

Jan. 15, 1952

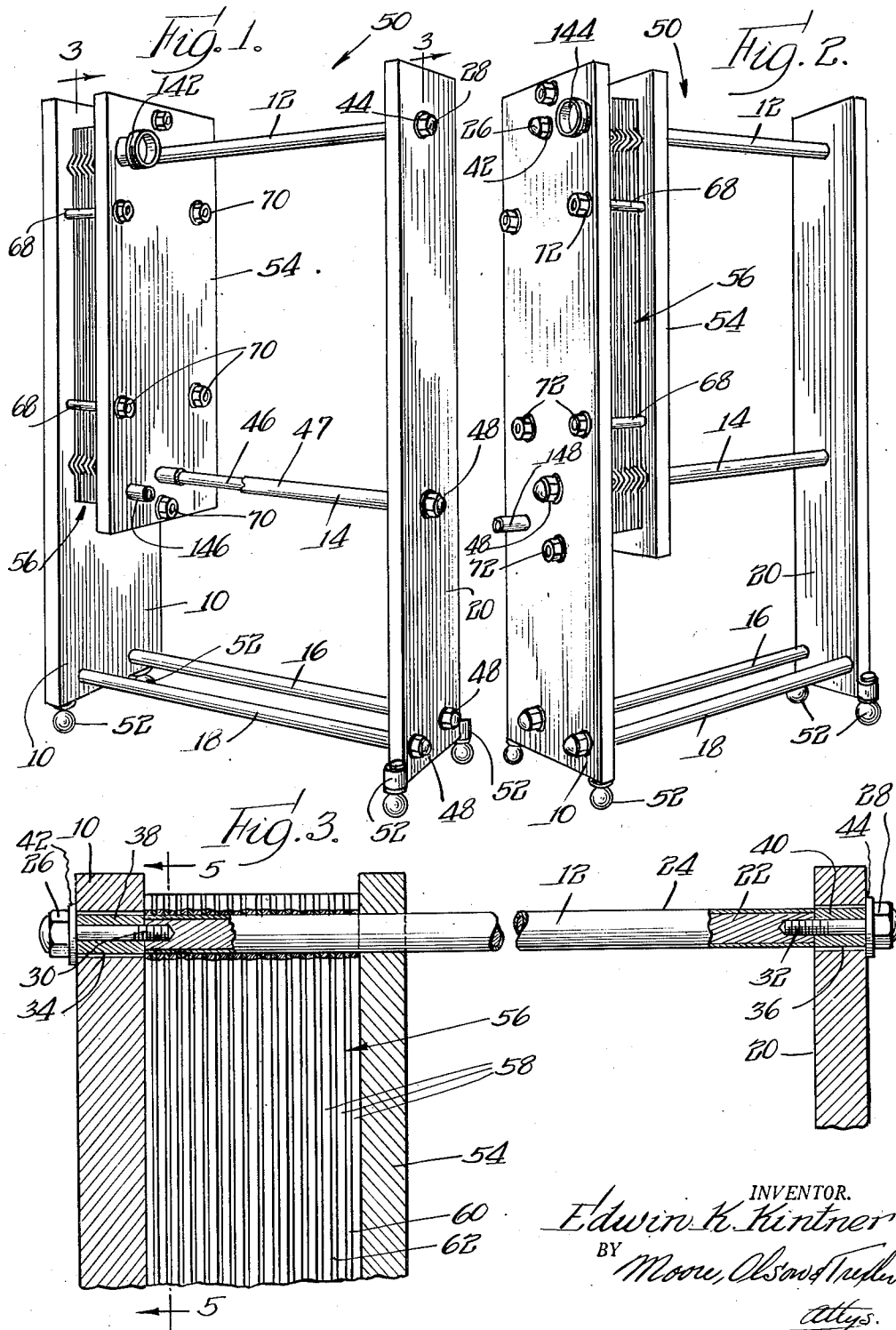
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2,582,871

HEAT EXCHANGER

Filed Aug. 31, 1948

4 Sheets-Sheet 1



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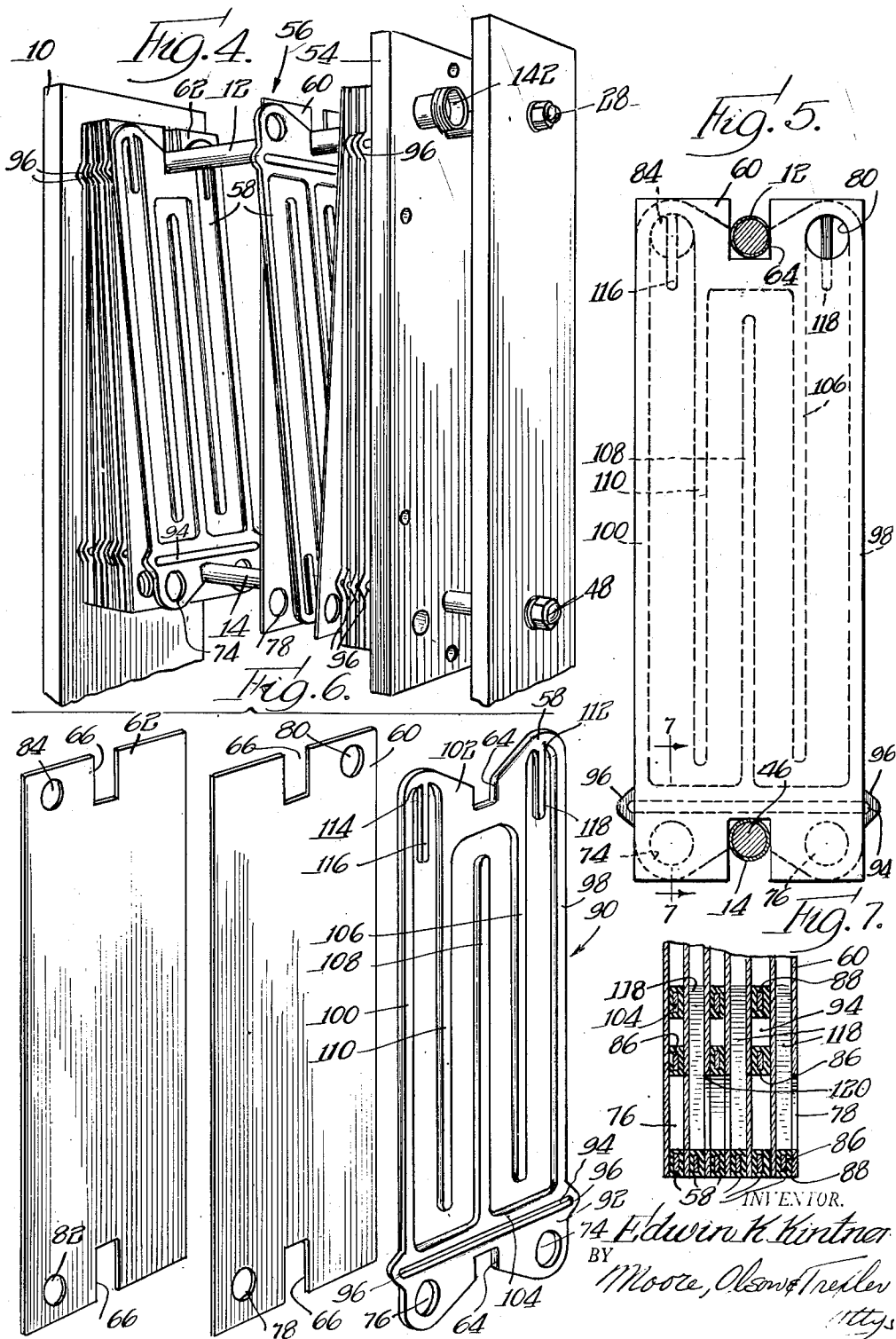
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HEAT EXCHANGER

