Oct. 28, 1958 J. R. MILLER 2,858,113

HEAT EXCHANGER

Filed Oct. 14, 1954 3 Sheets-Sheet 1

FIG. 1

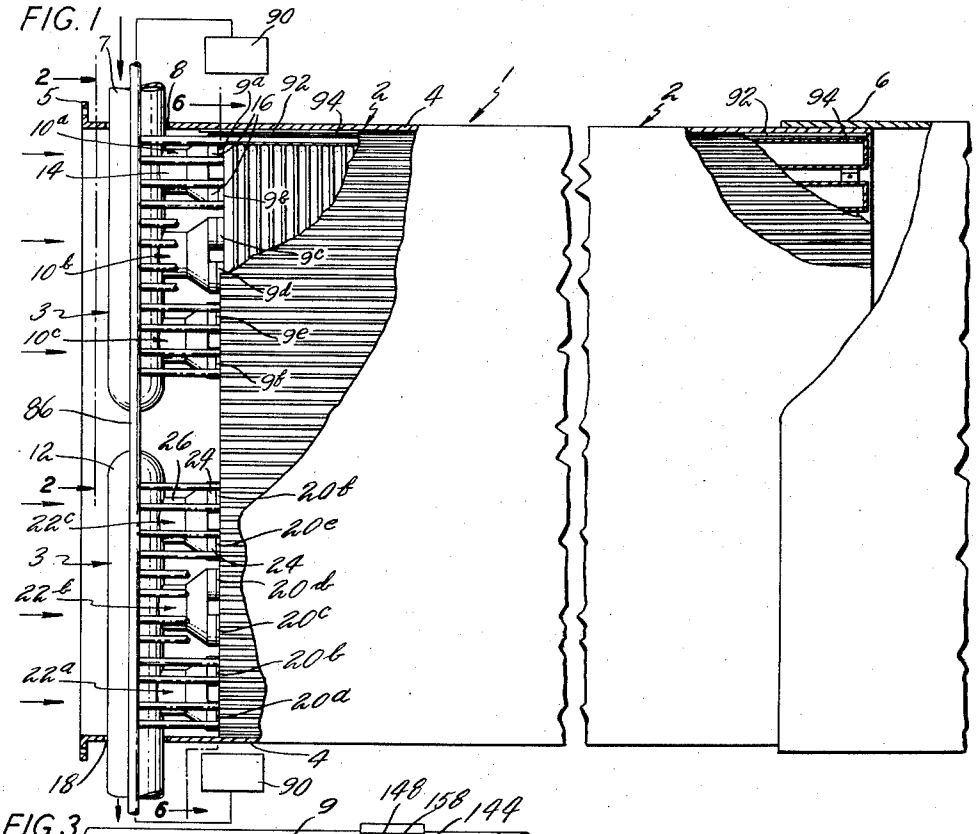


FIG. 3

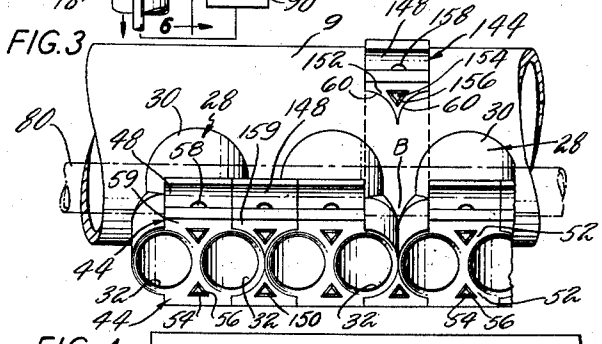


FIG. 5

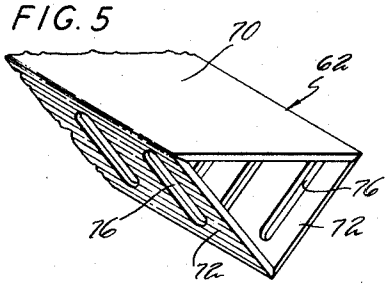
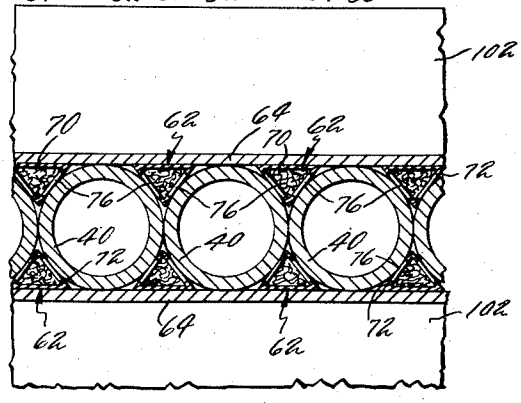


