

[54] METHOD OF PRODUCING A HEAT EXCHANGER

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Vorm. Benz ABT Stationärer Motorenbau, Mannheim, Germany[22] Filed: **July 11, 1973**[21] Appl. No.: **378,328**[52] U.S. Cl.: **29/157.3 D**, 29/157.3 R, 113/118 D, 165/166[51] Int. Cl.: **B21d 53/02**, B23p 15/26

[58] Field of Search. 165/166; 29/157.3 D, 157.3 R; 113/118 D, 118 R

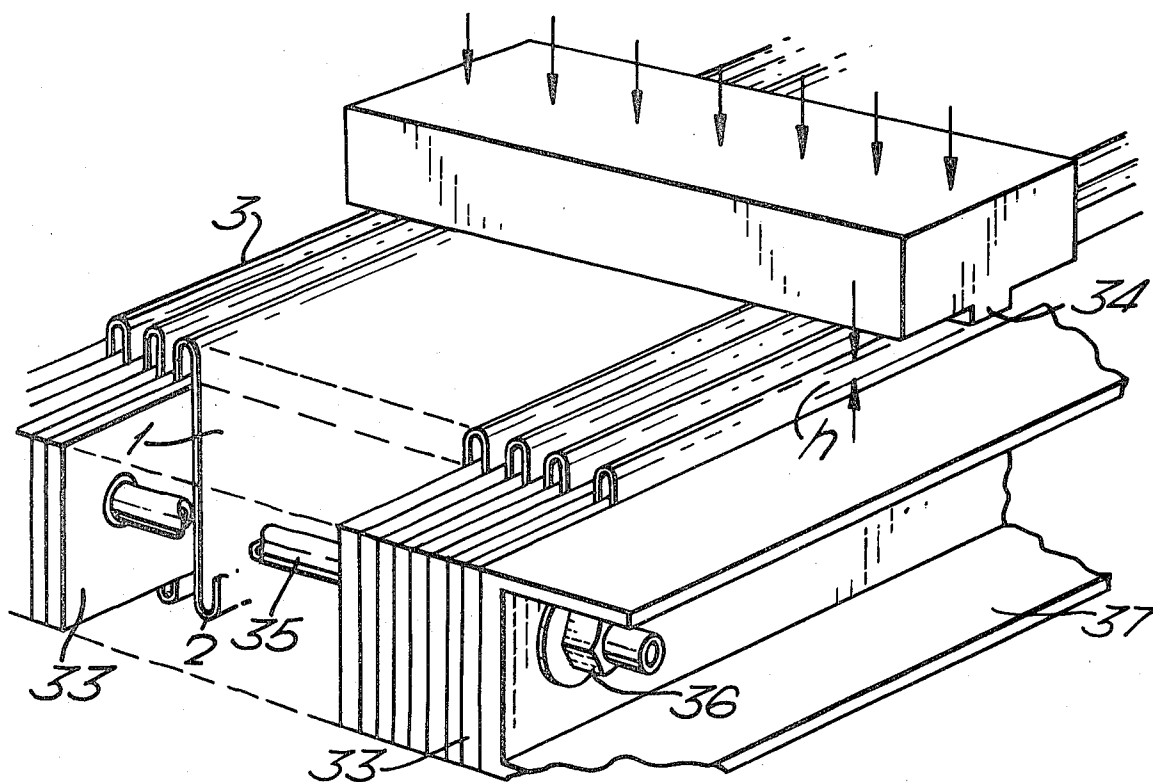
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Primary Examiner—Charles W. Lanham*Assistant Examiner*—D. C. Reiley, III*Attorney, Agent, or Firm*—Waters, Roditi, Schwartz & Nissen[57] **ABSTRACT**

A heat exchanger includes a rectangular housing consisting of four lateral walls and closely receiving a heat-transfer corrugated sheet. Two heat-exchange gases flow at the respective opposite surfaces of the sheet in the furrows defined by the sheet and are supplied to and discharged from the furrows via apertures through two opposite walls of the housing. Plate-form sealing elements of refractory material are caused to press firmly against respective opposite corrugated edges of the sheet by plate-like end members closing the ends of the housing and a spring disposed between one end member and the nearer sealing element.

