No. 817,490. PATENTED APR. 10, 1906.

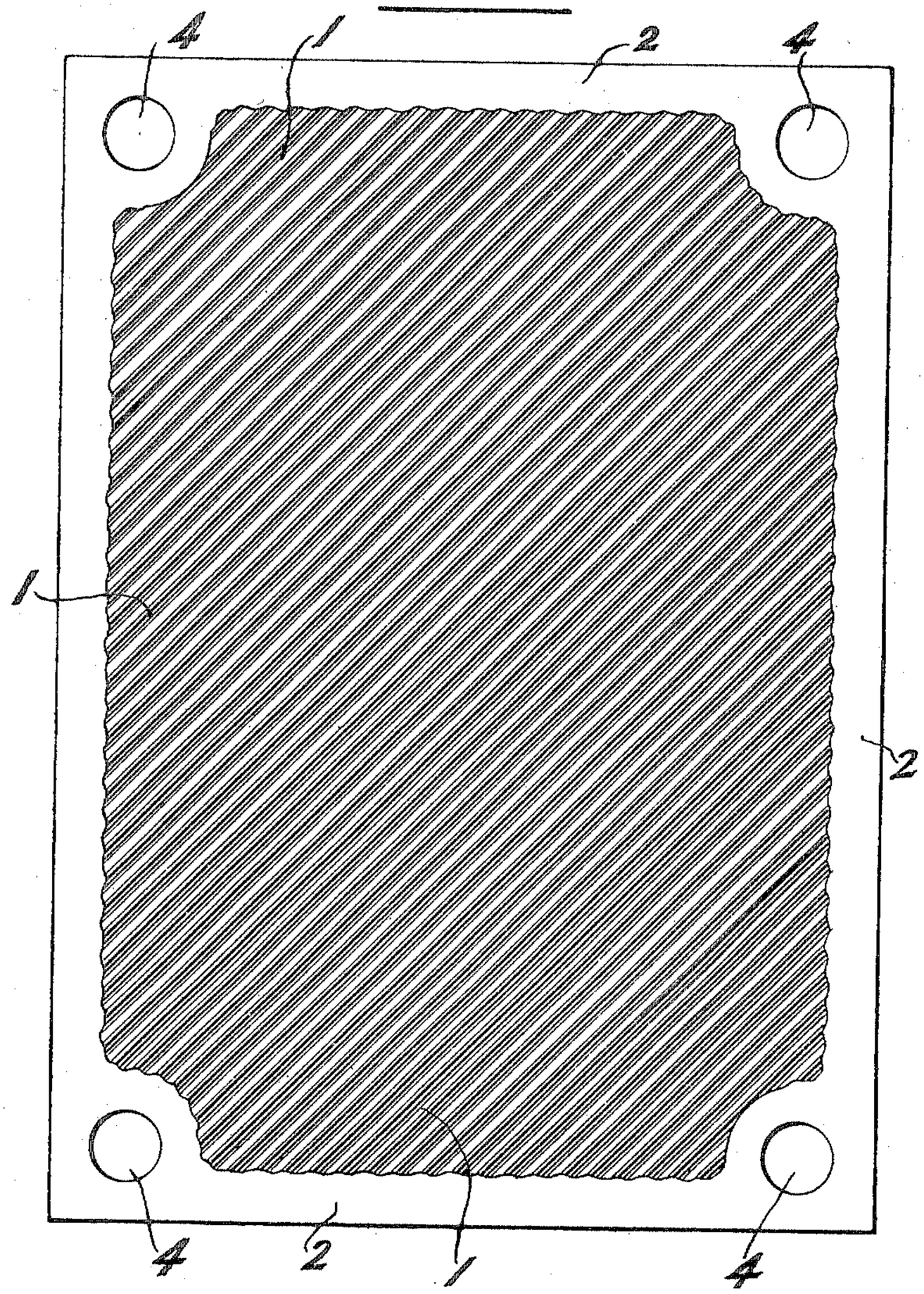
G. F. JARVIS.

SURFACE HEATING OR COOLING APPARATUS.

APPLICATION FILED DEC. 21, 1905.

4 SHEETS—SHEET 1.

FIG. 1.



Witnesses

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4 SHEETS—SHEET 2.

FIG. 2.

