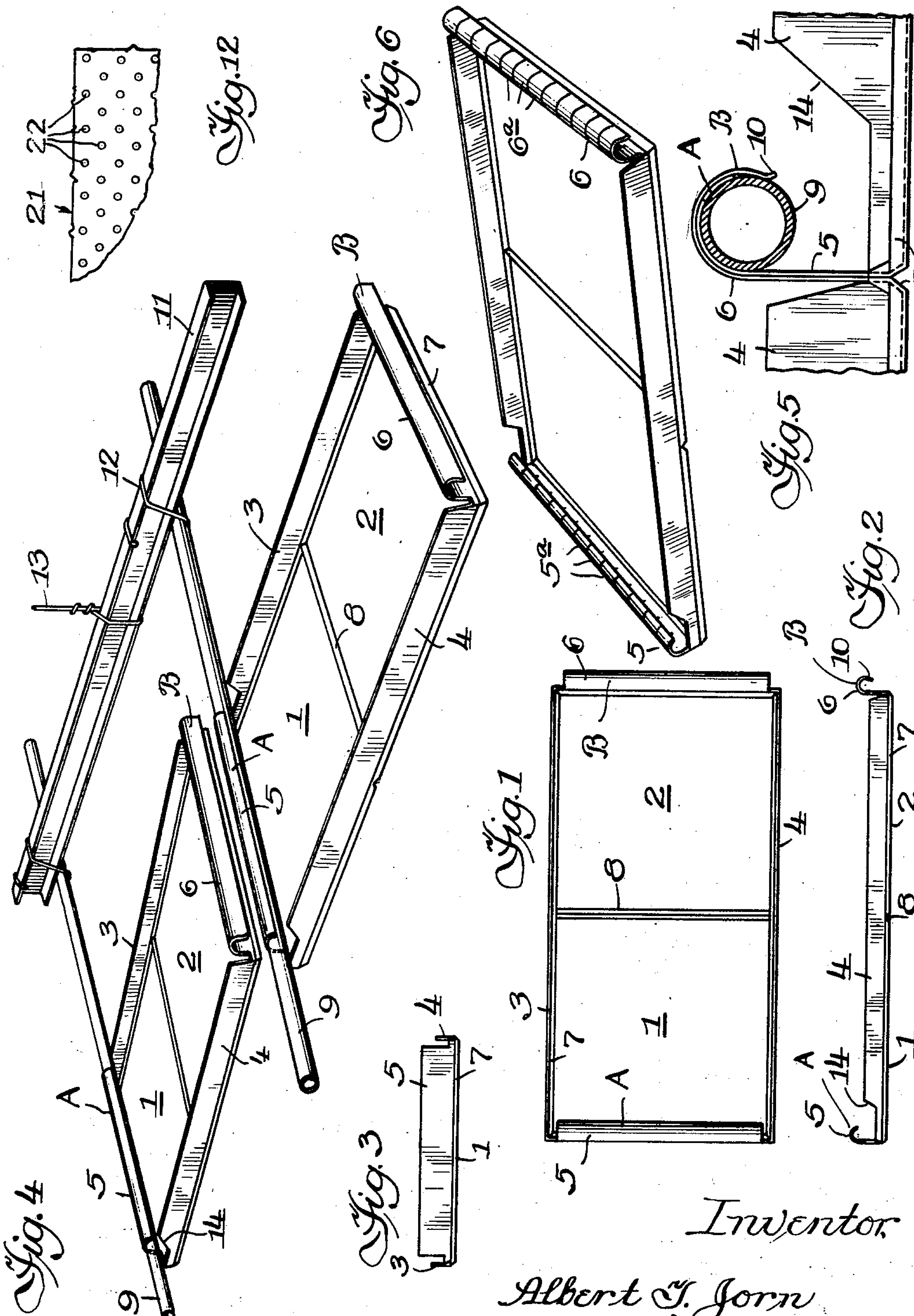
June 7, 1955 | A. T. JORN | 2,710,175

HEAT EXCHANGE PANEL STRUCTURE