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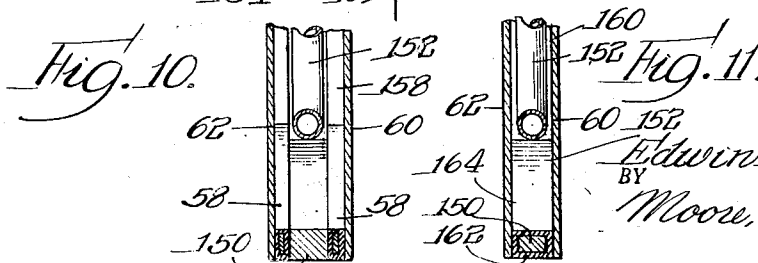
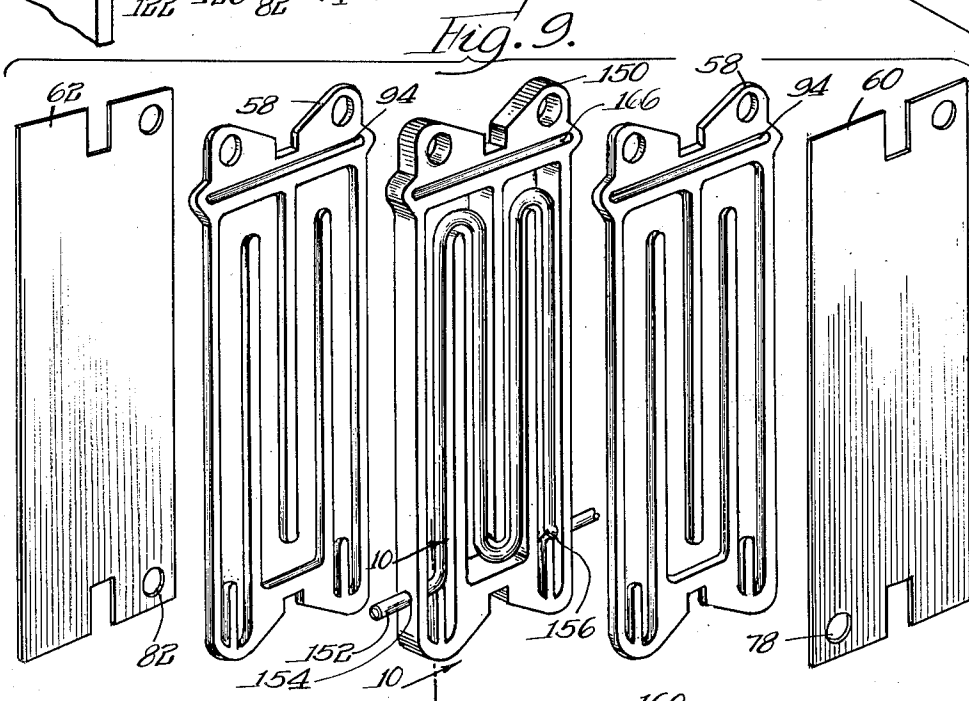
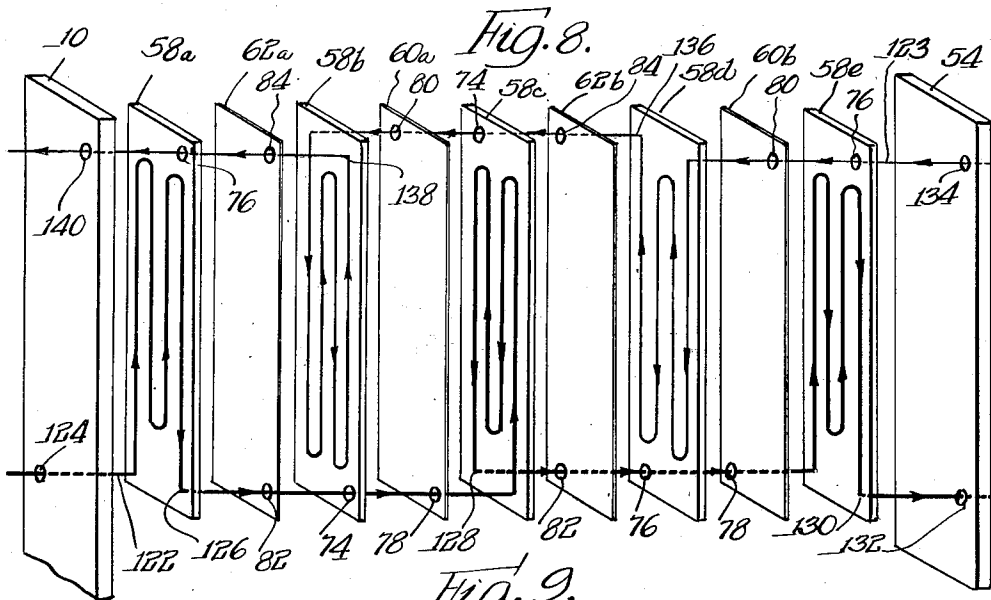
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HEAT EXCHANGER

