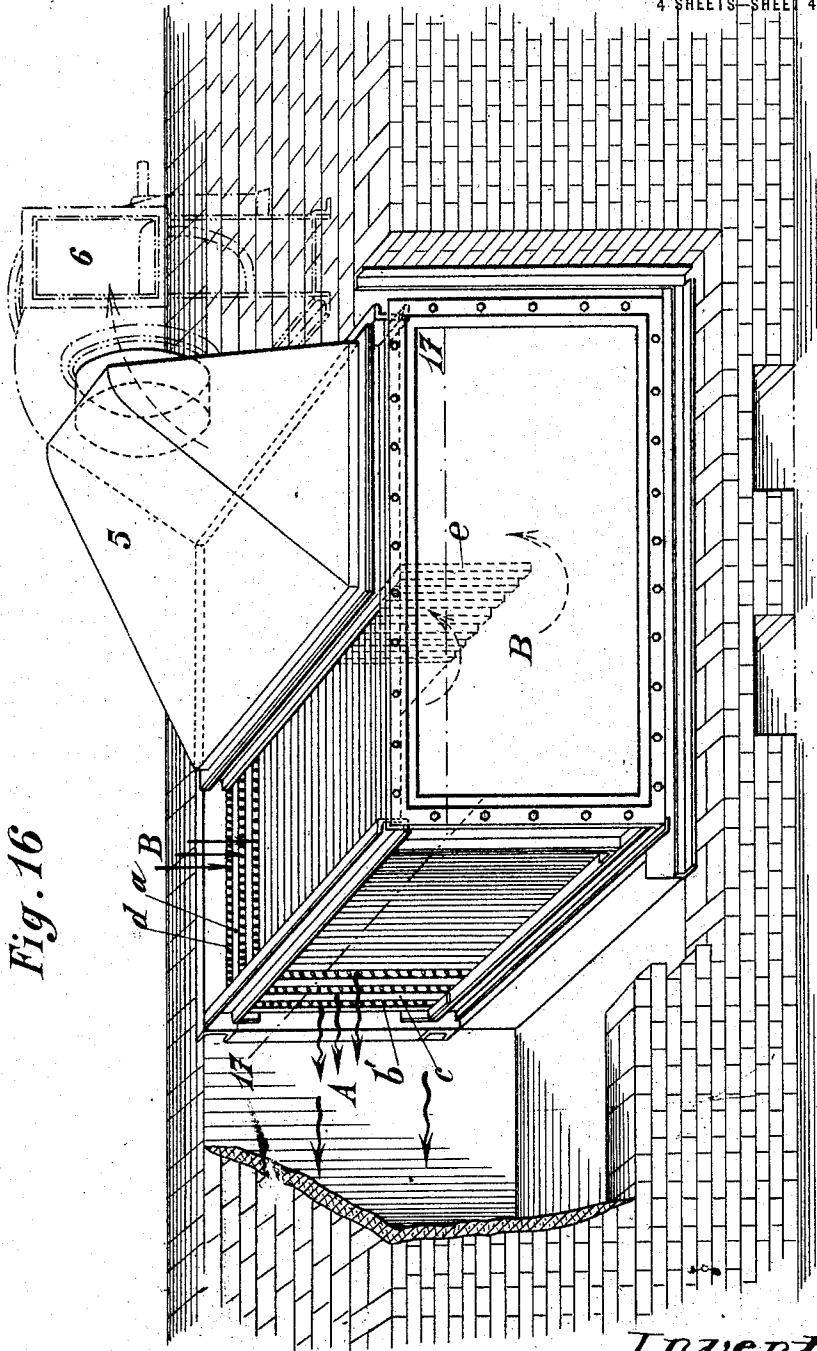


Fig. 16

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UNITED STATES PATENT OFFICE.

EMILE PRAT, OF PARIS, FRANCE

HEAT EXCHANGER.

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Specification of Letters Patent. Patented Mar. 21, 1922.

Application filed October 29, 1920. Serial No. 420,460.

To all whom it may concern:

Be it known that I, EMILE PRAT, citizen of the Republic of France, residing at Paris, France, 64 Rue de Miromesnil, have invented certain new and useful Improvements in Heat Exchangers, of which the following is a specification.

My invention relates to a heat-exchanger of the plate type. Exchangers of this type as generally used are composed of lamellar members, usually made of rectangular or semi-circular sheets of metal, separated either by a beading round their edges, or by an interposed flat piece of metal, or otherwise. In any case the two plates constituting a member are riveted or bolted together to form the heat-exchanger, these lamellar members being mounted side by side and spaced at uniform distances apart by cast-iron shoes or by other suitable means. This form of construction is always very complicated.