Filed Feb. 18, 1952 | 2 Sheets-Sheet 1



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2 Sheets-Sheet 2

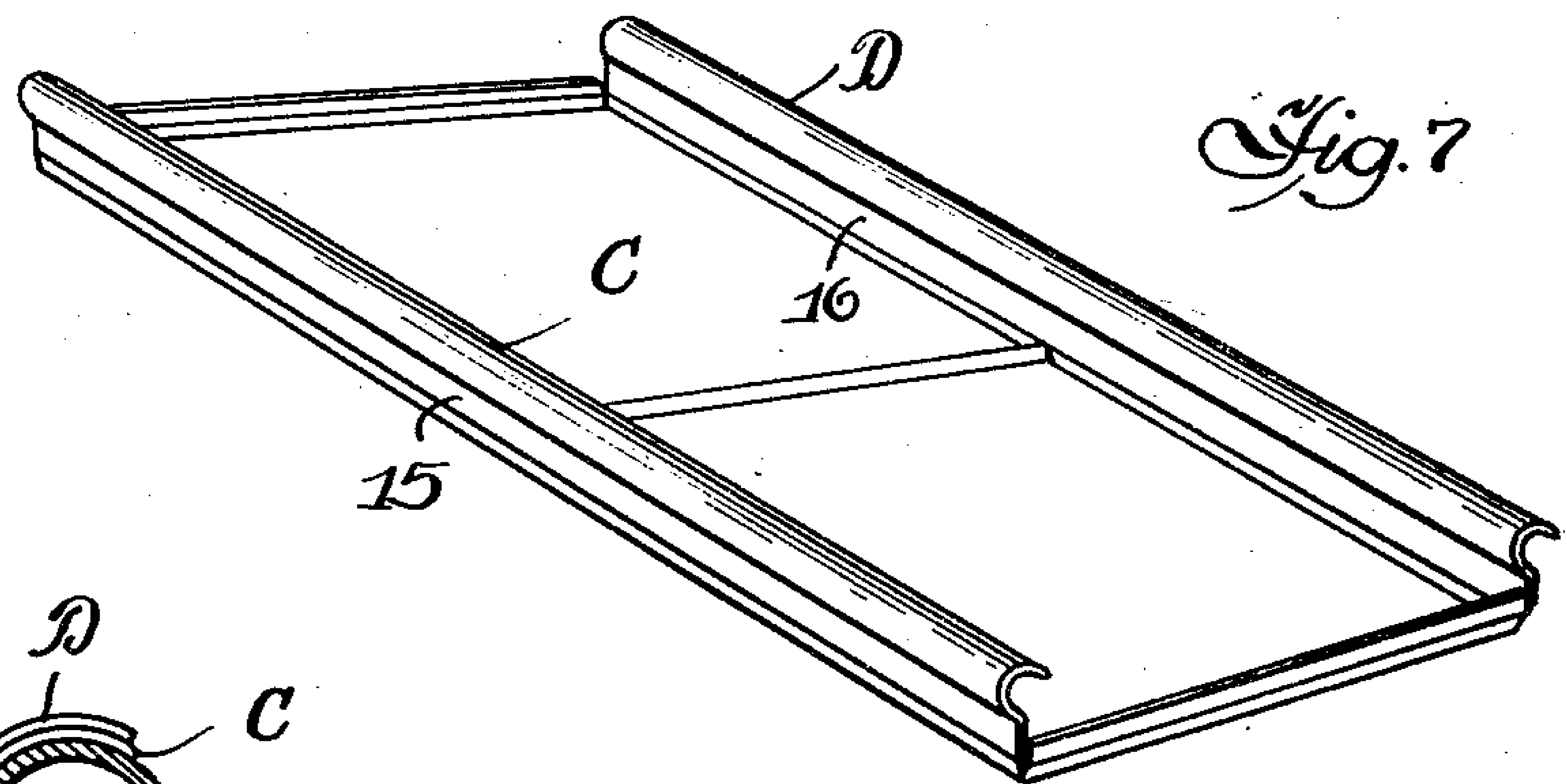


Fig. 7

Fig. 8

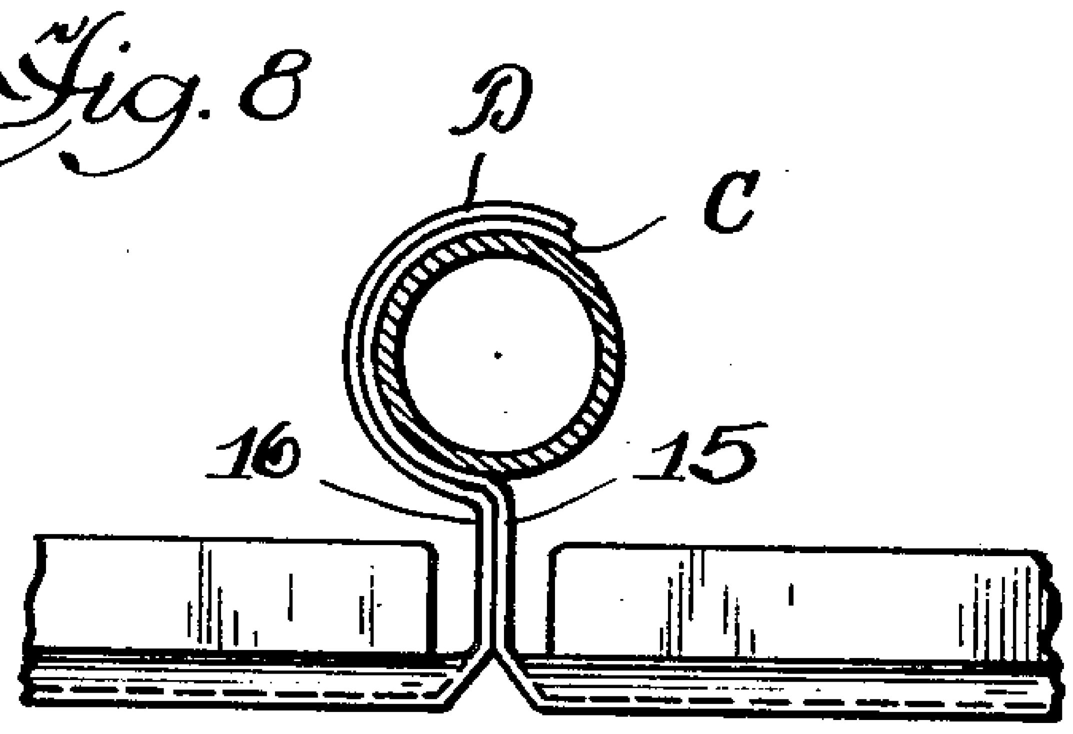