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4 Sheets-Sheet 3



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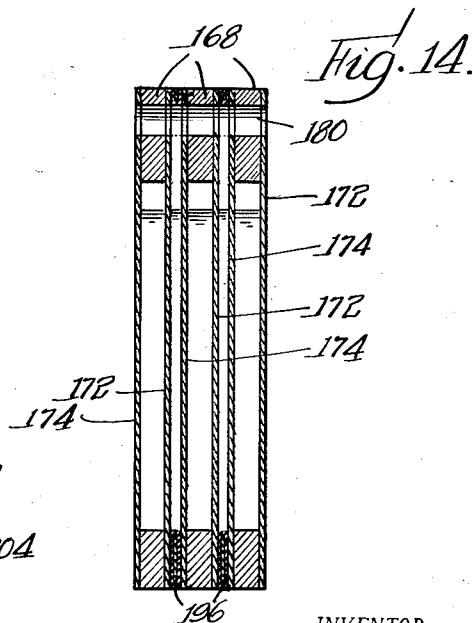
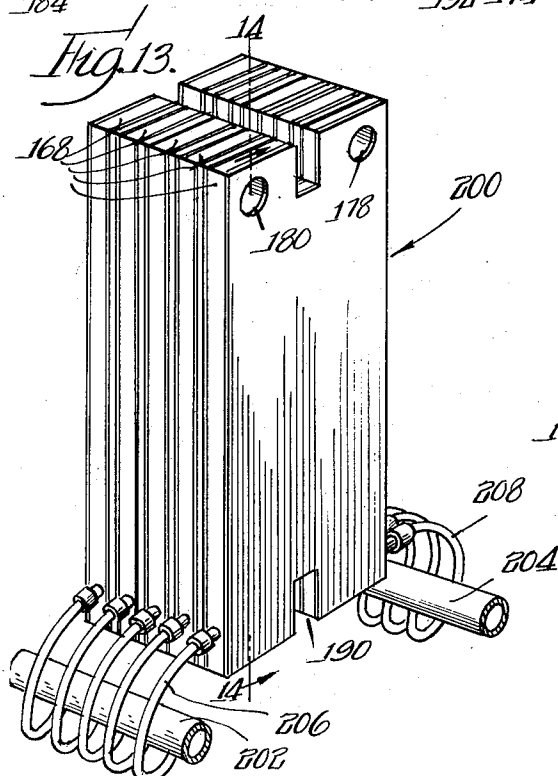
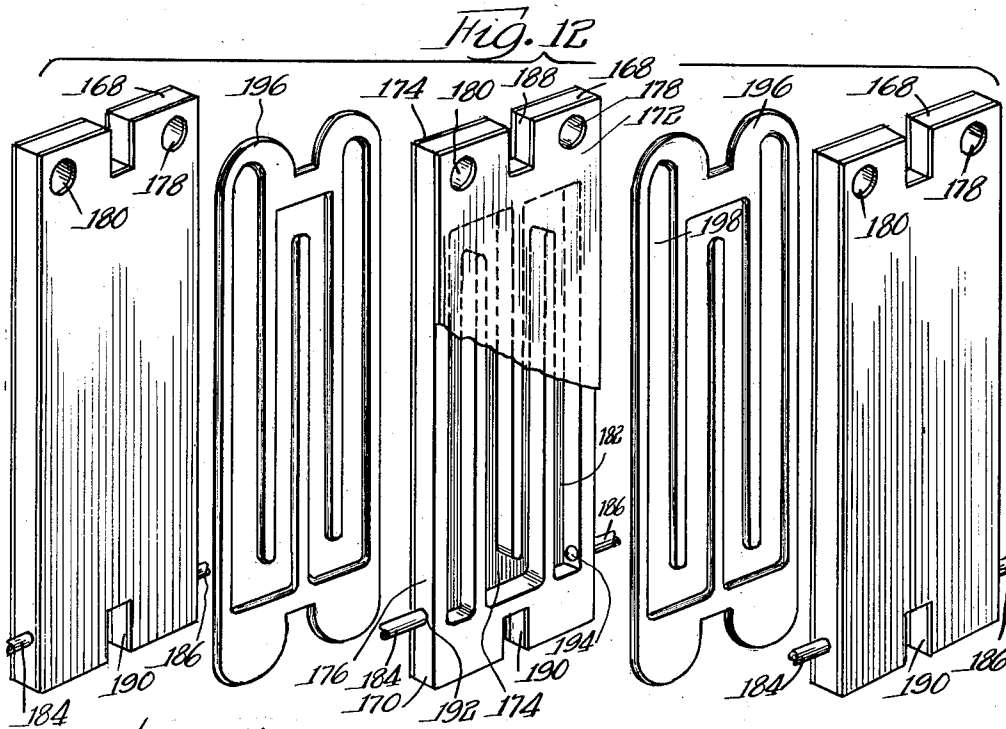
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HEAT EXCHANGER

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

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Application July 31, 1948, Serial No. 41,781

6 Claims. (Cl. 257—245)

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This invention relates to heat exchangers. More particularly, it relates to improvements in heat exchangers of the plate and gasket type.

It is an object of this invention to provide a one-piece gasket for plate and gasket type heat exchangers in which gasket full protection is provided against leakage between channels or passageways sealed thereby.

A further object is to provide a heat exchanger adapted to handle food products and comprising a one-piece gasket construction sealing a plurality of channels or passageways and including means in the gasket for preventing leakage between such channels or passageways.

Still another object is to provide a one-piece gasket for heat exchangers of the plate and gasket type which gasket seals a plurality of channels or passageways and is provided with means for directing to the exterior of the heat exchanger any material which may leak from such channels or passageways.

Still another object is to provide a one-piece gasket for heat exchangers of the plate and gasket type which gasket is adapted to seal a plurality of channels or passageways and comprises means for directing leakage from such channels or passageways to the atmosphere and means for supporting adjacent plates in the vicinity of openings formed through such plates.

Still another object is to provide heat exchangers comprising gaskets of the type described in the preceding objects.

Still another object is to provide heat exchanger construction of the plate and gasket type including readily demountable means for hanging plates therein.

Still another object is to provide a cold plate for a heat exchanger of the plate and gasket type comprising an expansion chamber for refrigerant gas.

Still another object is to provide a novel gasket construction adapted to be used with such cold plate.

A still further object is to provide a heat exchanger comprising such a cold plate.

A still further object is to provide a heat exchanger comprising such a cold plate and a novel gasket construction adapted to be used with such cold plate.

Other objects will appear hereinafter.

It has now been found that the foregoing objects may be accomplished by the structures illustrated in the accompanying drawings which form a part of this specification and which are included in order that the invention may be better understood and in which Fig. 1 is a view in per-

spective of a heat exchanger embodying features of the present invention.

Fig. 2 is a second view in perspective of the device shown in Fig. 1, but viewing it from the end opposite to that in which it is viewed in Fig. 1.

Fig. 3 is an enlarged fragmentary vertical cross sectional view through the device shown in Fig. 1 on the line 3—3.

Fig. 4 is a further view in perspective, similar to the view shown in Fig. 1 but illustrating the device in open position to facilitate cleaning.

Fig. 5 is a vertical cross sectional view on the line 5—5 in Fig. 3.

Fig. 6 is an exploded view in perspective, illustrating the gasket and typical plate constructions.

Fig. 7 is a fragmentary vertical cross sectional view on the line 7—7 of Fig. 5.

Fig. 8 is a diagrammatic view illustrating the flow of fluids through the device shown in Fig. 1.

Fig. 9 is an exploded view in perspective, illustrating the plate and gasket members employed in another embodiment of the invention.

Fig. 10 is a fragmentary vertical cross sectional view through a heat exchanger embodying elements shown in Fig. 9 and taken on the line 10—10 of Fig. 9.

Fig. 11 is a view similar to Fig. 10, illustrating still another embodiment of the invention.

Fig. 12 is a view similar to Fig. 9 illustrating still another embodiment of the invention.

Fig. 13 is a view in perspective showing the parts illustrated in Fig. 12 in assembled relation; and

Fig. 14 is a fragmentary vertical cross sectional view on the line 14—14 in Fig. 13.