FIG. 4



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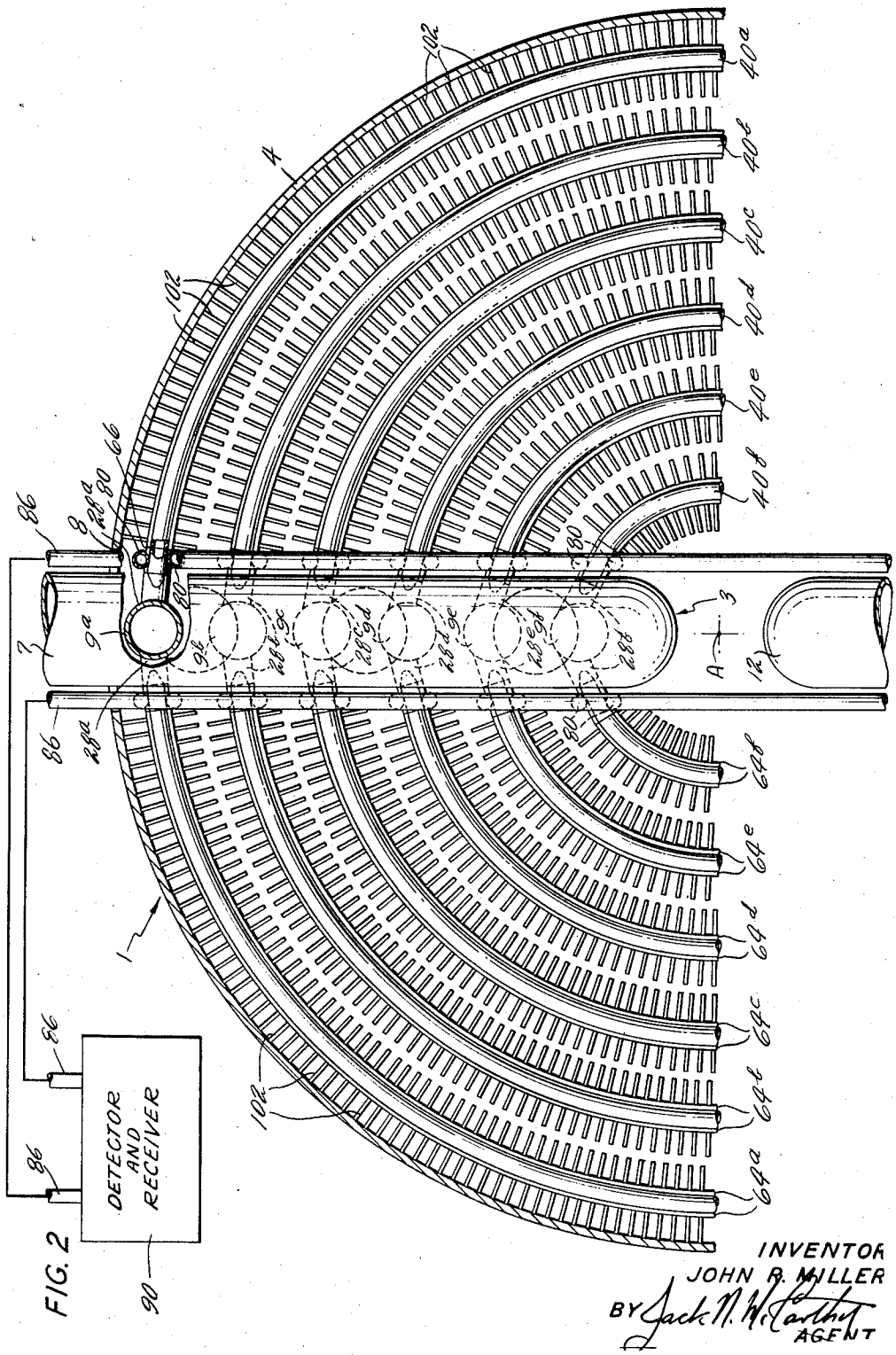