1 Claim, 7 Drawing Figures

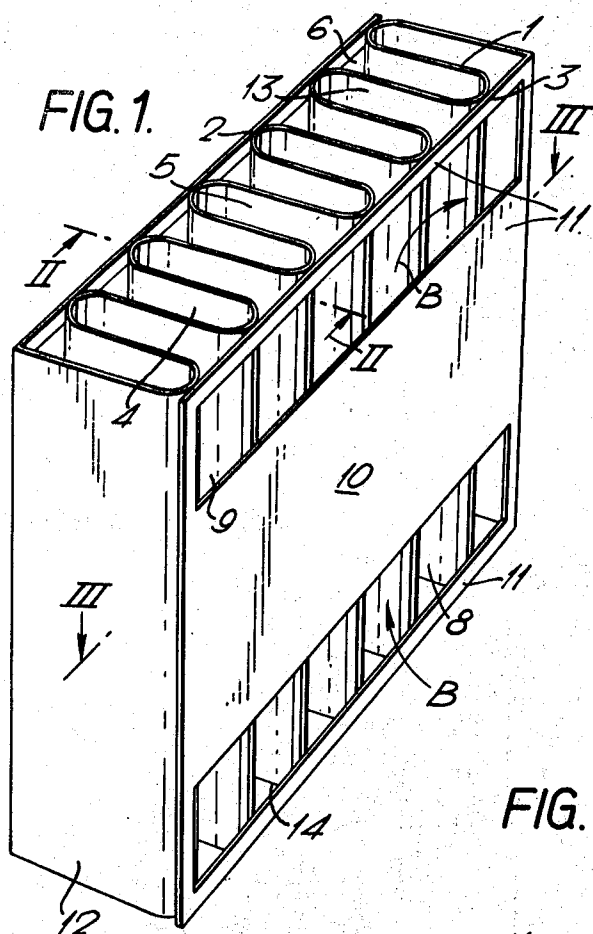
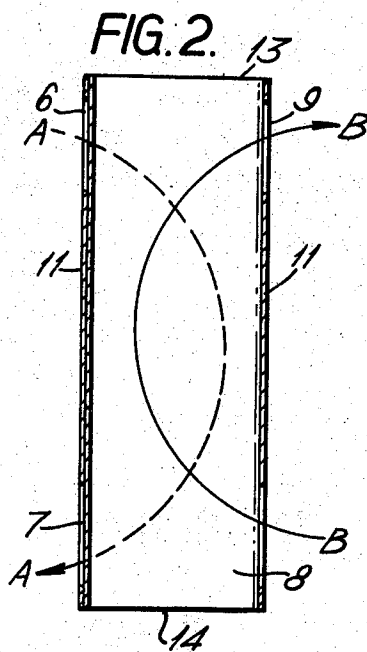


FIG. 3.

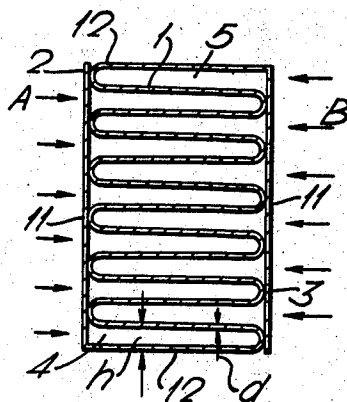


FIG. 5.