Heat exchangers embodying the features of the present invention may be supported on any desired type of frame structure. The structure illustrated in Figs. 1 and 2 has been found to possess certain advantages in use, but the invention is not intended to be limited thereto. This preferred structure includes vertically extending stationary head 10, rigidly connected by a series of spacer bars 12, 14, 16 and 18 to a front piece 20. The head 10 and the front piece 20 are preferably formed of relatively heavy rigid plate material, such as metal plate for example steel, the stationary head 10 preferably being from one and one-half to two or more inches thick. As will appear hereinafter, the front piece 20 may be of lighter construction, being formed for example from three-fourths inch steel plate, although the invention is not intended to be limited to a front piece of this thickness.

The spacer bars 12 and 14, in addition to co-

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operating with the stationary head 10 and front piece 20 to provide a rigid frame, serve as supports for the plate and gasket construction to be described. It is desirable in some cases to suspend plates or gaskets or both from the top spacer bar 12 and at the same time to be able to remove the suspended members from the structure for cleaning. To this end the spacer bar 12 is formed as illustrated in Fig. 3. As may be seen in this figure, the spacer bar 12 comprises a rod 22 extending between the head 10 and the front piece 20 and terminating at its opposite ends in the plane of the inner vertical face of the stationary head 10 and the front piece 20, respectively. The rod 22 is preferably encased by a sleeve 24 which takes up some of the wear and which may for example be formed of stainless steel for sanitary purposes. The rod 22 is secured to the head 10 and front piece 20 respectively by suitable bolts, such for example as hex-head bolts 26 and 28 respectively which are threaded into the opposite ends of the rod 22 as at 30 and 32. The bolts 26 and 28 as may be seen extend through openings 34 and 36 formed respectively in the stationary head 10 and the front piece 20. Each of these openings 34 and 36 is preferably made large enough so that the rod 22 with the sleeve 24 thereon may slide through the openings 34 and 36 readily. Within the openings 34 and 36 collars 38 and 40 respectively having outside diameters approximating those of the openings 34 and 36 and inside diameters just large enough to receive the bolts 26 and 28 serve to center the bolts 26 and 28 within the large openings 34 and 36. It will be seen that the collars 38 and 40 are of the same length respectively as the members 10 and 20 through which they extend. Finally, the construction includes washers 42 and 44 of larger diameter than the openings 34 and 36 so that when the bolts 26 and 28 are threaded into the rod 22 to tightly clamp the collars 38 and 40 respectively against the opposite ends of the rod 22 the washers 42 and 44 engaging the outer faces respectively of the head 10 and the front piece 20 position the inner faces of the head 10 and front piece 20 in substantially the same plane with the ends of the rod 22, thereby providing the desired rigid construction and spacing of the head 10 and front piece 20. At the same time this construction permits of ready removal of the rod 22 with its sleeve 24 simply by removing one of the bolts 26 or 28 whereupon the rod 22 and its sleeve 24 may be withdrawn through the opposite opening 34 or 36 as the case may be, permitting any hanging plates or gaskets suspended on the bar 12 to be taken out of the machine.

The spacer bar 14 is in some respects similar in construction to the bar 12 in that it includes a central rod-like portion 46 carrying a sleeve 47. Since there is ordinarily no occasion for removing the bar 14, however, it may be secured to the stationary head 10 and the front piece 20 in any desired manner, as for example by turning down the ends of the rod-like portion 46 and extending them through openings in the head 10 and the front piece 20 where they can be secured and threading nuts such as nut 48 onto the projecting ends of the bar 14. These nuts will clamp the head 10 or front piece 20 against the shoulders on the rod 46 formed by turning down the ends as described.

The bars 16 and 18 may be constructed as desired. In the embodiment illustrated they con-

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sist of rods the ends of which are turned down and threaded as described with respect to the rod 46. Nuts 48 secured on the threaded portions clamp the head 10 or front piece 20 as the case may be against the shoulder formed by turning the ends of the rods 16 or 18 down. It is preferred that the heat exchanger which is designated generally 50 be provided with suitable feet, such as feet 52, to facilitate movement. As may be seen, the front piece 20 and head 10 are each provided with two feet 52.

Supported on the spacer bars 12 and 14 between the stationary head 10 and the front piece 20 is a follow head 54 which cooperates with the stationary head 10 in clamping together the plates and gaskets as will be described. The follow head 54, like the stationary head 10, is preferably formed of a rigid material, for example steel plate and preferably has a thickness of the same general order as the stationary head 10 as set forth above. As illustrated in Figs. 1 and 2, the stationary head 10 and the front piece 20 are both longer than the follow head 54 in order to support the plate and gasket assembly 56 in an elevated position where it is conveniently accessible. It will be understood, however, that the invention is not to be limited to this particular type of arrangement. As is apparent from the drawings, the assembly of plates and gaskets previously referred to is supported on the spacer bars 12 and 14 between the stationary head 10 and the follow head 54. In the embodiment of the invention illustrated in Figs. 1 through 8, the plate and gasket assembly 56 consists of a series of gaskets 58 shaped and constructed as indicated in Fig. 6 and arranged with a series of plates, including plates of two types represented by the plate 60 and the plate 62, illustrated in Fig. 6. As best seen in Figs. 4 and 7, between each adjacent pair of gaskets 58 there is either a plate 60 or a plate 62 so that the arrangement consists of plate, gasket, plate, gasket, plate, gasket, etc. To prevent the gaskets 58 and the plates 60 and 62 from falling off the spacer bars 12 and 14 as soon as the clamping pressure is released, the gasket 58 is provided with slots 64 centrally on each end of suitable size to receive the spacer bars 12 and 14 in the manner shown in Figs. 4 and 5. Similarly, the plates 60 and 62 are formed with slots 66 on their opposite ends in which the spacer bars 12 and 14 are received. This method of supporting the gaskets 58 and the plates 60 and 62 on the spacer bars 12 and 14 permits the gaskets and plates to be readily removed in the manner indicated in Fig. 4, that is, by tilting the plate or gasket as the case may be until it can be lifted out.

In order that the gaskets 58 may provide an effective seal between adjacent plates 60 and 62, it is necessary that the assembly of plates and gaskets be tightly clamped together. To this end means is provided for clamping the follow head and the stationary head together with the assembly of plates and gaskets 56 therebetween as shown in Figs. 1 and 2. Any desired clamping means may be employed, but in accordance with the preferred construction illustrated in the drawings, the clamping means comprises a series of rods 68 having heads 70 on one end thereof. It has been found that very satisfactory clamping can be obtained by employing six of the rods 68 positioned as indicated in Fig. 1 and extending through aligned openings in the stationary head 10 and the follow head 54. Although the rods 68 could be inserted first through either the fol-

low head 54 or the stationary head 10, it has been found preferable to insert these rods first through the follow head 54 so that the heads 70 on the rods 68 engage against the outer surface of the follow head 54. This arrangement has been found to give less trouble with the stripping of the threads on the rods 68 or the cooperating nuts 72 which are preferably permanently secured to the outer face of the stationary head 10. An ample thread portion is provided on the rod 68 so that these rods 68 may be easily engaged in the nuts 72 and then drawn up until the desired clamping pressure is applied.