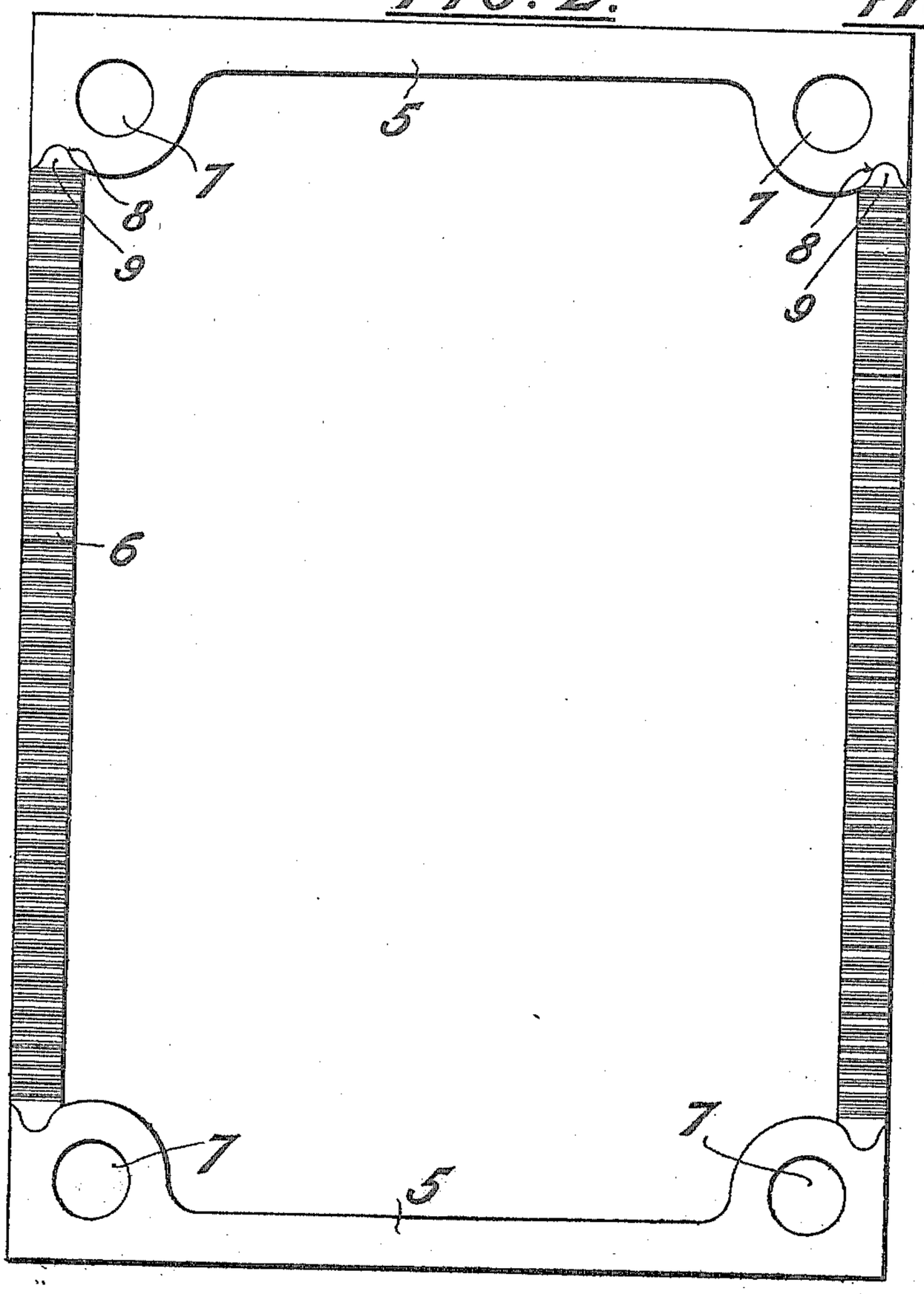
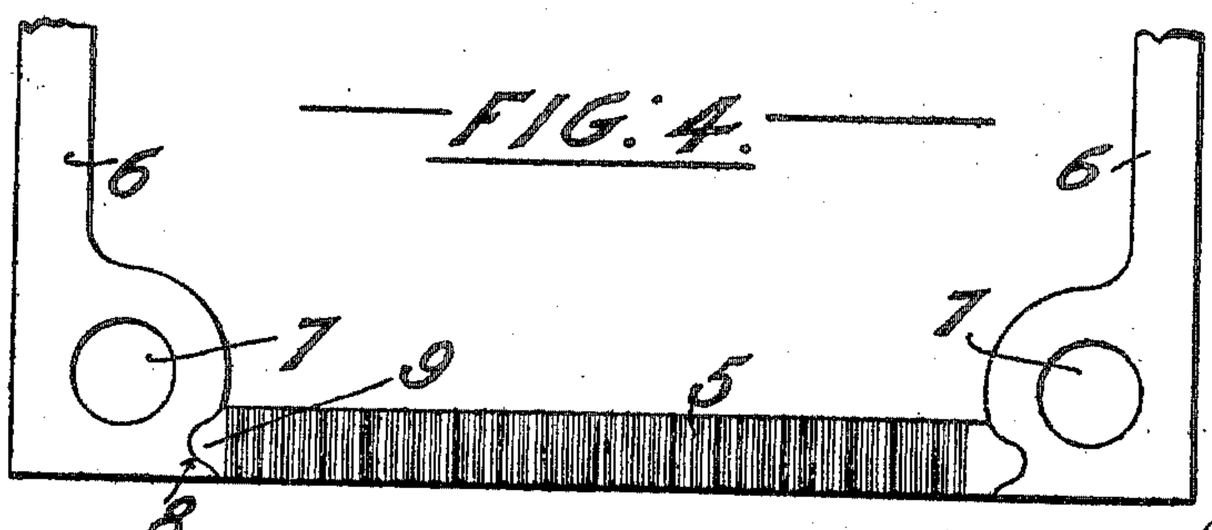


FIG. 3.