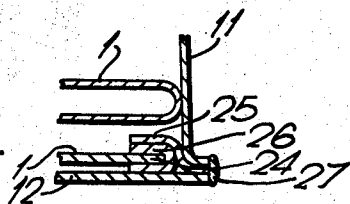
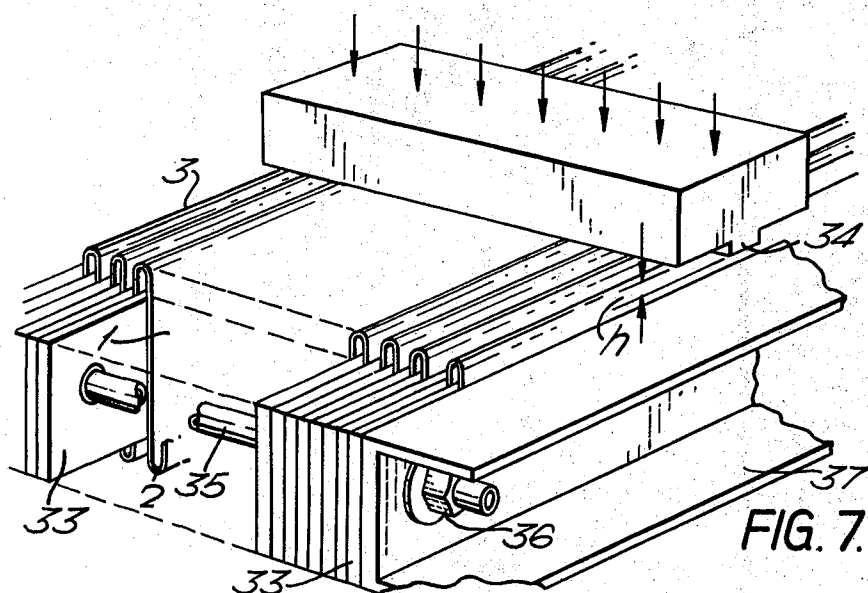


FIG. 4.