The construction of the gaskets 58 forms an important part of this invention. In a plate and gasket heat exchanger of the type shown, the fluids between which heat is to be exchanged are arranged to flow on the opposite sides of each of the plates 60 and 62 so that the heat exchange occurs in each instance through a plate 60 or a plate 62. The gaskets 58 in addition to sealing between the plates 60 and 62 to prevent the fluids between which heat is being exchanged from escaping from the machine, also direct the flow of fluid over the plane surfaces of the plates 60 or 62, as the case may be. Fluids between which heat is to be exchanged are admitted through a head such as the head 10 or the head 54 and must be conducted past certain gaskets and plates in order to reach plates and gaskets spaced from the head where the particular fluid is admitted. Thus, fluids are directed past the gasket 58 through the openings 74 and 76 provided in one end thereof. A similar purpose of directing fluids past plates 60 and 62 is served by openings 78 and 80 in plate 60 and 82 and 84 in plate 62. In this connection it may be pointed out that plates 60 and 62 are identical in form, except for the location of the openings 78, 80, 82 and 84 therein. Furthermore, these plates 60 and 62 are merely typical of the type of plates which may be used in an assembly of plates and gaskets such as the assembly 56. Although the openings 78, 80, 82 and 84 in the plates 60 and 62 are so located as to align properly with the gasket 58, it is within the scope of the invention to employ plates having openings in any one, two, three or all of the four corners of the plate, depending upon the manner in which it is desired to direct fluids between which heat is to be exchanged through the heat exchanger designated generally 50.

Except for the number and location of the openings, such as 78, 80 etc., all of the plates 60 and 62 are preferably identical in construction and are formed of a thin rigid material, preferably thin sheet metal and where food products are to be handled they are preferably stainless steel. The opposite broad faces of these plates are plain and substantially parallel and are preferably polished smooth. The thickness of the plates can be varied as desired and preferably is varied somewhat, depending upon the pressure to be employed. For pressures under about 50 pounds per square inch, 18-gauge stainless steel has been found to be entirely satisfactory. The size of the plates can likewise vary as desired, so long as the gaskets are proportioned to the size of the plates. It has been found, however, in practice that plates about 12 inches wide by about 36 inches long give very satisfactory results.

Coming back now again to the gasket 58 which as stated forms an important part of

the structure, it is pointed out that this gasket preferably consists of a rigid template such as the sheet steel 86 each element of which is encased in a suitable covering of resilient material 88. It has been found preferable to form the resilient covering of neoprene synthetic rubber composition, and this is particularly true when food is being handled. The configuration of the template 86 is identical with that of the gasket 58.

Although it is an important characteristic of the gasket 58 that it is in one piece, it in reality comprises two parts, one of which designated as 90 directs the flow of fluid over the surface of a plate 60 or 62 and the other of which designated as 92 provides sealed ports through which fluid is directed past the gasket 58. Heretofore these two parts 90 and 92 have been formed as separate gaskets, because it is essential, particularly for food handling, that leakage between ports such as 74 and 76 and the channels in the portion 90 be absolutely prevented by providing means for directing leakage from the ports or channels to the atmosphere. This is done by means of what is called a leak detector slot which is interposed between ports 74 and 76 and the channels in the portion 90.

In gasket constructions heretofore known the inclusion of the leak detector groove has necessitated forming the gasket in two separate parts. The present invention provides means whereby a leak detector groove designated as 94 may be provided without necessitating the formation of gasket 58 in two separate portions. This means takes the form of ear portions 96 formed on the opposite sides of the gasket 58 thereby permitting the leak detector slot 94 to extend out beyond the edges of the plates 60 or 62 and communicate with the atmosphere, or, to put it another way, the ear portions 96 formed on the template 86 provide a connection between the portion 90 and the portion 92 of the gasket. The leak detector slot 94 extends across the gasket 58 as shown and also extends entirely through its thickness so that leakage on either face of the gasket 58 from the port 74 or the port 76 or the portion 90 of the gasket must necessarily enter the leak detector slot 94 and pass to the atmosphere at one end of the slot 94 and cannot reach either port from the portion 90 or reach the portion 90 from either port. Although it has been found convenient to provide the ears 96 on both sides of the gasket 58, it will be apparent many of the advantages of the structure can be obtained by providing an ear on only one side since this is sufficient to permit the slot 94 to be extended far enough to communicate with the atmosphere.

So long as the leak detector slot 94 is located between the channels of the gasket which direct fluid over the surface of a plate such as 60 or 62 and any ports directing fluid past the gasket 58, the configuration of the gasket may take any of a wide variety of forms within the scope of the present invention. The configuration of the gasket 58 illustrated is a preferred structure and permits the use of the same gasket for directing the flow of both the fluids between which heat is to be exchanged.

The portion 90 of the gasket 58 necessarily is provided with a continuous peripheral portion comprising side members 98 and 100 and end members 102 and 104. In addition to this continuous peripheral portion, the gasket is provided with three ribs or vanes 106, 108 and 110 by means of which a fluid entering either at the

point 112 through an opening such as the opening 80 in the plate 60 or the point 114 through a corresponding opening (not shown) is caused to flow across the surface of two plates 60 or 62 between which the particular gasket 58 is clamped in the path lying between the peripheral portion 100 and the rib 110 of the gasket. From this channel the fluid is directed around the end of the rib 110 and up between the ribs 110 and 108 around the end of the rib 108, down between the ribs 106 and 108, around the end of the rib 106 and up between the rib 106 and the peripheral portion 98 to the point 112 from which it passes through an opening in one of the plates between which it is clamped and is conducted to another gasket or out of the heat exchanger. It will be understood that the channel just described extending from the point 114 to the point 112 is provided by openings which extend through the full thickness of the gasket. Thus fluid entering the point 114 and flowing down between the peripheral portion 100 and the vane 110 is in contact with both of the metal plates between which the gasket 58 is clamped.

One gasket 58 is positioned with the ports 74 and 76 lowermost, and the next gasket is positioned with these ports uppermost, etc. In this way one of the two fluids between which heat is to be exchanged is conducted through the heat exchanger 50 from one plate over which it flows to the next plate over which it flows through a header or headers formed by aligned openings in plates and gaskets along the bottom of the exchanger 50, and the other fluid is conducted through a similar header or headers in the top of the exchanger 50.

In order to support plates such as 60 and 62 adjacent openings such as 78, 80, etc., on the side which is in communication with a point 112 or 114 of a gasket 58 for instance, fingers 116 and 118 are provided (the opposite side of the plate 60 or 62 being in engagement with an end 92 of the gasket 58). These fingers extend from the peripheral portion 102 of the gasket 58 longitudinally of and centrally of the channels extending respectively between peripheral portion 100 and vane 110 and peripheral portion 108 and vane 106. As may be seen in Fig. 7, the fingers 116 and 118 are long enough so that their ends are located inwardly of the peripheral portion 104 of adjacent gaskets 58 whereby these fingers together with other parts of the same gasket lying opposite to the said adjacent peripheral portions 104 insures good sealing contact between the opposite faces of the peripheral portion 104 and the plates between which it is clamped. Referring to Fig. 7 it will be seen that at a point such as the point 120 a plate would be provided with relatively poor support on its left-hand side were it not for the finger 118. Fingers 116 and 118 thus cooperate with the leak detector slot 94 in preventing leakage between a port 74 or 76 and the portion 90 of the gasket 58.