FIG. 4.



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4 SHEETS—SHEET 3.

FIG. 5.

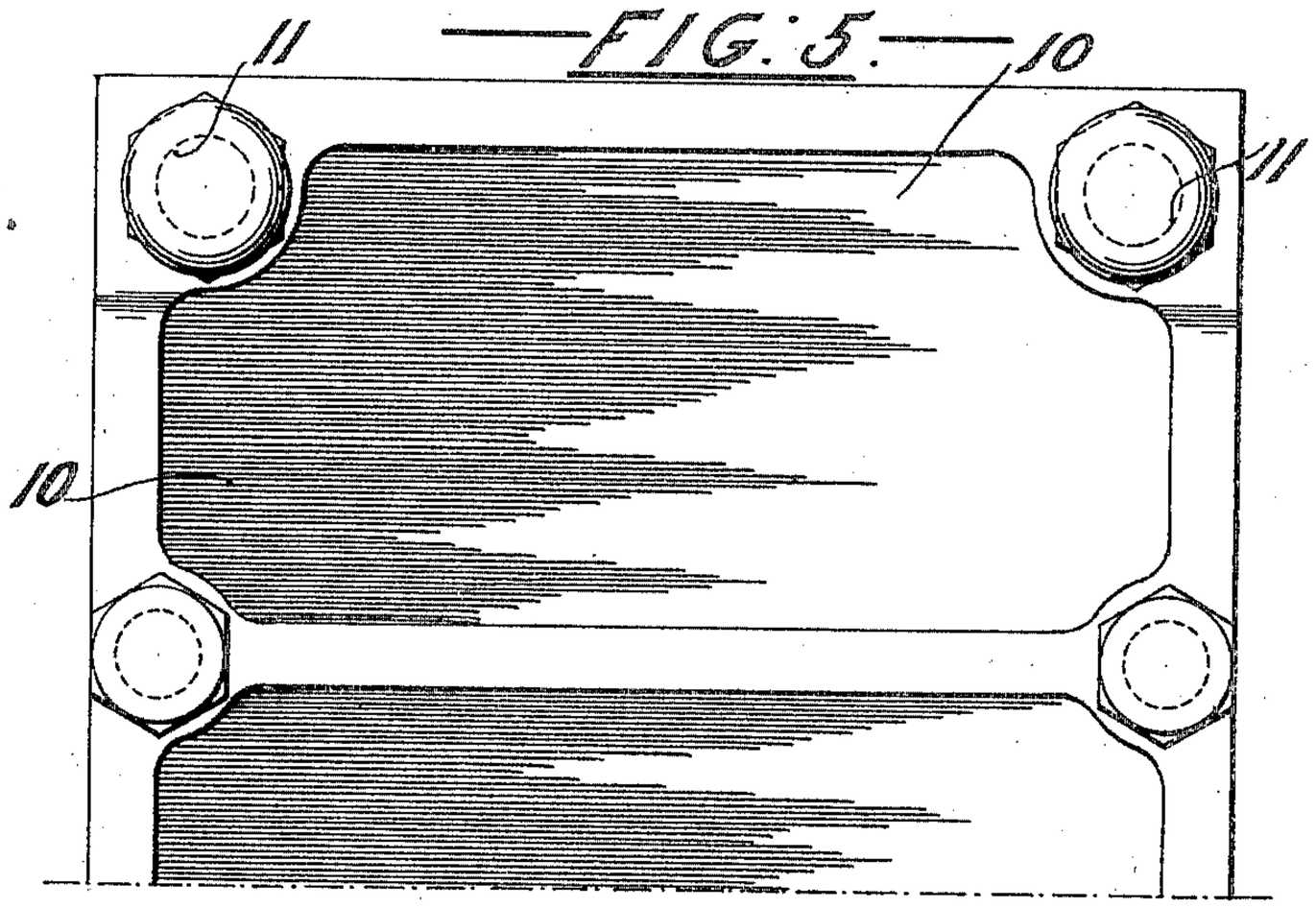


FIG. 6.