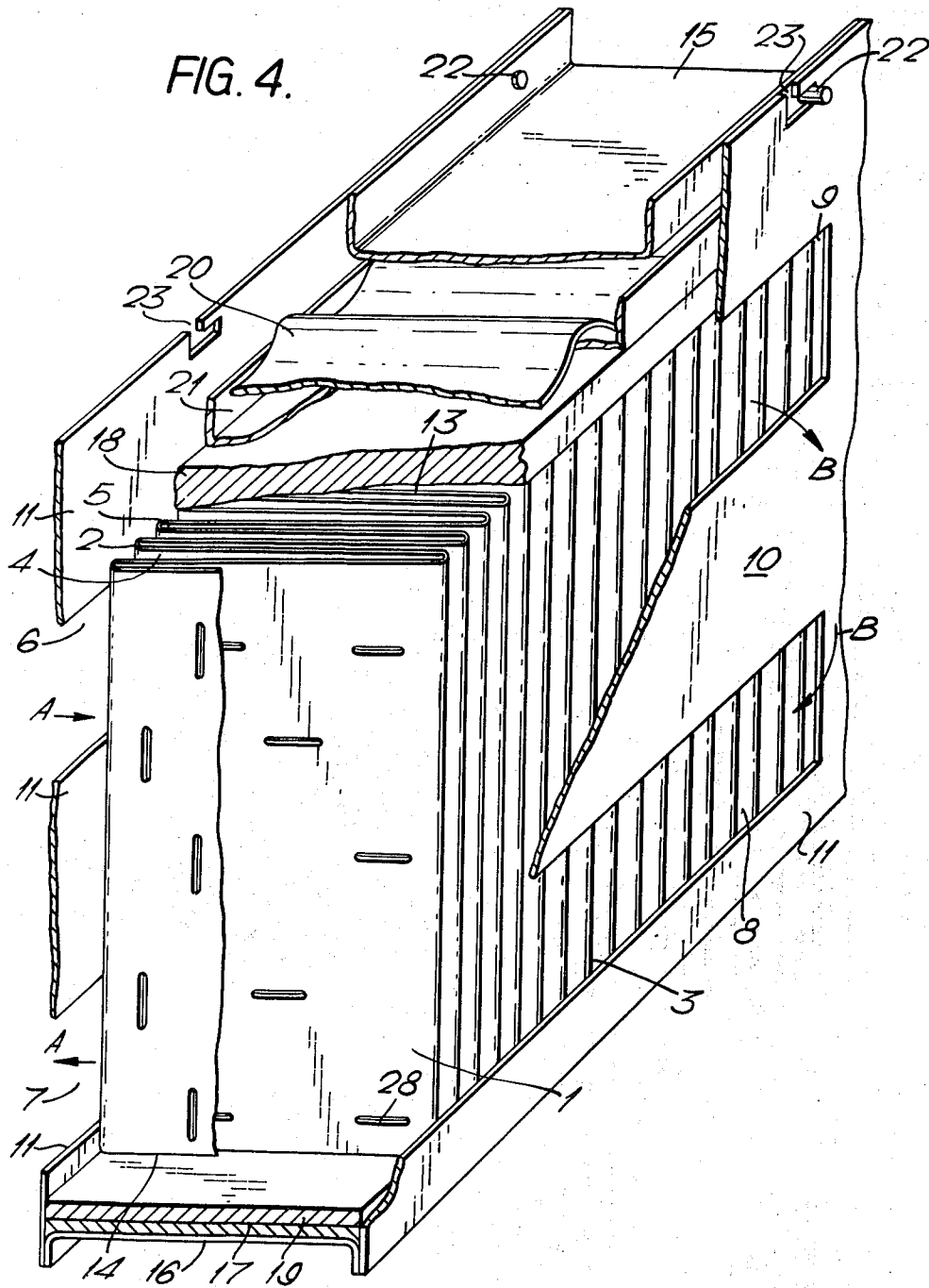
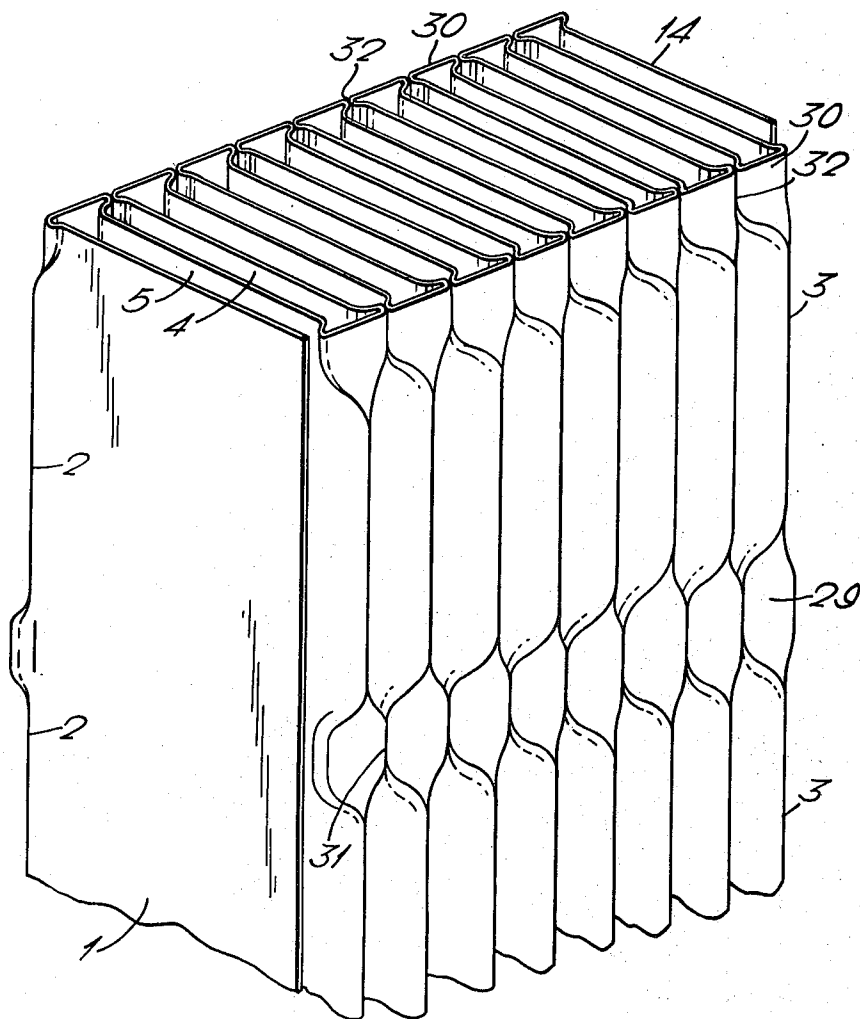


FIG. 6.