Gasket 58 may be formed of any desired thickness within the scope of the invention. It is preferable, however, that it be relatively thin since it is by this means that most effective heat exchange is obtained. Plate and gasket heat exchangers of the type shown depend largely for their effectiveness upon the fact that the heat exchange takes place between relatively shallow flowing streams of the fluids between which heat is to be exchanged. A preferred over-all thickness for gasket 58 is about one-eighth of an inch. Preferred width for the channels such as the channel

formed between the peripheral portion 100 and the rib or vane 110 is about two inches. Thus the fluid flowing over the surface of a plate 60 or 62 will flow in a stream about one-eighth inch thick and about two inches wide. These stream dimensions, however, are given only as illustrations and as a preferred embodiment and are not to be regarded as limitations since it is within the scope of the invention to use other stream dimensions if desired. By way of further illustration, the template for the one-eighth inch gasket is preferably formed of 22-gauge sheet steel and is coated with neoprene to give the gasket an over-all thickness of about 120 to about 130 thousandths of an inch, that is, approximately one-eighth of an inch. Still further illustrating, when employing stainless steel plates twelve inches wide, it is preferable that the small ears 96 on the gaskets 58 project about three-fourths of an inch beyond the edge of the stainless steel plate on either side as seen for example in Fig. 5 and that ends of the slot 94 project out beyond the steel plate about three-eighths of an inch. It is again pointed out, however, that these dimensions are merely illustrative and that they may be varied as desired so long as the slot 94 projects far enough to communicate with the atmosphere on at least one side of the machine.

Fig. 8 shows a flow diagram for one particular embodiment of this invention of which there are many. For purposes of illustrating flow in this figure, it has been necessary to show the parts exploded and to omit from the drawing the details of the structure of the gasket 58. It is to be understood, however, that each member designated 58 in Fig. 8 is actually identical with the gasket 58 shown in Fig. 6. Also in Fig. 8 the heavy line 122 shows the path of flow of one fluid and the light line 123 shows the path of flow of the other fluid. Starting at the left-hand side of Fig. 8 with the stationary head 10, it may be seen that the fluid for which the path of flow is indicated by the heavy black line 122 enters through a port 124 in the stationary head 10 and flows upwardly, then down, then up again, then down in the channels provided by the gasket 58-a between the stationary head 10 and the plate 62-a until it comes to the point designated 126 where it is able to enter the opening 82 in the plate 62-a. It passes through this opening, through the aligned opening 74 in the gasket 58-b, through the aligned opening 78 in the plate 60-a, from which it enters channels provided by the gasket 58-c between the plates 60-a and 62-b in which it flows until it comes to the point 128 where it can enter the opening 82 in plate 62-B from which it passes through the opening 76 in the gasket 58-d, through the opening 78 in the plate 60-B, from which it can enter the channels provided by the gasket 58-e between the plate 60-b and the follow head 54. These channels guide it between plate 60-b and follow head 54 until eventually it comes to the point 130 where it can enter the opening 132 in the follow head 54 and leave the machine. The other liquid the path of flow of which is designated by the light line 123 preferably will be admitted through the opening 134 in the follow head 54, passing through the aligned opening 76 in the gasket 58-e, through the opening 80 in the plate 60-b, from which it enters the channels provided by the gasket 58-d between the plates 60-b and 62-b. In these channels it is guided between these plates along the path indicated until it comes to the point 136 where it can pass through the opening 84 in

plate 62-b through the opening 74 in gasket 58-c, through the opening 80 in plate 60-a and into the channels provided by the gasket 58-b between plates 60-a and 62-a. At the end of these channels at point 138 the fluid passes into and through the opening 84 in plate 62-a, through the aligned opening 76 in gasket 58-a and out of the machine through the opening 140 in the stationary head 10.

Referring back to Figs. 1, 2 and 4 it is pointed out that it is preferred to provide sanitary ports, such as 142 and 144, located respectively on the follow head 54 and the stationary head 10 to admit food products to or discharge them from the exchanger. On the other hand, non-food products or cooling or heating media such as steam, brine, cold water, etc. may be admitted or discharged through any desired type of port, for example, ports provided by drilling and tapping the head 10 or the follow head 54 to receive ordinary water pipe, such as the pipe sections 146 and 148 shown in Figs. 1 and 2.

Fig. 9 illustrates a cold plate designated generally 150 which is adapted to be used in combination with a pair of gaskets 58 such as have been described above and with plates such as the plates 60 and 62 or other similar plates, of which there are a wide variety as described above, differing only in the number and location of the openings therethrough. As may be readily seen in Fig. 9 the cold plate 150 has the same general configuration as the gaskets 58. It is, however, preferably formed of a rigid material and is preferably somewhat thicker than the gaskets 58. By way of illustration the plate 150 might be a casting and is preferably formed of metal such as aluminum, steel or the like.

The plate 150 further differs from the gasket 58 in that it is provided with a continuous tube 152 which extends through the side walls of the plate as at 154 and 156 and extends from these points around through the channels in the plate 150 as indicated in the drawings. The thickness of the plate 150 will be determined by the diameter of the tube 152, that is, the plate 150 will always have a thickness greater than the diameter of the tube 152 so that the tube 152 may extend wholly within the space between the planes of the broad faces of the plate 150. The particular form of the tube 152 shown is, however, merely illustrative. Thus, for example, instead of running a single piece of tubing of uniform diameter through the full length of the channels, tubing headers can be extended laterally of the channels from the inlet and exit and lengths of tubing, if desired, of smaller diameter extended between the headers in the various straight portions of the channels or any other desired arrangement may be used.

Freon gas or other refrigerant in compressed form will be supplied to the tube 152 and expanded therein as it passes through the portion of the tube 152 extending within the confines of the plate 150, exerting a refrigerating effect within the tube 152. As in the embodiment of the invention described above, the plate 150 with a gasket 58 on either face will be clamped between a pair of plates such as the plates 60 and 62 shown so that in the clamping arrangement relatively thick channels will be provided as indicated at 158 in Fig. 10 which shows the elements in assembled relation. Preferably the space in these relatively thick channels which is not occupied by the tube 152 will be filled with a medium having good heat transfer properties, for example, water, or

alternatively water may be supplied through the opening 78 in plate 60 to enter the thick channels designated 158 in which it will flow up and down between the plates 60 and 62 until it reaches the opening 82 in the plate 62, from which it will pass out of the heat exchanger or be directed elsewhere in the heat exchanger.

In a complete heat exchanger the assembly, including the cold plate 150 and the two gaskets 58, would simply replace alternate gaskets 58 in the flow diagram shown in Fig. 8, for example, leaving the remainder of the assembly as shown, or the assembly including the cold plate 150 and the pair of gaskets 58 could be substituted in any heat exchange structure of the type described herein for alternate gaskets 58. The heat exchange medium in the thick channels designated as 158 whether stationary or flowing will be cooled by the expansion of the refrigerant within the tube 152 and will in turn cool the adjacent plates 60 and 62 thereby cooling the medium to be cooled which is flowing over the opposite faces of the plates 60 and 62. The purpose in employing tube 152 for the refrigerant and surrounding it with the medium having good heat transfer properties is to minimize the possibility that the liquid medium being cooled will be cooled to such an extent that it will solidify within the heat exchanger.