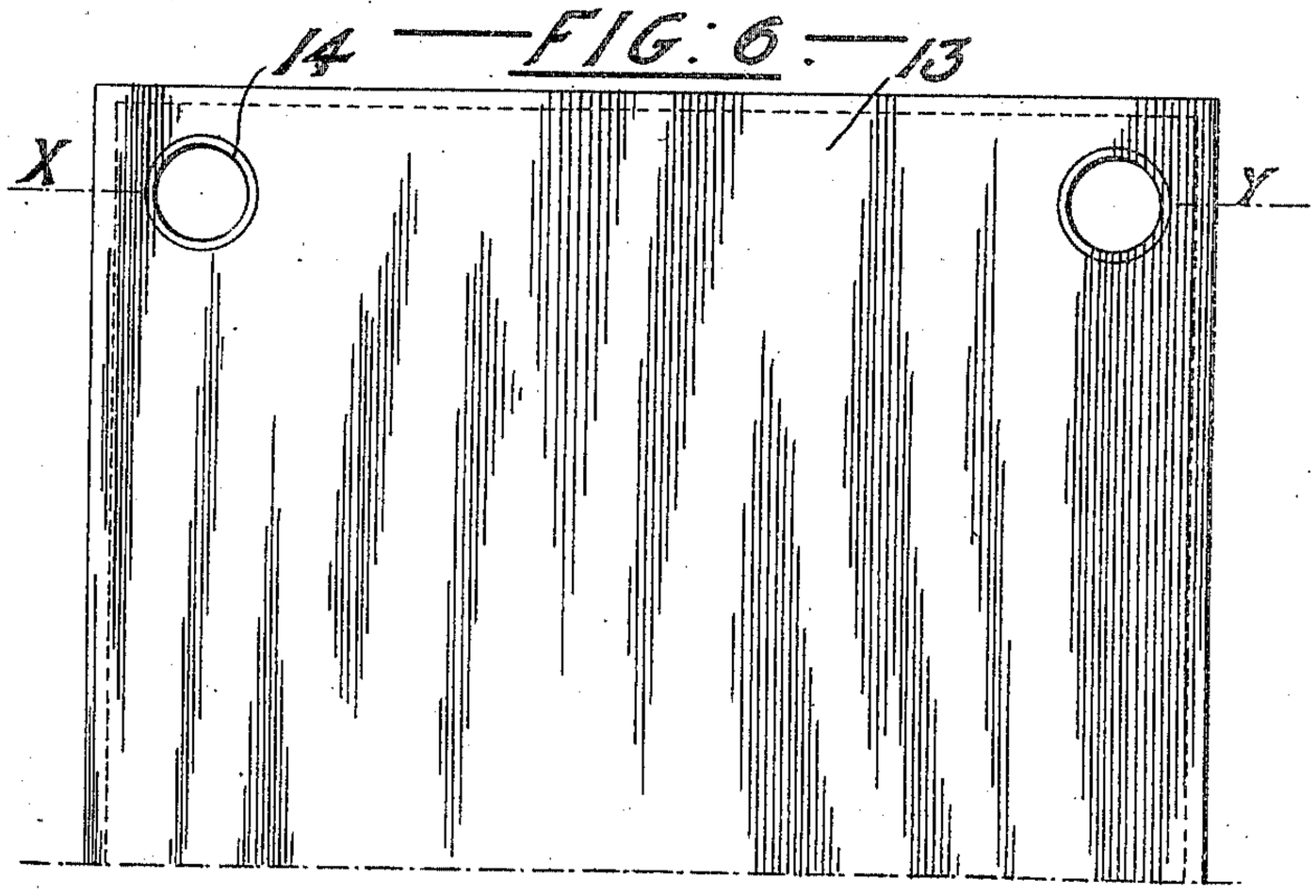
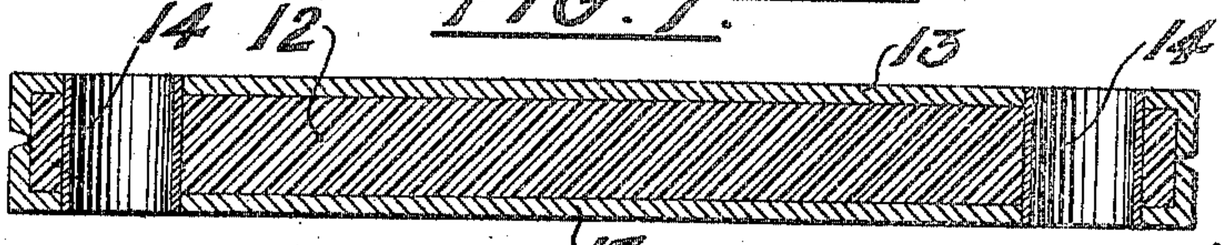


FIG. 7.