METHOD OF PRODUCING A HEAT EXCHANGER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a heat exchanger, more particularly an air preheater.

2. Description of the Prior Art

A heat exchanger is known having a heat-transfer wall in the form of a corrugated metal sheet whereof the folds are through 180° each time. With its housing, this sheet forms a block-shaped assembly which also includes inlet and outlet apertures for the two heat exchange media. The furrows are closed at the ends of the assembly, at which the corrugated edges of the sheet are situated, by welded or soldered joints to separate the two media. This can be carried out either by butt soldering of cover plates to the corrugated edges, or by soldering-in spacers between the folds, or by bending the sheet to bring together its corrugated edges and then welding them together. Such a construction is shown for example in German Patent Specification No. 1,111,221, FIGS. 2 and 3.

The afordescribed welding or soldering involve a considerable amount of work. A further important disadvantage is that there is a marked tendency to form cracks at the joint zones owing to the unavoidable thermal stresses between the corrugated sheet and the soldered-on cover plates or soldered-in spacers or at the welded-together corrugated edges, since the rigid joints produced cannot sufficiently take up the stresses which occur by deformation.

SUMMARY OF THE INVENTION

According to one aspect of the present invention there is provided a heat exchanger, comprising a corrugated metal sheet which forms a heat transfer wall, portions of one surface of said sheet bounding a first group of furrows which furrows alternate with folds in said sheet, first inlet means communicating with said first group of furrows for supplying a first fluid medium thereto, first outlet means communicating with said first group of furrows for receiving said first fluid medium therefrom, portions of the opposite surface of said sheet bounding a second group of furrows which furrows alternate with other folds in said sheet, second inlet means communicating with said second group of furrows for supplying a second fluid medium thereto, second outlet means communicating with said second group of furrows for receiving said second fluid medium therefrom, sealing elements contacting respective opposite corrugated edges of said sheet, and means urging said sealing elements to press firmly against said corrugated edges, said urging means comprising plate-like end members disposed near to the respective corrugated edges of said sheet.

According to another aspect of the present invention, there is provided in a method of producing a heat exchanger comprising a corrugated metal sheet which forms a heat transfer wall, the steps of inserting spacers into furrows alternating with folds of said sheet but so as to leave said folds exposed, clamping together said spacers with the interposition of said sheet, and pressing portions of said folds inwards simultaneously with bar-like tool to form at said folds projecting portions of said sheet which serve to maintain the width of said furrows.

The arrangement whereby the end members urge the sealing elements to press firmly on the corrugated edges of the sheet has the advantages of dispensing with expensive welding or soldering work at these edges and of providing the possibility of relative movement between the sheet and the end members, so that thermal stresses liable to produce cracking no longer occur.

If the heat exchanger is used as an air preheater for the combustion-supporting air of heating burners, e.g. of hot gas engines, the heat exchanger must be capable of withstanding temperatures of up to about 700°C. Advantageously, it is made capable of doing this by using as the sealing elements plate-form sealing elements consisting of felt-like refractory material. The felt-like property compensates for small irregularities in the corrugated edges and thus provides a satisfactory seal.

To prevent the plate-form sealing elements from being cut by sharp corrugated edges of the sheet, the sealing elements can advantageously be provided with an internal insert consisting of a refractory wire gauze.

The strength of the plate-form sealing elements can also be advantageously improved by coating the sealing elements with a hardening refractory substance at least at its major face directed towards the corrugated sheet.

The sheet is advantageously connected to a housing of the heat exchanger without the use of soldered or welded joints. This is achieved by inserting the sheet in a housing which consists of four lateral walls arranged in the form of a rectangle and opposite walls of which are formed with inlet and outlet apertures providing the inlet and outlet means, these walls otherwise closing-off the furrows. For this latter closure, it is sufficient to have metal-to-metal lines of contact between these walls and the sheet folds, since it is not necessary to have a complete seal at these regions, because the same medium is present at both sides of each line of contact.

