Jan. 28, 1964 G. WEISS 3,119,446

HEAT EXCHANGERS

Filed Sept. 17, 1959 3 Sheets-Sheet 1

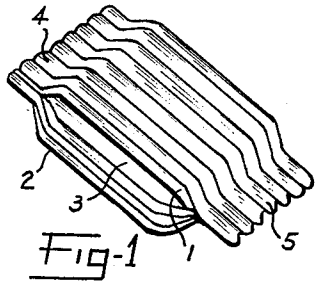


Fig-1

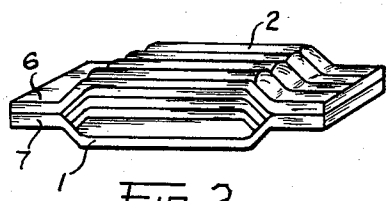


Fig-2

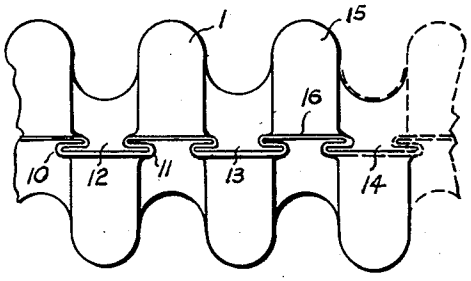


Fig-4

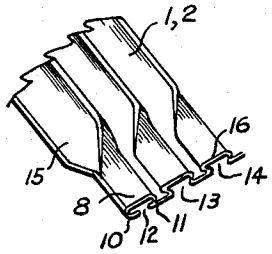


Fig-3

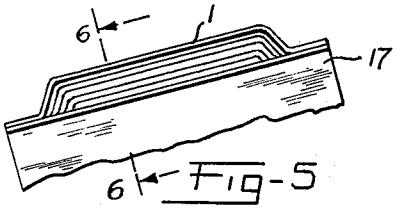


Fig-5

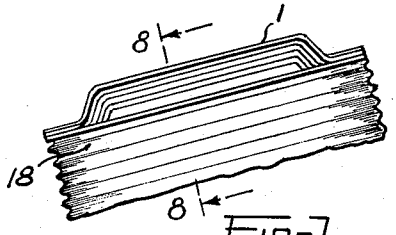


Fig-7

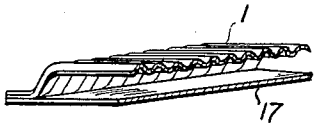


Fig-6

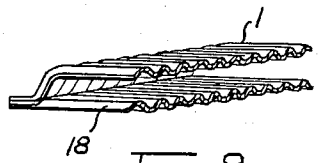


Fig-8

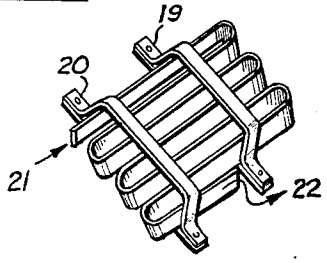


Fig-9

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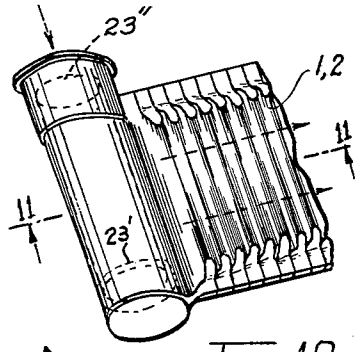