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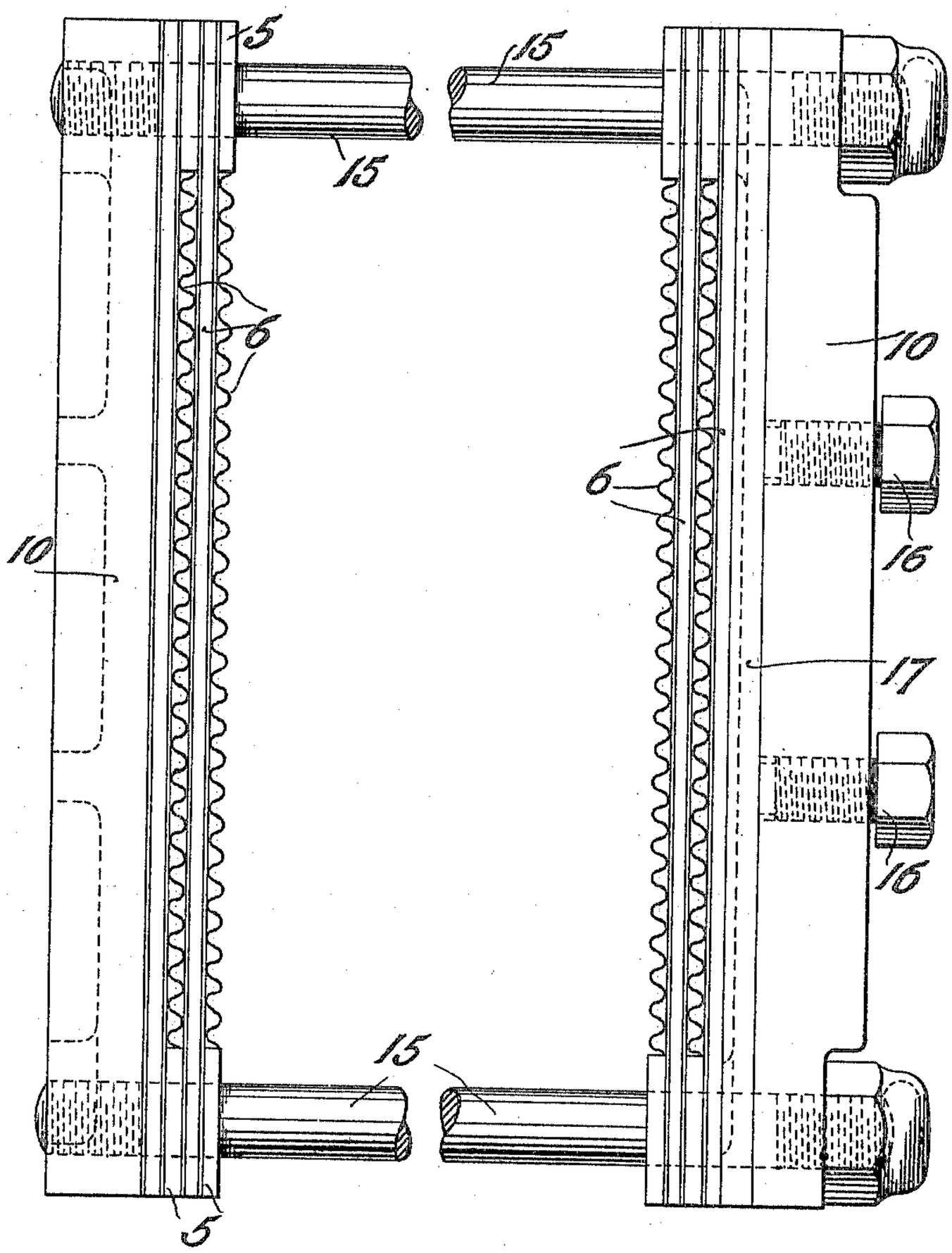
4 SHEETS—SHEET 4.

FIG: 8.



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UNITED STATES PATENT OFFICE.

GEORGE F. JARVIS, OF DARTMOUTH, ENGLAND.

SURFACE HEATING OR COOLING APPARATUS.

No. 817,490. Specification of Letters Patent. Patented April 10, 1906.

Application filed December 21, 1905. Serial No. 292,724.

To all whom it may concern:

Be it known that I, GEORGE FLINDERS JARVIS, a subject of the King of Great Britain, residing at Dartmouth, in the county of Devon, England, have invented certain new and useful Improvements in Surface Heating or Cooling Apparatus, of which the following is a specification.

Heretofore surface apparatus for heating, cooling, and the like have been constructed with corrugated or indented metal plates placed in contact with one another, or nearly so, surface to surface, so that the indented or corrugated surfaces (hereinafter termed "corrugated") of one plate are in contact, or nearly so, with the adjacent plates, and where the corrugations are continuous those of one plate extend in diverse direction to the corrugations of the next adjacent plate.