Fig. 10

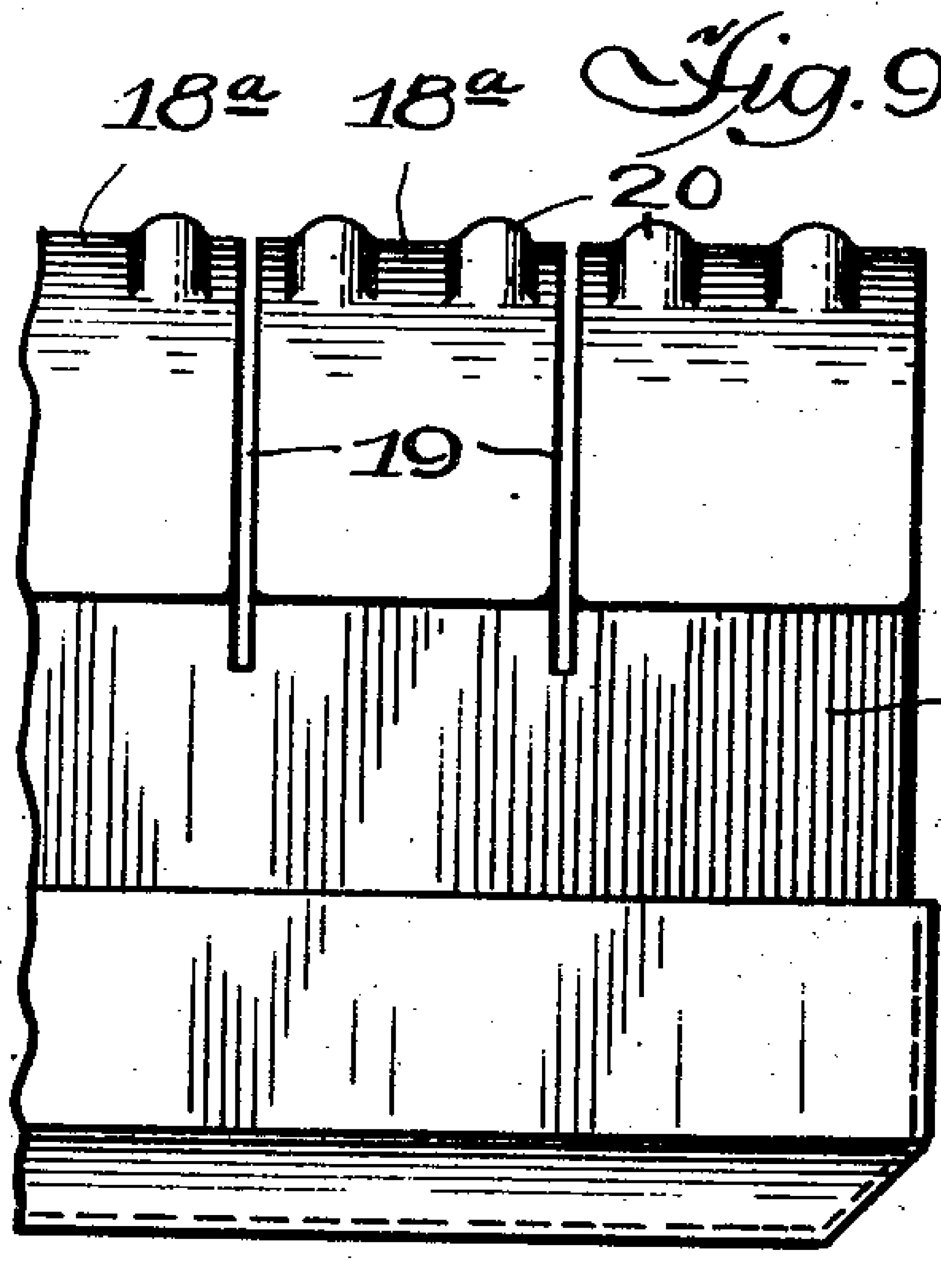
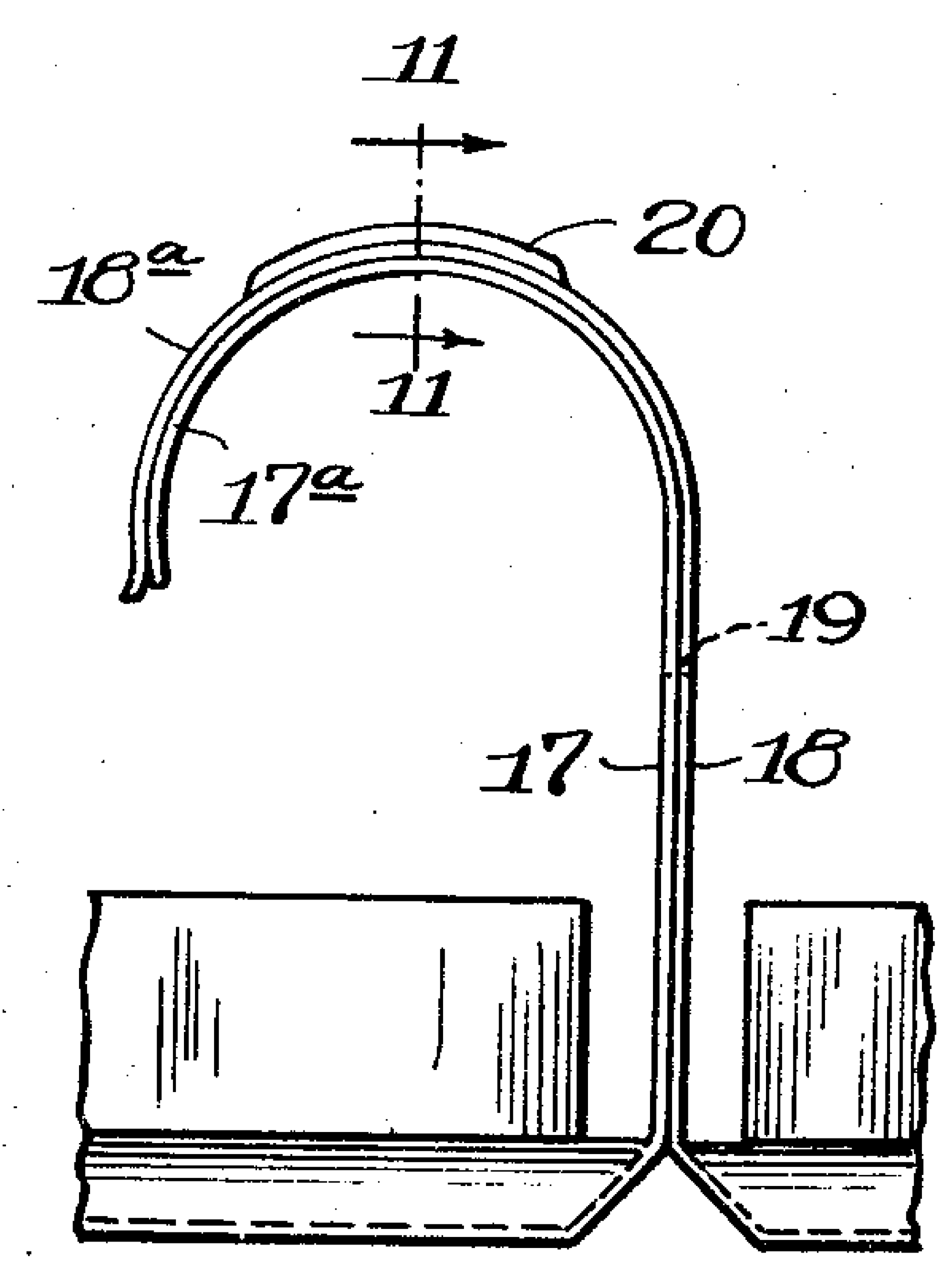