Heat exchangers have already been constructed with plates clamped between frames consisting partly of solid portions and partly of undulated portions, but in all such constructions the plates and frames were specially machined and in particular bored with holes to engage bolts for assembling the whole set of plates and frames whose disassembly is then complicated. The object of the present invention is to simplify considerably the construction of said members. The invention is characterized by the fact that the plates, which are formed by simple sheets not having been subjected to any machining, are clamped by outer means between the frames which comprise parts with resilient spirals or corrugations whose diameter when free is slightly larger than the final spacing of the plates, so that after clamping of the whole set of plates and frames, the spirals or corrugations transmit said clamping to the plates and force them against the adjacent frames while securing sufficient tightness.

In the accompanying drawings, which illustrate typical embodiments of the invention:

Figure 1 represents, in perspective, two successive units of an exchanger, the plates and frames being in position previous to locking together.

Figure 2 is a front elevation and Figure 3 a plan of several units assembled together.

Figures 4 and 5 represent modifications of the frames.

Figure 6 is a sectional detail shewing a form of joint between the frames and plates.

Figure 7 is a cross section and Figure 8 a front view of an element of the exchanger comprising bracing spirals which are in form of zig-zag instead of being completely helical, and Figure 9 is a cross section of a modification in which the spirals are in the form of sine curves.

Figures 10 and 11 are perspective views in which the smoke element and the air element respectively possess additional spirals.

Figure 12 shows in cross section the inlet and outlet ends of the plates having a special configuration.

Figures 13, 14 and 15 illustrate modified forms of said ends.

Figure 16 is a view showing the general arrangement of the exchanger inside a chimney flue, and Figure 17 is a partial section in plan taken on line 17-17 of Figure 16 showing the assemblage of plates and frames inside a case.

In the embodiment shown in Figures 1, 2 and 3, the first frame is composed of bars *a*, *a* and spirals *b*, *b'* similar to those of a spring but preferably fairly rigid, the spirals being arranged at right angles to the bars. The next frame is made up, so far as three of its sides are concerned, of bars *c*, *c*, *c*, the fourth side consisting of spirals *d* at right angles to the spirals *b*, *b'* of the first frame. Towards the middle, the spirals *d* are separated by a small bar *e* forming a baffle. Plain plates *f*, *f*, of sheet metal, are mounted between the frames without any preparation, and are fitted to the frames in such a way that the solid portions of these latter make contact with the plates, this contact being made tight enough to form a joint by means of the pressure exerted by the elastic spirals on the plates when the whole is clamped at the ends of the assembled members at right angles to the surface of the plates.

The frames *abb'* and *ced* are placed in succession with a plate *f* interposed between each of them. An angle iron 2 for instance is placed against the last plate on either end of the set. The iron 2 can slide inside angle or channel irons 3 which are invariably assembled together to form a case surrounding the set of plates and frames. The

irons 2 can be united to the irons 3 by means of bolts 4. When the plates and frames are placed vertically one adjacent the other before clamping, the set is at first slightly wider than the case formed by the irons 3, and the irons 2 are somewhat outside the irons 3. By tightening the bolts 4, the irons 2 are drawn close to the irons 3 and the different springs bb^1 and d of the frames are slightly flattened. The resistance of said springs is of course opposed to the drawing of the plates and frames together, but when the set is tightened by the bolts 4 the springs transmit to the plates f the pressure to which they are subjected and thus secure tightness of the plates on the solid parts of the frames.

The case formed by the irons 3 containing the plates and frames may be placed for instance inside a chimney flue (Figure 16).

Gases, coming for instance from a fire, circulate in the direction of the arrows A, entering between two adjacent plates through the spirals b and issuing on the opposite sides through the spirals b^1 . At the same time, the atmospheric air to be heated enters and issues through the spirals d , in the direction of the arrows B, flowing round the baffle e . The circulation spaces are bounded by the bars a and c of the frames, the spirals being arranged so as not to appreciably impede the passage of the fluids. The heated air passes into a conduit 5 leading said air for instance to a blower 6 or any other apparatus wherein it is to be utilized.

The frame $c d$ for the passage of the air, for example, instead of having continuous spirals along one of the sides as shewn in Figure 1, may have one side formed of spirals $g g$ (Figure 4) separated by a solid bar h ; or two of the sides of a frame (Figure 5) may be formed partly of spirals $k k$, and partly of bars m, m , according to the path which the air is desired to travel as indicated by the arrows B.

The form and arrangement of the various portions of the frames and plates, as well as the direction of circulation of the fluids, may vary according to circumstances, the solid portions, in particular, being of irons of any desired section.

If it be desired to make the whole tighter at the joints, any suitable device may be adopted according to the nature of the circulating fluids; welding for apparatus required to have very tight joints—or packing only may be employed. For the purpose contemplated a perfect joint is not required but the simple clamping of the plates and frames together will be sufficient, the principal object in view being the simplicity of the whole structure.