In such a structure, as is stated in the preamble of the specification of A. W. Brewtnall's United States Patent No. 799,621, dated September 12, 1905, it is necessary to close the interspaces at the edges upon two sides of the first pair of plates, leaving the interspaces at the edges upon the two ends of the first pair of plates open. The next chamber is formed between the external surface of one of the plates of the first chamber and the next adjacent plate, and in regard to this second chamber it is necessary to close the interspaces at the edges upon the two ends, while the two opposite sides are left open. When this is done, one of the mediums—say steam—can be passed in one direction between a pair of plates, while the other medium—say cooling-water—can be passed between the outer surface of one of such plates and the next adjacent plate in an opposite direction, and so on, one medium thus passing through alternate chambers in an opposite direction to the other medium. Now in such apparatus it has been heretofore proposed to effect the complete closure of the interspaces by running molten metal between the said edges; but this mode presents the serious disadvantage that the plates could not readily be separated for cleaning or easily put together again. To obviate this disadvantage, it has also been proposed to place distance-pieces or a distance-frame between the plain margins of each two adjacent plates to compose a structure consisting of plates and frames. Each of these distance-frames it has been proposed to form with serrations or orifices in its opposite bars to permit of the entrance and exit of fluids or gases, while the other bars of each frame were solid, and the structure being so built up it has been proposed to clamp the assemblage together by placing clamping-plates at each end of the structure, with bolts passing outside the edges of the plates and frames to draw the two clamping-plates together to so clamp the said plates and frames, and thus to make a tight joint between the margins of the plates and frames and to hold the structure rigid. Thus in such an arrangement the serrations were made upon the side bars of one distance-frame, while the next frame had serrations made in its end bars, so that one medium could pass between alternate chambers formed by the plates in one direction, while another medium could be passed in the other direction through the other chambers. Now this latter construction has been found to present some serious disadvantages when brought into practice. In the first place it was found to be convenient to construct the four-sided frames each in one piece and to form them by casting, because if the said frames were each made of four separate bars and not in one piece it was difficult to arrange each bar in its proper position and to then maintain the numerous bars all in their proper places until the clamping operation had been properly effected, while when the frames were each made in one piece (which could only be practically effected by casting) it was first impossible to make the said frames sufficiently thin to keep down the weight of the structure, while, secondly, it entailed much labor to plane the said frames truly parallel, as was required. Beyond this the fact of the bolts (extending between the two end clamping-plates) passing outside the edges of the assembled plates and frames called for a very massive and heavy construction of clamping-plates to make them sufficiently inflexible to withstand the transverse strains which were brought upon them, and, in fact, the slight springing of the clamping-plates prevented the assembled plates and frames receiving a perfectly equal pressure around all their edges.

This being the state of the art, the object of the present invention is to improve the construction of these distance-frames, so as to render them capable of advantageous and practical use and at the same time to render it unnecessary to employ clamping-plates of

excessive weight by providing that the plates when the structure is made according to this invention shall not be subjected to such transverse strains. To this end and according to this invention each distance-frame is composed of four separate strips—that is, two end strips and two side strips—each stamped out of sheet metal, such as brass, of the desired thickness, either the end strips or side strips, as may be required, being corrugated. Of these strips those which are made plain are formed with a hole near each end, and the corrugated plates are also formed with a hole at each corner, the holes formed at the ends of the plain distance-strips coinciding with the holes in the corrugated plates when the said strips are placed upon the edges of the said plates, so that bolts—that is, the clamping-bolts before referred to for drawing together the end clamping-plates—can be passed through the holes of the plain distance-strips and through the holes in the plates. The ends of the plain distance-bars are also made with rabbets or recesses to receive the correspondingly-formed ends of the corrugated distance-strips which compose the remaining two members of each frame.

The clamping-plates I employ, according to this invention, are preferably formed of a plate of hard steel coated with brass or other non-corrosible metal or with non-corrosible metal plates bent over the edges of the steel plate and burned together, and holes are made in these clamping-plates, lined with brass or similar tube, through which the clamping-bolts aforesaid are passed.

An example of construction of the invention is shown in the accompanying drawings, whereon—

Figure 1 is an elevation of one of the plates detached, showing its plain or flat margins and its corrugated surface. Fig. 2 is a similar elevation of one of the distance-frames complete composed of the four strips before mentioned, Fig. 3 being an end view of the frame, partly in section, shown at Fig. 2. Fig. 4 is an elevation of a portion of another distance-frame of similar construction, but where the end strips are corrugated while the side strips are flat. Fig. 5 is an elevation of one-half of an end clamping-plate of cast metal, and Fig. 6 is a similar view of one-half of a clamping-plate consisting of a steel or other hard-metal plate covered or coated with non-corrosible metal Fig. 7 being a horizontal section on the line X Y of Fig. 6. Fig. 8 is an end elevation showing the parts of the structure assembled, the centrally-located plates and distance-frames of the structure being omitted to simplify the drawing.