Fig-10

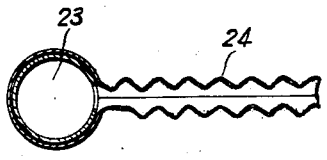


Fig-11

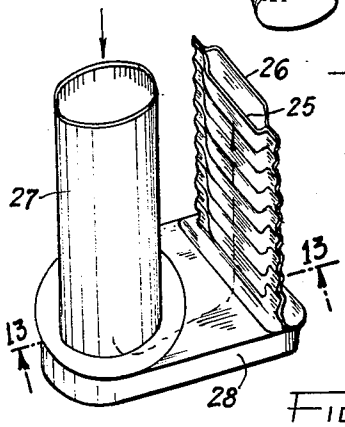


Fig-12

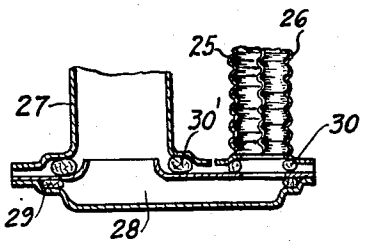


Fig-13

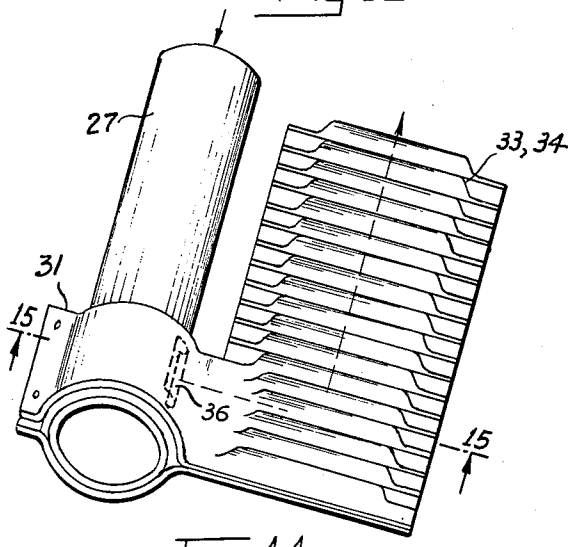


Fig-14

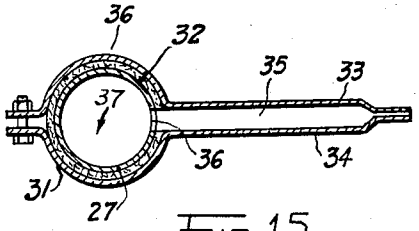


Fig-15

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HEAT EXCHANGERS

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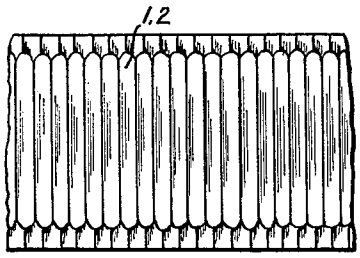


Fig-16

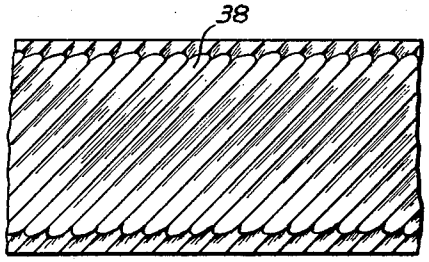


Fig-17

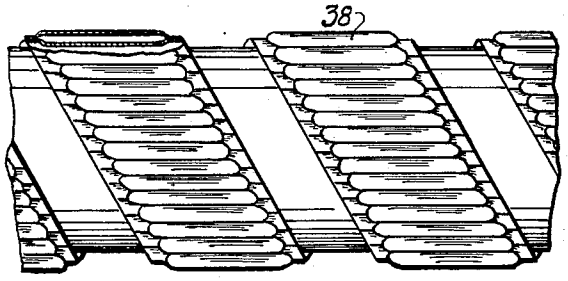


Fig-18

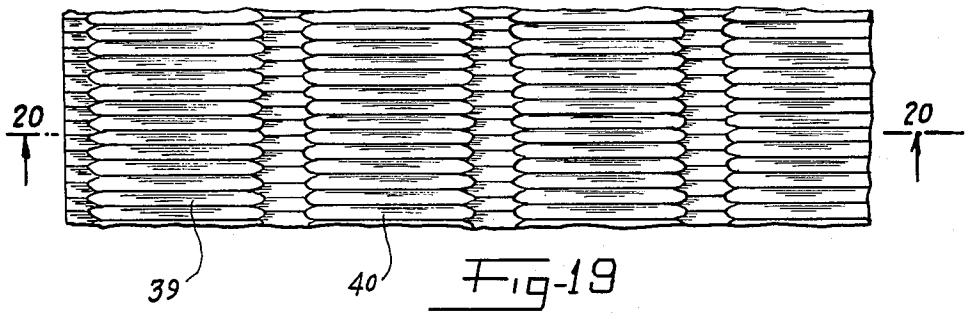


Fig-19

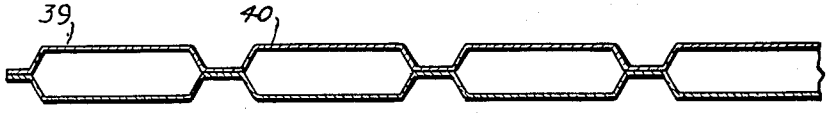


Fig-20

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United States Patent Office 3,119,446
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3,119,446
HEAT EXCHANGERS

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Filed Sept. 17, 1959, Ser. No. 840,766
1 Claim. (Cl. 165—170)

This invention relates to heat exchangers and more specifically to a heat exchanger adapted to be connected to cylindrical combustion chambers containing tubular heaters, for example heaters of the type disclosed in copending patent applications Serial No. 613,021, now Patent No. 2,996,062 granted August 15, 1961, and Serial Nos. 726,720 and 726,758, now abandoned.

One of the objects of the invention is a heat exchanger consisting of a flattened out tubing at least one side wall of which is undulated or corrugated preferably in a direction substantially transverse of the longitudinal extension of the tubing.