Fig. 9



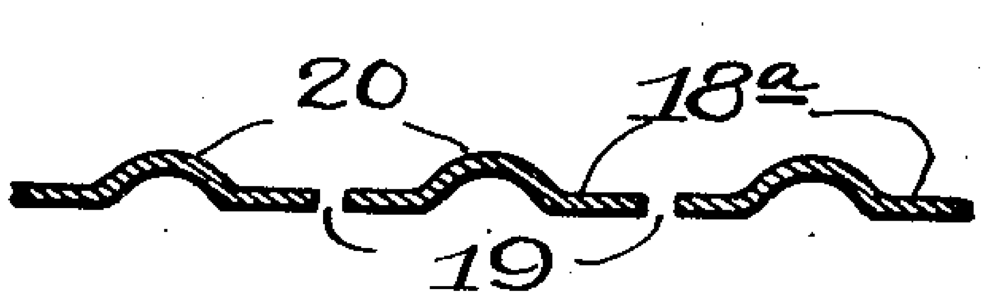


Fig. 11

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United States Patent Office

2,710,175

Patented June 7, 1955

2,710,175

HEAT EXCHANGE PANEL STRUCTURE

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Application February 18, 1952, Serial No. 272,135

9 Claims. (Cl. 257—124)

This invention relates to panel ceiling structures, which are used for heating rooms by what has come to be known as panel heating or radiant heating systems. It may at times be used for cooling purposes. The invention herein described is particularly directed to an improved form of ceiling panel and integral support therefor, for use in such a radiant ceiling structure, providing enhanced heat transfer efficiency and simplicity and security of installation.

These and other objects and advantages will be apparent from the following descriptions of illustrative constructions, taken together with the accompanying drawings, and in which drawings—

Figure 1 is a plan view of one embodiment of the invention;

Figures 2 and 3 are side and end elevations, respectively, of the ceiling panel or pan shown in Fig. 1;

Figure 4 is a perspective view of a portion of a radiant panel ceiling structure illustrating the arrangement of the ceiling pans therein and the manner of installation of the pans;

Figure 5 is a partial side view of a portion of the suspended ceiling assembly, the pipe being shown in section;

Figure 6 is a perspective view of a modified form of ceiling pan embodying the invention;

Figure 7 is a perspective view of another modified form of the invention;

Figure 8 is a side view of two ceiling pans as shown in Fig. 7 illustrating the manner in which they adjoin in the ceiling structure;

Figure 9 shows a still further modification;

Figure 10 is a side view of adjoining pans following the Fig. 9 form;

Figure 11 is a fragmentary section taken on the lines 11—11 of Fig. 10; and

Figure 12 shows a fragmentary plan view of the face of a pan adapted for acoustic purposes.