The sealing of the other, i.e. non-corrugated, edges of the sheet, which extend parallel to the folds, is advantageously also effected without soldered or welded joints by arranging that the two other walls of the housing, together with in each case a lip plate, embrace the non-corrugated edges of the sheet with the interposition of sealing elements of U-shaped cross-section also embracing those edges.

The pressing of the corrugated edges of the sheet on the sealing elements is conveniently brought about by subjecting the sealing elements to the pressure of one or more springs. In this way, the sheet can expand freely in the direction of its folds without any dangerous stresses taking place.

In order to reduce the risk of the spring force slackening under the action of heat, the spring or springs is/are situated advantageously near the colder corrugated edge of the sheet.

For maintaining the width dimensions of the furrows in a satisfactory manner and to improve the shape-retaining ability of the assembly, the sheet can be provided with indentations and corresponding space-maintaining projections.

It is also possible to achieve this object by maintaining the furrow walls spaced from one another by portions which are widened transversely of the folds and are produced by pressing the folds inwards from the

outside. When this is carried out, the metal sheet material of each fold yielding transversely to the fold, comes into contact with the neighbouring portions of the nearest folds and thus ensures that the necessary spacing is maintained.

This spacing arrangement can advantageously be ensured with a minimum of sheet deformation by arranging the widened portions in rows which extend at right angles to the folds.

These widened portions can be produced in a simple an inexpensive manner by means of a bar-shaped tool with which the folds are pressed-in locally, the remainder of the sheet being held in position by means of spacer plates which are held together by clamping means and leave the folds free.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be clearly understood and readily carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

FIG. 1 shows a perspective diagrammatic view of a corrugated sheet and a housing of a heat exchanger.

FIG. 2 shows a diagrammatic section taken on the plane II—II of FIG. 1,

FIG. 3 shows a diagrammatic section on the plane III—III of FIG. 1,

FIG. 4 shows the heat exchanger partly broken away and in perspective diagrammatic view,

FIG. 5 shows a horizontal section through a vertical edge region of the housing,

FIG. 6 shows a fragmentary perspective view of a modified version of the corrugated sheet, with pressed-in widened portions, and

FIG. 7 shows a method of producing the widened portions.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1 to 5, the heat exchanger has a heat-transfer wall in the form of a corrugated metal sheet 1 whereof the folds 2 and 3 are through 180° in each case. Alternating with the folds are flat furrows 4 and 5. The furrows 4 have an inlet aperture 6 and an outlet aperture 7 for combustion-supporting air which is to be pre-heated. The furrows 5 have an inlet aperture 8 and an outlet aperture 9 for exhaust gas the heat from which preheats the combustion air. The sheet 1 is inserted in a housing 10 comprising four lateral walls, namely two wide walls 11 and two narrow walls 12, which are arranged in the form of a rectangle. The walls 11 are formed with the apertures 6, 7, 8 and 9. Plate-like end closure members 15 and 16 are located near respective corrugated edges 13 and 14 of the sheet 1. Between the edges 13 and 14 and their nearby members 15 and 16 there are situated plate-form sealing elements 18 and 19 which consist of a felt-like refractory material, for example aluminium oxide, and which press firmly on the respective edges 13 and 14. Those surfaces of the sealing elements 18 and 19 which are in contact with the edges 13 and 14 can be reinforced by coating with a hardening refractory composition, for example a special cement. The sealing elements 18 and 19 can be provided with an internal insert, such as the insert 17 for the element 19, consisting of a refractory wire gauze, to give them increased strength. Between the sealing element 18 and the member 15 there is situ-

ated a corrugated leaf spring 20 which through an intermediate plate 21 makes the sealing elements 18 and 19 press firmly on the edges 13 and 14 of the sheet 1.