Another object of the invention is a flat tubular heat exchanger consisting of at least two sheeted strips spaced from each other and bulged out at the center to form at least one longitudinal channel and attached to each other at the edges with at least one of these strips being formed of undulating or corrugated material.

A further object of the invention is a heat exchanger system including a cylindrical combustion chamber connected to a flat and at least partially corrugated tubing, and having an axis substantially parallel to and preferably in the same plane with the longitudinal extension of the tubing.

Still another object of the invention is a heat exchanger tube connected to a combustion tube substantially along a generatrix thereof.

A more specific object of the invention is to connect the parallel edges of the metal strips forming a flat heat exchanger tubing by overlapping and bending around opposite but phase displaced corrugations to cause a zigzag type overlap or interlock, assuring gas tightness supplemented if necessary by seam welding or brazing.

These and other objects of the invention will be more fully apparent from the drawings annexed herewith in which FIG. 1 represents in a perspective view a flat tubing provided with undulating walls and embodying certain features of the invention.

FIG. 2 also in perspective shows a similar type of heat exchanger with a modified edge attachment.

FIG. 3 shows in perspective another modification of such an edge attachment, and FIG. 4 an enlarged side view of the edge attachment shown in FIG. 3.

FIGS. 5 and 6 show tubular heat exchangers in different perspective views and FIGS. 7 and 8 corresponding modifications of the structures shown in FIGS. 5 and 6.

FIG. 9 shows a flat tubular heat exchanger such as illustrated in FIGS. 1 through 8 in one form of an assembly.

FIGS. 10 and 11, in perspective and side views, respectively, the latter view in cross section, represent an assembly of a combustion chamber of a heater and a flat heat exchanger in accordance with the invention.

FIGS. 12 and 13 show corresponding views of a modification of an assembly such as shown in FIGS. 10 and 11, and FIGS. 14 and 15 represent corresponding views of another modification, FIG. 15 representing a cross section through FIG. 14 along lines 15—15 of FIG. 14.

FIG. 16 shows the tranversal corrugations on an enlarged scale, and FIG. 17 shows the corresponding part of a heat exchanger with oblique corrugations. FIG. 18 shows a spiral assembly of a heat exchanger such as illustrated in FIG. 17.

FIGS. 19 and 20 represent in top view and cross section, respectively, a parallel arrangement of corrugated sheets forming several parallel spaces joined at adjacent edge portions.

In FIG. 1, two undulating or corrugated sheets 1, 2 of flat heat conducting material such as copper, are arranged facing each other forming at a bulging out central portion, a flat channel space permitting passage of the heat conducting medium such as the exhaust gases of a heater element (not shown in FIG. 1), and having edge portions bent down and arranged superimposed upon each other in intermeshed relationship as indicated at 4, 5 respectively.

The double dished or convex structures at the flanges of each strip are raised, lowered or quite generally displaced with respect to the plane of the main corrugated flat portion and meeting or nesting with each other.

The superimposed edge of sheetings 1, 2 are brazed or welded together to provide a gas tight closure, and at the same time a stiffening ridge for the flat tubing is thus formed.

In the modification of FIG. 2, which may also form a step of manufacture subsequent to the manufacture of a structure such as shown in FIG. 1, the adjacent edge portions 6, 7 of sheetings 1, 2, are completely flattened out, pressed together and then brazed or seam welded together to provide a gas tight closure while increasing strength without reducing transverse flexibility.

FIG. 3 illustrates an edge attachment wherein phase displaced and superimposed edge undulations of corrugated sheets 1, 2 facing each other, are bent over at 10, 11.

The mating or nesting corrugations are collapsed over (or into) each other resulting in flat interlocked channels 12, 13, 14, etc., increasing in a labyrinth like fashion, the lateral path from the inner space 15 of the heat exchanger to its outside, so as to reduce the risk of escape of gas from the interior space of the heat exchanger, laterally between the abutting edge zones of the plates. Thus either gas tight cold welds are formed, or alternatively, if necessary, gas tightness may be enhanced by adding seam welds or brazings applied at line 16 or any other lines to each of outer channels 12, 13, 14, etc.

FIG. 4 also shows the two metal strips 1, 2 being joined by a transverse seam weld and partial overlap (see the solid and the dotted lines). This may be done prior to the corrugating operation. Its purpose lies for example, in the use of stainless steel in contact with high temperature exhausts, and depending on temperature, copper or aluminum may be used for better heat transfer.

In the modification of FIGS. 5 and 6, only one of the tube walls, i.e. 1, is shown corrugated and formed into a channel while the other wall 17 is formed as an uncorrugated substantially straight, flat or curved surface to which edge portions of channel wall 1 are flattened and attached by brazing or welding, all this without departing from the scope of this disclosure.