In accordance with the present invention, the ceiling panel or pan dealt with in this invention has a broad, flat surface, and flanges integral therewith and extending upwardly from opposite margins of the broad panel surface and embodying integral pipe hooks to provide means for supporting the pan and conducting heat to the radiating surface of the pan. The pans are preferably fabricated from sheet material, such as aluminum, having a high heat conductivity capacity. The pan flanges used to support the pan in the ceiling structure are intended to engage pipes which serve both to support and heat the ceiling elements.

Referring to the illustrative constructions and turning first to Figs. 1, 2 and 3, the ceiling panel element therein illustrated is a pan-like device having broad flat surface areas **1** and **2**, flat side flanges **3** and **4** extending upwardly at right angles along the opposite sides of the broad surface area of the pan, and end flanges **5** and **6** extending upwardly along opposite ends of the pan. In the particular form of the device here illustrated, the peripheral areas of broad faces **1** and **2** are bevelled, as at **7**, and

a V-groove **8** is impressed from side to side midway between the ends of the pan to form tile-like faces, for esthetic effects.

Pipes **9** (Figs. 4 and 5) constitute the source of heat, being connected to a suitable header (not shown) to receive therethrough a fluid heat conductor, and they also provide the elements upon which the pans are supported, as by being hung therefrom.

The principal function of side flanges **3** and **4** is to stiffen the pan so that the pans may be more easily handled without damage and the finished ceiling has a good appearance.

While end flanges **5** and **6** also serve to stiffen the pan structure, their principal function in accordance with the present invention is to act as integral hook supports for the pan in the suspended ceiling and furnish a heat bridge between the pipes **9** and the pan. Hook-like elements A and B forming the upper terminal portions or extremities of flanges **5** and **6** respectively are formed to conform generally to the surface of the pipes **9** which they engage in the ceiling assembly.

Following the present invention, the hooks at opposite ends of the pans both open or face in the same direction, but are not otherwise identical. Advantageously, the curved extremity of each flange **5** has an inner curvature which is substantially identical with the curvature of the external surface of pipe **9** and the hook sector A is an arc of approximately 180 degrees so that this element merely rests snugly upon the upper half of the horizontal pipe **9**. The inner surface of the hook extremity B of each flange **6** is intended to engage and lap the outer curved surface of the hook element A of a flange **5**, which, of course, has less curvature than the inner surface thereof. The hook B is nevertheless formed with normal inner surface curvature approximately equal to or even somewhat greater than that of the external surface of hook A and the hook is extended to form an arc of somewhat more than 180 degrees, say, 200 degrees. Hook portion B of flange **6** of one pan may resiliently overlap the hook portion A of flange **5** of an adjoining pan to hold it in place on the pipe **9** by a somewhat spring action. The extreme edge portions of flanges **6** are desirably turned outwardly as at **10** for ease in assembling.

As shown in Fig. 4, the necessary number of ceiling pans to cover the entire ceiling area are hung by their ends in side-by-side relation from and between the spaced, parallel pipes **9**, which, in turn, may be supported by channels **11** by means of suitable clips **12**. The channel beams **11** may be supported in any suitable manner from the building structure, as by pencil wires or hanger straps **13** depending from the ceiling joists or slabs.

Each pan is installed in succession by hooking hook portion A of flange **5** over a pipe section, a portion of side flanges **3** and **4** being cut away, as at **14**, to permit the pipe to pass by the edge of the flange, after which the opposite end of the pan, or hook portion B of flange **6**, is forced down upon the hook portion A of flange **5** of the adjoining pan. The hook portion B of flange **6** is forced open slightly in this process and the pan snaps into position by virtue of the strain in the somewhat springy metal from which the pans are fabricated.

The pans are installed by proceeding in courses. In the illustration of Fig. 4, work is proceeding from right to left, the right-hand pan being settled in position and the left-hand pan being shown in an intermediate installation position. From Figs. 4 and 5, it will be seen that the hook A of flange **5** rests upon the upper cylindrical surface of pipes **9** in close conformity therewith. The hook B of flanges **6**, on the other hand, extends further around the pipe and grips both flange **5** of the adjoining panel and the pipe with a continuous spring pressure which serves to press the underlying portion of flange **5** tightly against the pipe and hold the engaging flange surfaces tightly together, since this arrangement offers appreciable resistance to the upward movement of the ends of the pans adjacent flange **6**.