The spring 20 is situated near the colder corrugated edge of the sheet 1 that is to say at that end of the housing 10 at which the air inlet aperture 6 and the exhaust gas outlet aperture 9 are situated. The member 16 is securely connected to the walls 11 and 12 of the housing 10 whereas the member 15 is detachably connected thereto. The connection of the member 15 to the housing 10 can be made, as FIG. 4 shows, by a bayonet-type joint wherein pins 22 secured to the member 15 engage in angled grooves 23 in the walls 11 and lock the member 15 in the closed position. This kind of closure permits easy removal of the member 15, which for this purpose must be capable of longitudinal displacement. The folded plate 1 can be cleaned when removed from or even while remaining in the housing 10. Adjoining the apertures 6, 7, 8 and 9 are inlet and outlet ducts 24 which have been left out of the drawings in order to make them easier to read. They can be welded for example to the walls 11 of the housing 10 or secured there in some other way. The non-corrugated edges of the sheet 1, as FIG. 5 shows for one edge 24, are embraced by the walls 12 together with in each case a lip plate 25 with the interposition of a sealing element 26 of U-shaped cross-section embracing the edge 24. The sealing element 26 can consist for example of a paintable refractory substance such as, for example, a special cement which subsequently hardens. In this case it has to be renewed each time the sheet 1 is taken out of the housing. The parts 11, 12 and 25 are welded or soldered together at the region 27, but may instead be connected together in another way, for example by beading-over. The paths followed by the heat-exchange media are shown in the drawings, more particularly FIG. 2, by the arrows A for the combustion air and the arrows B for the exhaust gas. It will be noted that the two media streams are substantially in counter-flow with respect to each other.

The drawings are not representative of the actual dimensions of the sheet 1 if the apparatus is an air pre-heater. In such a case, the furrows 4 and 5 are much narrower than shown here. 1–1.5 mm and 0.4 mm respectively are preferred dimensions for the furrow width h (FIG. 3) and the sheet thickness d . To maintain the width dimensions of the furrows 4 and 5 and to improve the dimensional stability of the corrugated sheet 1, the sheet 1 can be formed with indentations to provide corresponding space-maintaining projections 28. The dimension of the sheet 1 in the direction of the folds 2 and 3 can also be much greater than is shown here.

Referring to FIGS. 6 and 7, to maintain the width dimensions of the furrows 4 and 5, the folds 2 and 3 are pressed inwards, forming portions 29 and 30 which are widened transversely to the folds and which contact one another at the regions 31 and 32 and thus define the spacing of the corrugations of the sheet 1. The number and positions of the portions 29 and 30 depend on the length of the furrows 4 and 5 and the size of the apertures 6 to 9. Conveniently rows of widened portions 29 or 30 are provided along all horizontal edges of the housing 10. To produce the portions 29 or 30, a spacer plate 33 the thickness of which equals the desired width of the furrow is inserted into each furrow 4 or 5, as FIG. 7 shows. The spacer plates 33 leave the

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folds free so that they can be pressed to a widened shape locally with the help of a bar-shaped tool 34. In this operation, the sheet 1 is held in position by the spacer plates 33 since the spacer plates are clamped together by clamping screws 35 and nuts 36 through U-members 37. As FIG. 7 shows, the bar-shaped tool 34 can have a rectangular profile. However, it can instead have a wedge-shaped or semi-circular profile. It is hardened and ground. The height h thereof is slightly greater than the necessary press-in depth, owing to the resilience of the sheet 1. This depth depends on the furrow width, the uniformity of the folds and the thickness of the sheet 1, and is determined by tests. The pressing-in operation is carried out on a hydraulic press the ram

6

of which can be moved in a finely controlled manner.

We claim:

1. In a method of producing a heat exchanger comprising a corrugated metal sheet which forms a heat transfer wall, the steps of inserting spacers into furrows alternating with folds of said sheet but so as to leave said folds exposed, clamping together said spacers with the interposition of said sheet, and pressing portions of said folds inwards simultaneously with a bar-like tool to form at said folds projecting portions of said sheet which serve to maintain the width of said furrows.

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