In the modification of FIGS. 7 and 8, the flat wall is replaced by a corrugated, or undulating wall 18 of substantially the same corrugated configuration as wall 1 but extending substantially into one plane only or at least along a uniformly curved surface while the opposing corrugated wall 1 is more or less U or channel shaped in the manner indicated in FIGS. 5 and 6 at 1, with the different but opposed edge portions being attached to each other in a gas tight fashion such as shown in FIGS. 1 to 4, or in any other appropriate manner without departing from the scope of this disclosure.

In FIG. 9 a flat tubular heat exchange member such as shown in FIGS. 1 to 8, is arranged itself in an undulating assembly indicated by 1, 2 which is held together by two pairs of brackets 19, 20, with the inlet of the heat ex-

changer being indicated at 21 and its outlet at 22, or conversely.

FIGS. 10 and 11 show a corrugated flat tubing 1, 2 according to the invention wherein the intermeshed and interlocked edge portions are flattened and connected to or assembled with a cylindrical combustion chamber such as indicated at 23; the inner space 24 of flat tube 12 communicates with chamber 23 along a generatrix of chamber 23 closed by cap 23'. Chamber 23 may also contain a heater element such as shown in FIG. 10 at 23'' and attached to plug 23'.

In another assembly, illustrated in FIGS. 12 and 13, the flat heat exchanger tubing consists of two outer corrugated walls 25, 26 which may be attached to each other at their edges in a manner similar to that shown in FIGS. 1 through 4 or in any other appropriate manner without departing from the scope of this disclosure.

Such flat multi-channel tubing may effectively be used by itself or in combination with a cylindrical combustion chamber such as shown in FIGS. 12 and 13 at 27. In this case channel walls 25, 26, and combustion chamber 27 may be arranged parallelly spaced and interconnected at one of their ends, respectively, by a shallow elbow connection or return bend 28 provided with the necessary gaskets 29, 30 and 30' assuring gas tight attachment of chamber 27 and channel walls 25, 26.

In FIGS. 14 and 15, a flat tube structure such as shown in the preceding figures at 1, 2 or at 25, 26 is shown to be connected to a combustion tube 27 by means of a bracket 31 attached through a gasket 32 to tube 27 and extending into wall portions 33, 34 of flat tube 1, 2. In this way the work space 35 of tube structure 1, 2 is made to communicate through opening 36 with the work space 37 of tube 27 in the form of a unitary structure.

In order to prevent corrosion, the inside surface of steel strips 1, 2 or 25, 26, or at least one of them is coated with a plastic of the epoxy, phenolic, vinyl or other corrosion resisting type which will burn off in the portions which are higher than 500° F. Since condensation will not occur above 212° F., the portion of the metal exposed to moisture will thus be protected for the following reasons:

These organic coatings will burn off at the upstream portions of a heat exchanger according to the invention when exposed to 500° F. and over, but this is not serious since the heat exhaust gases are not wet. However, those portions of the metal which are exposed to temperatures below 212° F. where condensation begins to occur will be protected. Further, since these coatings are removed in the region above 500° F., they do not interfere with heat transfer (especially when they are not required to perform any function) so as to obviate the need for "cooling" in application to cover the low temperature positions of the metal exclusively.

FIG. 16 shows transversal corrugations on an enlarged scale.

In FIG. 17 corrugations are arranged obliquely with respect to the longitudinal extension of the heat exchanged spaces or channels permitting the channels to be bent into a longitudinal spiral 38 shown in FIG. 18.

In FIGS. 19 and 20, multiple sections consisting of 2 or more flat channels 39, 40 are illustrated. This arrangement is applicable to the various channel structures shown in FIGS. 1 to 17. The center flanges 40 may be interlocked or welded or simply left in contact, loosely. In any case, there is additional strength in this rather wise and large surfaced structure.

While the invention has been illustrated and described specific types and shapes of heat elements and heat exchanger elements, and on specific arrangements and combinations of such heaters, and heat exchangers, the invention is by no means limited to the structures shown and described but may be applied in any appropriate manner whatsoever without departing from the scope of this disclosure.

I claim:

A heat exchanger comprising a pair of opposing heat conducting sheets extending longitudinally and laterally, each of said sheets having coplanar lateral edge zones coextensive in length therewith, the respective edge zones of said sheets being in opposing contact, at least one of said sheets being bent outwardly in the zone intermediate said edge zones thereof so that the zones of said sheets intermediate said contacting edge zones are transversely displaced in substantially parallel relationship, each of said sheets having regularly spaced undulatory corrugations extending laterally and coextensive in width therewith, the distance between said transversely displaced intermediate zones of said sheets being large relative to the amplitude of said undulations, the corrugations of the said opposing edge zones being in registration and intermeshed and said intermeshed corrugations being flattened and having their sides interlocked in said edge zones.

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