In the completed suspended radiant ceiling assembly, as used for heating, hot water is circulated through pipes **9**, and the heat flows from the pipes through the metal of the flanges **5** and **6** to faces **1** and **2** of the pans and is then radiated to the room below. The panel ceiling surface may be decorated if desired.

The surface of commercial pipe, particularly galvanized pipe, are not perfectly even and a single bump on the pipe will have the effect of holding the surface of a pan flange, which is intended to engage the pipe closely, away from the pipe surface, with the result that heat transfer is greatly impaired. This undesirable condition may be substantially remedied by subdividing the lengths of the hooked extremities of flanges **5** and **6** into adjacent independent finger elements *5a* and *6a*, as shown in Fig. 6. This is accomplished by cutting or slotting the curved portions of the flanges at laterally spaced intervals throughout the lengths of the flanges. In this form of the device, each individual hook element **5a** and **6a** acts independently of other portions of the respective flanges, so that a bump upon or irregularity in the external surface of the underlying pipe will prevent close contact between the flange and pipe of only a part of the flange, the remainder serving its function of transferring heat by direct contact with the pipe. Thus a better fit is provided between flange and pipe. This subdivided flange construction has the additional advantage of contributing to the ease of installation of the pans since the necessary number of the finger elements may readily be bent back out of the way where necessary to do so because of the presence of an obstruction such as a channel beam **11**.

Furthermore, by reason of the divided elements **5a** and **6a**, not only may obstructions be avoided but a ready means is provided of balancing heat transfer capacities of several pipes. Since the heating capacity of the ceiling in a given zone is essentially directly proportional to the amount of the heat bridge feeding heat from the pipe to the panel, disconnection or removal of any given number of flange sections or fingers **5a** and **6a** will reduce the capacity of a given panel in proportion.

In the further modified form shown in Figs. 7 and 8, the flanges **15** and **16**, corresponding to the flanges **5** and **6** respectively, are formed somewhat differently in that their hook portions C and D are curved about a center which is substantially vertically aligned with the straight vertical portion of the flange, as best seen in Fig. 8, whereas in the earlier figures, the vertical portions are tangential to the curved portions. In both cases the curved or hook portions encircle or overlap slightly more than half the circumference of the pipe. In the Fig. 7 form in order to engage the flanges or hooks with the pipe, the panels are moved into engagement with the pipes by a vertical and lateral movement rather than by a movement first vertically, then laterally, and then downwardly as in the forms shown in Figs. 1 to 6. To accommodate this simple lateral movement in installing the pans of Fig. 7, the flanges **15** and **16** have their hook portions C and D curved on an arc which extends in an up and down direction, in order to leave a lateral opening in the hook portion.

The form of hooked flange shown in Figs. 7 and 8 has an added advantage in enhancing heat transfer between the pipe and panel, since it provides a shorter distance of travel from the pipe to the panel face through the flange, the point of departure of the flange structure from the pipe being at the lowermost surface of the pipe. This form also may contribute to greater ease and speed of installation.

In Figs. 7 and 8 the flanges are shown extending along the sides of the pans instead of the ends. By this modi-

fication the heat transfer capacity may be further increased, it being understood that the pipes are placed closer together in such instance.

In the still further modified form shown in Figs. 9 to 11 inclusive the flanges **17** and **18** correspond in general with the flanges **5** and **6** respectively and the flanges **15** and **16** respectively. Somewhat as shown in Fig. 6, the hook portion of flange **18** is divided into laterally spaced spring sections **18a** as by slots **19**. In the Fig. 9 form, however, each section **18a** is corrugated as at **20** to stiffen the hook and enhance its resistance to permanent set or deformation while retaining its spring or resilient action. This is particularly useful where the material of the pans and their flanges is aluminum. Since flange **18** overlaps flange **17** the latter is not corrugated but is held more tightly in contact with the pipe by reason of the greater stiffness of the hook of flange **18**.

If the ceiling is to incorporate an acoustic control system, as well as a heating system, the pan faces may be perforated as shown with reference to the fragment of pan **21**, at **22** (Fig. 12) to permit the transmission of sound to a suitable sound absorbing material (not shown) arranged above the suspended ceiling.

Although the description has referred to the pans and ceiling as parts of a radiant heating system, it will be understood that the same structure may be employed for cooling purposes when it is not being used for heating, as by circulating cold water through the pipes.