Each plate, as shown by Fig. 1, is formed by stamping or otherwise with corrugations 1, which do not extend to the edges of the plate, leaving, therefore, plain flat end margins 2 and side margins 3, having holes 4 formed through the flat portions of the plate at each corner, and all the plates used in the structure are similar.

Each distance-frame, Figs. 2, 3, and 4, is, as aforesaid, composed of four separate strips—that is, two end strips 5 and two side strips 6—one frame, as shown at Figs. 2 and 3, having the side strips 6 corrugated, while the next frame, as at Fig. 4, has the end strips 5 corrugated and the side strips 6 plain, and each plain strip of each frame is formed at each end with a hole 7 and is of such thickness that when one of the plates, such as at Fig. 1, is placed in surface contact with another similar plate, so that the corrugations of the first plate cross those of the second plate, the plain strip will fill up the interspace between the opposed plain margins of the two plates. Beyond this the inner edges of the plain strips at the ends thereof are formed with rabbets or recesses at 8 to receive the correspondingly-formed ends 9 of the corrugated strips which compose the remaining two members of each frame and which are made of thinner metal, so as to allow of such corrugations. As shown in the drawings, these strips are corrugated transversely or thereabout of their length, and the total depth of the corrugated strips (see Fig. 3) is the same as the thickness of the plain members, and the corrugations may advantageously be formed between the same dies which have been employed to form the corrugations of the plates, thereby insuring that the corrugated strips are exactly of the proper depth.

The clamping-plate may, if desired, be constructed of cast metal, as heretofore; but as illustrated at Fig. 5 this clamping-plate 10 has holes 11 (shown by dotted lines at Fig. 5) formed near the corners coinciding with the holes 7 of the plain distance-strips and with the holes 4 of the corrugated plates. I, however, generally prefer to employ an end clamping-plate, such as is shown at Figs. 6 and 7, consisting of a steel or other hard-metal plate 12, the outside surfaces of which are coated with non-corrosible metal, or, as shown, are covered by brass or other non-corrosible plates 13, which are bent over the edges of the steel plate 12 and burned together or otherwise connected, while the holes corresponding to the holes 11 of Fig. 5 are lined with a piece of brass or other non-corrosible tube 14.

In assembling such a structure the clamping-bolts 15 (shown at Fig. 8) are threaded through the holes of an end clamping-plate, those clamping-plates shown at Fig. 8 being similar in construction to that illustrated at Fig. 5, or the ends of the bolts, as shown at Fig. 8, are screw-threaded into such holes in a clamping-plate, such as 10. Then the plain side strips of a distance-frame, Fig. 4, are threaded over the bolts, the latter passing

through the holes 7 near the ends of the said side strips, and then the corrugated end strips are placed in position, so that their ends fit into the rabbets or recesses 8, Fig. 2, of the plain side strips. Next a corrugated plate, such as at Fig. 1, having corresponding holes in its margin, is threaded over the said bolts and brought with its plain margins into contact with the distance-frame, which has already been threaded thereon. Then the next distance-frame is placed in position by the plain end strips being threaded over the bolts and corrugated side strips placed with their ends in the recesses of the said end strips, and then another plate, such as at Fig. 1, is threaded onto the bolts with its corrugations extending in a diverse direction to those of the first plate, and this procedure is continued until sufficient of the plates and frames have been placed in position. Then the opposite end clamping-plate is placed over the bolts and the two plates are drawn together by nuts, so as to clamp the margins of the corrugated plates and frames tightly together.

In the example shown at Fig. 8 the right-hand clamping-plate 10 is shown fitted with pressure-screws 16, which can be made to act in between the bolts 15 and up against a plate 17, placed between the inner face of the said clamping-plate and the next distancing-frame, so as to adjust the pressure intermediate between the bolts 15; but although such is sometimes a convenient arrangement this invention is not limited thereto.

What I claim as my invention, and desire to secure by Patent, is—

1. In surface heating or cooling apparatus; the combination with a number of superposed corrugated plates equal in size, each plate having a plain flat margin at all its edges and having a hole through each corner of such plain margin; of a distance-frame located between the plain margins of said plates and equal in size thereto, each frame having a hole at each corner coinciding with the holes in the corrugated plates, two opposite members of each frame being solid and flat while the two other members are corrugated, end clamping-plates corresponding in size and shape to the corrugated plates and having holes at the corners thereof to correspond in position with the holes in said corrugated plates and frames, and bolts passing through the holes of the clamping-plates, corrugated plates and frames to clamp the structure together.