Fig. 11 illustrates an alternative cold plate construction 160. This would take the place of the plate 150 and the two associated gaskets 58. This plate 160 is constructed in the same way as the plate 150 with the single exception that it is provided with a coating 162 of neoprene or other resilient material in the same manner as the template for gaskets 58 is provided with a coating of neoprene or other resilient material. The thickness of the plate 160 which may be employed as a template for the plate 150 may be varied as desired to give any desired thickness to the channels 164 provided therein through which the tube 152 extends. The resilient coating 162 will permit the plate 160 to simply be substituted for a gasket 58 in an assembly such as illustrated in Fig. 8, that is, plates such as 60 and 62 will be clamped directly against the opposite faces of plate 160. Attention is particularly directed at this point to the fact that both the plate 150 and the plate 160 include a leak detector slot 166, as illustrated in Fig. 9, similar to the slot 94 provided in the gaskets 58, although this may be omitted from the plate 150 when it is used in combination with gaskets 58, since the slots 94 in these gaskets will be adequate to carry off to the atmosphere any leakage.

Figs. 12, 13 and 14 illustrate still another form of cold plate designated generally 168. In Fig. 12 the middle one of the three cold plates shown in the exploded view has portions broken away and the remainder of the interior construction indicated by dotted lines. As may be seen in this figure the plate 168 is of sandwich type construction including a body portion 170 sandwiched between a pair of facing plates 172 and 174 which plates may be identical in construction with plates such as plates 60 and 62 previously described. The body 170 like the gasket 58 and the plate 150 previously described includes a flow directing portion 176 which may be constructed to direct flow along any desired path but preferably directs flow in the path indicated in the same manner as the gasket 58 and the plate 150. The upper end of the body 168 is provided with ports 178 and 180 similar to the ports 74 and

76 in the gasket 58. It does not, however, have the leak detector slot of gasket 58 since such slot is not required in the plate 168 for reasons which will become apparent. Extending through the edge wall of the body 168 into the opposite ends of the channel 182 along which body 168 directs flow are a pair of tubes 184 and 186 through one of which a fluid medium can be directed into the channel 182 and after flowing the length of the channel may be directed out of the other.

It will be noted that the plate 168 differs from the constructions previously described in that it includes as integral parts thereof the heat exchange plates 172 and 174, corresponding to plates 60 and 62 and which in the other constructions are in each instance separate from the flow directing member. The body 170 is preferably formed of rigid material preferably metal such as steel, aluminum or the like, the particular kind of metal used being selected with regard to the material which is to be introduced and removed through the tubes 184 and 186. For example, the body 170 might be a metal casting or a piece of sheet metal routed or otherwise cut out to provide the channels 182 and drilled or otherwise cut to provide the ports 178 and 180, the space bar receiving slots 188 and 190 and the openings 192 and 194 for the tubes 184 and 186. The plates 172 and 174 are then suitably secured to the body 170. In accordance with the preferred construction the body will be of metal such as steel and the plates 172 and 174, particularly if the plate 168 is to be used to cool a food product, will be formed of stainless steel and polished on their outer faces. These plates 172 and 174 are then welded to the body 168 around the entire periphery of the flow directing portion 176 and also about each of the ports 178 and 180 to insure against any leakage from the ports 178 and 180 or from the channels 182 between either the plate 172 or the plate 174 and the body 170. By this means the plate 168 becomes an integral structure containing within its interior channels 182 in which flow may be directed across the surface of each of plates 172 and 174 and providing on its exterior heat exchanging surfaces over which a fluid medium may be directed to exchange heat with the fluid medium flowing in the channels 182.

Plate 168 is designed to receive a refrigerant such as a compressed refrigerant gas through one of the tubes 184 and 186 which will then expand in the channels 182 and eventually leave through the other tube, meanwhile exerting a refrigerant effect on the heat exchange plates 172 and 174, although the plate 168 could be used to handle media other than a refrigerant. It will be noted that this plate 168 differs from plates 150 and 160 in that the refrigerant is in direct contact with the adjacent heat exchange plates instead of being contained in tubes within the channels 182.

As suggested above, plate 168 requires no leak detector slot because the welded construction precludes leakage. Similarly because only the medium which is to exchange heat with that circulating in channels 182 is directed through the heat exchanger past the various plates and gaskets, the gaskets 196 designed for use with the plate 198 likewise do not require leak detector slots. These gaskets 196 to be used with the plate 168 preferably have the configuration indicated in Fig. 12. In general they are preferably of the same construction as the gasket 58 in-

cluding a template the elements of which are encased in a material such as neoprene. As in the gasket 58 the flow directing portions of the gasket 196 may take any desired form, although preferably they will have the form indicated in the drawings. It will be apparent that when the parts of an assembly, as indicated in Figs. 12 and 13, consisting in order of plate 168, a gasket 196, a plate 168 and so on, are clamped together as indicated in Fig. 13 and as described in connection with previous constructions including other plates and gaskets, a fluid medium introduced into ports 178 or 180 will enter the channels 198 provided in the gasket 196 and in these channels will be caused to flow over the surface of the adjacent cold plates 168 eventually coming to the other of the ports 178 or 180 from which it can be directed out of the heat exchanger. As will be apparent an assembly of plates 168 and gaskets 196 shown in Fig. 13 and designated generally 200 may be supported on a frame structure such as is shown in Figs. 1 and 2 or, alternatively, may be supported in any desired manner. Similarly it may be clamped together in any desired way. While plates 150, 160 and 168 are described above as cold plates designed to receive a refrigerant, it will be apparent that any of these or similar plates, particularly plate 168, are not limited in use to cooling since any other desired fluid medium, such as steam, for example, may be directed through these plates in place of the refrigerant, and heat exchange medium surrounding the tubes in plate 150 and 160 will serve to decrease the intensity of the heat exchange effect. For the purpose of introducing refrigerant or other medium into the plates 168 and removing it through tubes 184 and 186 it is preferable to provide headers 202 and 204 which extend alongside of the assembly 200 as indicated in Fig. 13. Relatively long flexible connections 206 and 208 extend from the headers 202 and 204, respectively, up to the tubes 186 and 188, respectively. The relatively long flexible connections are provided to permit the plates 168 and gaskets 196 to be separated for purposes of cleaning.

In the above description all of the plates and gaskets to be supported on a frame such as that shown in Figs. 1 and 2, are indicated as being provided with slots on their opposite ends in which the spacer bars 12 and 14 are received. If desired, these slots particularly on the upper end may be replaced with holes extending through the plate or gasket as the case may be and entirely enclosed by the material of the plate or gasket thus permitting the plate or gasket to be suspended particularly from the upper spacer bar 12 and to be removable only by removing the spacer bar 12 which can, however, be readily accomplished particularly when the spacer bar 12 is constructed as above described.