So constructed and arranged, there is provided a panel ceiling of the type and for the purposes described which eliminates the necessity of extraneous fastenings for the panels on the pipes and which assures and enhances a heat bridge effect between pipe and panel. Quicker application is promoted and the possibility of incorrect installation minimized, thus requiring less labor and supervision. Permanence of level of the panels is assured and dropping of the pans due to vibration or expansion and contraction is prevented, thus enhancing ceiling appearance, while at the same time when it is desired to remove a panel for any purpose this may be readily done by pushing up on a panel, a blow for this purpose being required to be given at only one end of the panel, i. e., the end where the flange overlaps the flange of the adjoining panel. Pressures applied to wash or scour the surface do not displace the panel. Due to increased potential heating capacity a less efficient radiating surface for the panel may be employed whereby the color or other ornamental characteristics of the panel surfaces may be varied if desired.

From the foregoing description it will be apparent to workers in the art that other modified forms of pan and integral hook, embodying the teachings of the present invention, may be employed, and such changes may be made as fall within the scope of the appended claims without departing therefrom. Particular features shown and described in connection with particular embodiments of the invention are interchangeable between the several forms. For example, the corrugations shown with the separated hook elements of Fig. 9 may be used with a continuous flange hook such as that shown in Fig. 1. Also, it will be understood that the straight lower portion of the flange may be tangential to the hook, as shown in Fig. 2, in line with the center of the hook curve, as flange **15**, Fig. 8, or may be located at any point intermediate these positions.

Invention is claimed as follows:

1. In a panel ceiling for a heat transfer system including a plurality of spaced parallel fluid-conducting pipes arranged in a horizontal plane and rectangular panels forming a ceiling surface under said pipes, that improvement therein in which each panel has a first flange rising from one side thereof and having an inwardly facing arcuate portion which hooks over and engages a pipe in laterally demountable relation thereto and a second flange rising from the side of said panel opposite

said first flange and having an outwardly facing arcuate portion, both of said flanges terminating at the extremities of said arcuate portions, the arcuate portion of said second flange being curved over an arc of slightly more than 180 degrees and lapping and resiliently clamping the arcuate portion of the first flange of an adjoining panel in laterally demountable relation thereto.

2. The structure of claim 1 wherein the arcuate portions of the flanges are slotted at laterally spaced intervals to provide independent spring fingers.

3. The structure of claim 1 wherein the arcuate portions of the second flanges of the panels are outwardly corrugated to enhance the resistance thereof to permanent deformation.

4. The structure of claim 1 wherein the arcuate portions of the flanges are narrowly slotted at laterally spaced intervals to provide independent spring fingers and the fingers of the second flanges of the panels are outwardly corrugated to enhance their resistance to permanent deformation.

5. The structure of claim 1 wherein the flanges include straight portions tangential to the arcuate portions.

6. The structure of claim 1 wherein the flanges include straight portions between the arcuate portions and the panels and the arcuate portions are located with their centers in substantial alignment with said straight portions.

7. The structure of claim 6 wherein the arc of the arcuate portions of both first and second flanges of the panels is slightly more than 180 degrees.

8. In a panel ceiling for a heat transfer system including a plurality of spaced parallel fluid-conducting pipes arranged in a horizontal plane and rectangular panels forming a ceiling surface under said pipes, that improvement therein in which each panel has a first flange rising from one side thereof and having an inwardly facing arcuate portion which hooks over and engages a pipe in laterally demountable relation thereto and a second flange rising from the side of said panel opposite said first flange and having an outwardly facing arcuate portion, said first flange being curved over an arc of approximately 180 degrees and terminating at the extremity of said arcuate portion, the arcuate portion of said second flange being curved over an arc of approximately 200 degrees and lapping and resiliently clamping the arcuate portion of the first flange of an adjoining panel in laterally demountable relation thereto.

9. A panel for panel heating systems comprising a flat rectangular sheet metal panel having a first flange rising from one side thereof and having an inwardly facing arcuate portion adapted to hook over and engage a pipe in laterally demountable relation thereto and a second flange rising from the side of said panel opposite said first flange and having an outwardly facing arcuate portion, both of said flanges terminating at the extremities of said arcuate portion, the arcuate portion of said second flange being curved over an arc of slightly more than 180 degrees and being adapted to lap and resiliently clamp the arcuate portion of the first flange of a second and adjoining panel in laterally demountable relation thereto.

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