2. In surface heating or cooling apparatus; the combination with a number of superposed corrugated plates equal in size, each plate having a plain flat margin at all its edges and having a hole through each corner of such plain margin; of distance-frames located between the plain margins of the said plates, each distance-frame consisting of two separate oppositely-located flat strips equal in thickness to the distance between the plain margins of the adjacent plates and having holes at the ends of each strip coinciding with the holes through the margins of the plates, and two separate oppositely-located strips completing the frame, each of said oppositely-located strips being corrugated transversely of its length, the height of the corrugations being equal to the thickness of the plain strips, means for interlocking the ends of the corrugated strips with the inner facing edges at the ends of each plain strip, and bolts to pass through the holes of the corrugated plates and frames for clamping the structure together.

3. In surface heating or cooling apparatus; the combination with a number of superposed corrugated plates equal in size, each plate having a plain flat margin at all its edges and having a hole through each corner of such plain margin; of distance-frames located between the plain margins of said plates, each distance-frame consisting of two separate oppositely-located flat strips equal in thickness to the distance between the plain margins of the adjacent plates and having holes at the ends of each strip coinciding with the holes through the margins of the plates and having recesses at the inner facing edges at the ends of each plain strip, two separate oppositely-located strips completing the frame, each of said oppositely-located strips being corrugated transversely of its length, the height of the corrugations being equal to the thickness of the plain strips, and having the ends of the corrugated strips formed to engage in the recesses of the opposite plain strips, and bolts to pass through the holes of the corrugated plates and frames for clamping the structure together substantially as set forth.

4. In surface heating or cooling apparatus; the combination with a number of superposed corrugated plates equal in size, each plate having a plain flat margin at all its edges and having a hole through each corner of such plain margin; of distance-frames located between the plain margins of said plates, each distance-frame consisting of two separate oppositely-located flat strips equal in thickness to the distance between the plain margins of the adjacent plates and having holes at the ends of each strip coinciding with the holes through the margins of the plates and having recesses at the inner facing edges at the ends of each plain strip, two separate oppositely-located strips completing the frame, each of said strips being corru gated transversely of its length, the height of the corrugations being equal to the thickness of the plain strips, and having the ends of the corrugated strips formed to engage in the re-

cesses of the opposite plain strips, end clamping-plates corresponding in size and shape to the corrugated plates and frames, and having holes at the corners thereof, and bolts to engage the end clamping-plates and to pass through the holes of the corrugated plates and frames for clamping the structure together, substantially as set forth.

5. In surface heating or cooling apparatus; the combination with a number of superposed corrugated plates equal in size, each plate having a plain flat margin at all its edges and having a hole through each corner of such plain margin; of distance-frames located between the plain margins of the said plates, one such distance-frame composed of two separate flat side strips equal in thickness to the distance between the plain margins of the adjacent plates and having a hole at each end coinciding with the holes through the margins of the plates and having recesses at the inner facing edges at the ends of each of said side strips, and two separate end strips completing the frame, each corrugated transversely of its length, the height of the corrugations being equal to the thickness of the plain strips and having the ends of the corrugated end strips formed to engage in the recesses at the ends of the plain side strips, a second distance-frame composed of plain end strips having holes at their ends and corrugated side strips, the said frame being located alternately between the margins of the superposed plates to form alternate chambers for the passage of fluid in opposite directions and clamping-plates corresponding in size and shape to the corrugated plates and frames and having holes in the corners thereof, and bolts to engage the end clamping-plates and to pass through the holes of the corrugated plates and frames for clamping the structure together substantially as set forth.

6. In surface heating or cooling apparatus; the combination with a number of superposed corrugated plates equal in size, each plate having a plain flat margin at all its edges and having a hole through each corner of such plain margin; of distance-frames located between the plain margins of said plates, each distance-frame consisting of two separate oppositely-located flat strips equal in thickness to the distance between the plain margins of the adjacent plates and having holes at the ends of each strip coinciding with the holes through the margins of the plates and having recesses at the inner facing edges at the ends of each plain strip, two separate oppositely-located strips completing the frame, each of said strips being corrugated transversely of its length, the height of the corrugations being equal to the thickness of the plain strips, and having the ends of the corrugated strips formed to engage in the recesses of the opposite plain strips, a clamping-plate for each end of the structure, each clamping-plate consisting of a steel plate corresponding in size and shape to the corrugated plates and frames and having corresponding holes at the corners thereof, and a casing of non-corrosible metal covering the surfaces of said steel plate, and bolts to engage the end clamping-plates and to pass through the holes of the corrugated plates and frames for clamping the structure together substantially as set forth.

In witness whereof I have hereunto set my hand in the presence of two witnesses.

GEORGE F. JARVIS.

Witnesses:

WILLIAM HY. WEST

HARRY FOLLETT.