The detail view Figure 6, for instance, shews an arrangement, comprising a chan-

nel iron, in place of the bars c of Figure 1, surrounded by a piece of asbestos fabric, i , felt or similar material, retained in the hollow of the channel iron by a friction-tight bar j . This arrangement has the advantage of preserving the simple character of the whole exchanger.

Instead of being completely helical in form, the resilient parts may be composed of strips of waved or corrugated metal, or otherwise.

In Figures 7 and 8 the bracing n arranged between the plates f of an element is constituted by a strip of steel sheet bent in a zig-zag. Said sheet may be fastened to one of the plates by a rivet o or any other suitable means. When the elements are clamped together, the strips n are slightly deformed and rest on the plates f just like the spirals $bb^1 d$ of Figures 1-3, thus preserving the spacing of the plates without preventing circulation of the fluid.

In the case of Figure 9, the strip of metal is undulated with curved parts.

The strips according to Figures 7, 8 and 9 present the advantage of being rapidly executed by simply mounting them on usual machine-tools and working them from rolled band-irons for instance.

The plates of the heat exchanger may not be plane surfaces, but curved for instance, and in such case the braces are accordingly adapted thereto.

It may occur that air or another fluid is sent under pressure between the plates of an element, said plates then risking to be deformed. In order to avoid such deformation, according to Figures 10 and 11, additional spirals are placed within the element or cell where the other fluid of the exchanger circulates, so as to receive the load resting on the plates subjected to the pressure.

In the example of Figure 10, combustion gases of a furnace circulate inside the frame formed by the bars a and spirals bb^1 . Additional spirals p are located between the end spirals bb^1 .

If air under pressure circulates in the adjacent cell bordered by the frame cd , the plate f between the two cells rests on the spirals p , the latter being slightly resilient while being fairly rigid like the spirals b and d , and said plate will not have any appreciable deformation. Furthermore, the multiplicity of spirals p , placed on the way of the fluid causes whirls which are favorable to the transmission of heat from one fluid to the other.

The same arrangement may be provided in the cell where air or any other fluid circulates, for instance in the case of Figure 11, if a gas or steam under pressure circulates in the cell bordered by the frame $a b b^1$, spirals p_1 may be added to the frame cd .

The spirals p or p_1 instead of being completely helical, may be formed in particular by strips of metal like the spirals b , b_1 , and d .

When a fluid enters one of the cells it is subjected to a contraction which causes an appreciable loss of pressure if the contraction does not occur along a suitable outline such as shown in Figure 12. In said figure the ends of the plates f are curved at q according to a suitable angle of contraction so as to reduce to a minimum the loss of pressure; it is known that said angle approximates 30° . Likewise, at the outlet of the cell, the plates f are curved to give the best transformation of kinetic pressure into dynamic pressure, and the angle of expansion or so called diffusion approximates 7° .

The ends of the curved parts q and r of the plates of two adjacent cells may simply rest on one another by their resiliency. But in order to increase the tightness of the elements, said ends may be formed, as in Figure 13, to surround a cord s , or any other plastic material, interposed between them.

Said ends instead of being formed by the plates f themselves, may be constituted by separate V-shaped resilient members t (Figure 14) resting on the portion of the plates f passing beyond the frames c , or by solid members t' (Figure 15). The plates can then be again formed by plain sheets.

The invention is applicable to the exchange of heat between gases, vapours or liquids of any kind whatsoever, and especially to air heaters, radiators, refrigerators, condensers, feed-water heaters, or any heat-exchanging apparatus.

What I claim is:

1. A heat-exchanger for fluids whereof the constituent members are formed by the juxtaposition of plain plates clamped between

frames formed of solid portions as joints between the plates, and of elastic undulations exerting pressure on the plates whilst allowing the passage of fluids.

2. A heat-exchanger for fluids comprising plain plates clamped between frames, said frames being formed partly of solid portions and partly of elastic undulations allowing the passage of fluids, and solid baffles connected with the frames.

3. A heat-exchanger for fluids comprised of plain plates, frames interposed between said plates, said frames being formed partly of solid portions and partly of elastic undulated portions allowing the passage of fluid, and means for securing a tight joint between said solid portions and the plates.

4. A heat-exchanger for fluids comprised of plain plates clamped between frames, said frames being formed partly of solid portions as joints between the plates, and partly of fairly rigid elastic undulations exerting pressure on the plates whilst allowing the passage of fluids.

5. A heat-exchanger for fluids comprising plain plates interposed between frames formed of solid portions and resilient portions whose width is slightly greater than the distance apart of the plates, said frames also having other resilient portions intermediate the edges of the plates, and clamping means situated outside the edges of the plates and frames.

6. A heat-exchanger for fluids comprising plain plates, distancing frames formed of solid portions and undulated resilient portions, the inlet and outlet ends of the plates being curved to give passageways for the rational circulation of the fluids.

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