It is an important advantage of this invention that it provides for the first time a one-piece gasket adapted to be used in combination with plane surfaced heat exchange plates in a film type heat exchanger and which includes means in the form of a leak detector slot for preventing any leakage of one of two fluid media between which heat is being exchanged into the channels or headers through which the other fluid media is being directed. The leak detector slot extending entirely through the thickness of the gasket and communicating with the exterior of the heat exchanger provides an area within the confines of the gasket which is at atmospheric pressure and toward which any leakage of either fluid medium

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which is under pressure in the heat exchanger will tend to move in preference to moving toward the other high pressure area in which the other fluid medium is flowing.

Still another important advantage of the gasket 58 resides in the ability of this gasket to serve as the sole spacing means between the heat exchange plates clamped against its opposite faces. This advantage is realized when the resilient casing for gasket 58 is a resilient neoprene composition or other similar resilient composition that does not flow appreciably under the heat and/or pressures encountered in the heat exchangers in which gasket 58 is used. Another feature of gasket 58 as well as other similar heat exchanger members disclosed herein which contributes to the capacity of gasket 58 and of the other similar members such as cold plate 160 to serve as the sole spacing means between adjacent heat exchange plates is the relatively broad area of contact of the gasket or other part with the heat exchange plates which is provided by giving the gasket or other part the configuration shown therein or some similar configuration. Further, by providing the plate supporting fingers on the opposite ends of the channels through which the media are directed over the surface of the heat exchange plates the heat exchange plates are firmly supported adjacent openings therethrough and opposite the leak detector slot on the adjacent gaskets to further prevent leakage.

The novel cold plate construction also provides a desirable modification of heat exchanger construction and has the advantage of being readily substituted in existing heat exchangers for portions thereof. Other advantages of the invention will be apparent from the foregoing description.

It is apparent that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof and therefore it is not intended to be limited except as indicated in the appended claims.

I claim:

1. A heat exchanger for exchanging heat between fluid media comprising a series of thin heat exchange plates, one-piece gaskets readily separable from said plates and each interposed between an adjacent pair of said plates and means for releasably clamping together said series of plates with said gaskets therebetween, each of said plates being formed with ports for said fluid media, said gaskets each having an opening therethrough forming a channel communicating with said ports for directing the flow of one of said media over the surfaces of the pair of plates between which said gasket is interposed and having another opening therethrough for directing the flow of another of said media past said gasket and each of said gaskets having a slot extending through said gasket from one face to the other thereof between said gasket openings and extending across the width of said gasket channel out toward at least one edge of said gasket beyond the edges of said plates to receive leakage from either of said gasket openings before it reaches the other gasket opening and conduct said leakage to the exterior of said exchanger.

2. A heat exchanger for exchanging heat between fluid media comprising a series of thin heat exchange plates, one-piece gaskets readily separable from said plates and each interposed between an adjacent pair of said plates and means for releasably clamping together said series of plates with said gaskets therebetween, each of said plates being formed with ports for said fluid

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media, said gaskets each having an opening therethrough forming a channel communicating with said ports for directing the flow of one of said media over the surfaces of the pair of plates between which said gasket is interposed and having another opening therethrough for directing the flow of another of said media past said gasket, each of said gaskets having an ear extending beyond the edges of said heat exchange plates and a slot extending through said gasket from one face to the other thereof between said gasket openings and extending across the width of said gasket channel out toward at least one edge of said gasket and into said ear beyond the edges of said plates to receive leakage from either of said gasket openings before it reaches the other gasket opening and conduct said leakage to the exterior of said exchanger.

3. A heat exchanger for exchanging heat between fluid media comprising a series of thin heat exchange plates, one-piece gaskets each separable from and interposed between an adjacent pair of said plates, each of said gaskets comprising a template and a body of resilient material encasing each element of said template and means for releasably clamping together said series of plates with said gaskets therebetween, each of said plates being formed with ports for said fluid media, said gaskets each having an opening therethrough forming an elongated channel communicating with said ports for directing the flow of one of said media over the surfaces of the pair of plates between which said gasket is interposed and having another opening therethrough for directing the flow of another of said media past said gasket and each of said gaskets having a slot extending therethrough from one face to the other thereof between said gasket openings and extending across the width of said gasket channel out toward at least one edge of said gasket beyond the edges of said plates to receive leakage from either of said gasket openings before it reaches the other gasket opening and conduct said leakage to the exterior of said exchanger.

4. A heat exchanger for exchanging heat between fluid media comprising a series of thin heat exchange plates, one-piece gaskets each separable from and interposed between an adjacent pair of said plates, each of said gaskets comprising a template and a body of resilient material encasing each element of said template and means for releasably clamping together said series of plates with said gaskets therebetween, each of said plates being formed with ports for said fluid media, said gaskets each having an opening therethrough forming an elongated channel communicating with said ports for directing the flow of one of said media over the surfaces of the pair of plates between which said gasket is interposed and having another opening therethrough for directing the flow of another of said media past said gasket, an ear on each gasket extending beyond the edges of said plates and each of said gaskets having a slot extending through said gasket from one face to the other thereof between said gasket openings and extending across the width of said gasket channel out toward at least one edge of said gasket and into said ear beyond the edges of said plates to receive leakage from either of said gasket openings before it reaches the other gasket opening and conduct said leakage to the exterior of said exchanger.

5. A heat exchanger for exchanging heat between fluid media comprising a series of thin

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heat exchange plates, one-piece gaskets each separable from and interposed between an adjacent pair of said plates and comprising a template and a body of resilient neoprene composition encasing each element of said template, and means for releasably clamping together said series of plates with said gaskets therebetween, each of said plates being formed with ports for said fluid media, said gaskets each having an opening therethrough forming a thin, elongated channel communicating with said ports for directing the flow of one of said media over the surfaces of the pair of plates between which said gasket is interposed and having another opening therethrough for directing the flow of another of said media past said gasket, an ear on each of said encased templates extending beyond the edges of said plates and a slot extending through each gasket from one face to the other thereof between said gasket openings and extending across the width of said gasket channel out toward at least one edge of said gasket and into said ear beyond the edges of said plates to receive leakage from either of said gasket openings before it reaches the other gasket opening and conduct said leakage to the exterior of said exchanger.

6. A heat exchanger for exchanging heat between fluid media comprising a series of thin heat exchange plates each formed with ports for said fluid media, one-piece gaskets each separable from and interposed between an adjacent pair of said plates and means for releasably clamping together said series of plates with said gaskets therebetween, said gaskets each having an opening therethrough forming a channel overlying and communicating with said ports for directing the flow of one of said media over the surfaces of the pair of plates between which said gasket is interposed and having another opening there-

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through for directing the flow of another of said media past said gasket and each of said gaskets having a slot extending through said gasket from one face to the other thereof between said gasket openings and extending across the width of said gasket channel out toward at least one edge of said gasket beyond the edges of said plates to receive leakage from either of said openings before it reaches the other gasket opening and conduct said leakage to the exterior of said exchanger, and finger-shaped portions having a thickness equal to the full thickness of said gasket and extending therefrom longitudinally of said channel over and beyond an adjacent port of an adjacent plate for supporting said plate in the vicinity of said port.

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