FIG. 2

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FIG. 6

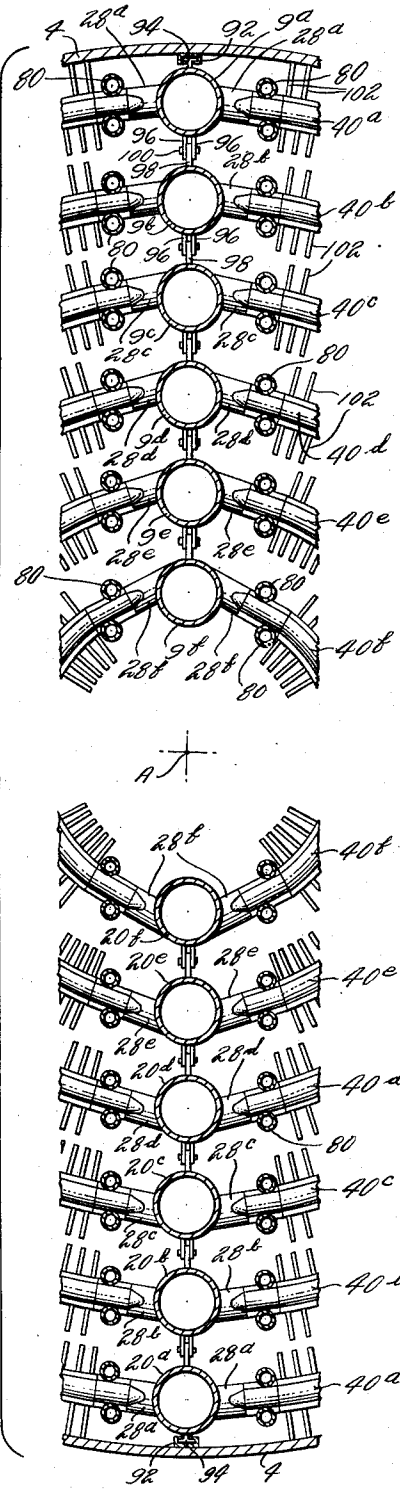
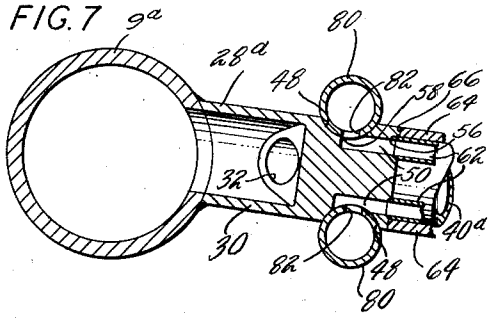


FIG. 7



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United States Patent Office 2,858,113 Patented Oct. 28, 1958

2,858,113

HEAT EXCHANGER

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Application October 14, 1954, Serial No. 462,137

9 Claims. (Cl. 257—241)

This invention relates to a surface type heat exchanger for the transfer of heat from one fluid to another through intervening surfaces.

An object of this invention is to provide a heat exchanger which is ideally suited for use within a circular duct.

Another object of this invention is to provide a heat exchanger which will withstand very high pressures, or variations thereof to low pressures.

A further object of this invention is to provide a heat exchanger having a large heat transfer surface per unit volume of space occupied.

Another object of this invention is to provide a heat exchanger having incorporated therein a leak receiver and detector.

Further objects and advantages will be apparent from the following specification and drawing:

Fig. 1 is a side view of the heat exchanger partially in section with a portion in the center removed.

Fig. 2 is a view taken along the line 2—2 of Fig. 1 showing the top half of the heat exchanger with a portion of the inlet header removed to show the connection of the fluid flow tubes to the inlet header extensions.

Fig. 3 is a view showing a section of an inlet header extension with several inlet header extension adapters connected thereto.

Fig. 4 is a sectional view taken through a portion of a line of fluid flow tubes.

Fig. 5 is a perspective view of a portion of a leak detection duct.

Fig. 6 is a view of the center section of the heat exchanger taken along line 6—6 of Fig. 1.

Fig. 7 is an enlarged view of an inlet header extension adapter.

Referring to the figures, in Figs. 1 and 2, this heat exchanger 1 is shown as being of a one-pass and cross-flow arrangement, and comprises a main gas flow duct or chamber 2 and a fluid header system 3. The gas flow duct or chamber 2 has a circular outer casing 4 with its forward end having a circular flange 5 fixed thereto and with its rearward end slideably mounted in a duct member 6. Circular flange 5 may be fixed to any inlet device desired and duct member 6 may be fixed to any exhaust device desired.

The fluid header system 3 has a main inlet header 7 and a main outlet header 12. The main inlet header 7 passes through an opening 8 in the outer casing 4 of the gas flow duct or chamber 2 of the heat exchanger 1 and extends radially to a point near the center A of the duct. A plurality of inlet header extensions 9 extend lengthwise in a radial plane within the casing of the heat exchanger from a point adjacent to the main inlet header 7. Said radial plane extends through the main inlet header 7.

In the heat exchanger shown in the drawings, six of these inlet header extensions are incorporated. To further identify a specific inlet header extension the general reference numeral 9 has added thereto the letters *a* through *f*. The reference numeral 9*a* is applied to the inlet header extension located adjacent the outer casing 4, and the remaining numerals 9*b*, 9*c*, 9*d*, 9*e* and 9*f* are applied to each inlet header extension, respectively, as it is located progressively in toward the center A of the heat exchanger. While six inlet header extensions 9 have been shown it is to be understood that any other desirable number may be used.

Inlet header adapters 10 connect the main inlet header 7 to the inlet header extensions 9. Each inlet header adapter 10 connects two inlet header extensions 9 to the main inlet header 7. An inlet header adapter 10 is a unit comprising an inlet pipe 14 connected to two outlet pipes 16. As viewed in Fig. 1, inlet pipe 14 of each inlet header adapter 10 is fixed to the inlet header 7 with the outlet pipes 16 of each inlet header adapter extending rearwardly, one over the other in a radial line. Outlet pipes 16 are fixed, one each to the forward end of an inlet header extension 9.

Three of these inlet header adapters 10 are incorporated in the heat exchanger shown in the drawings. Inlet header adapter 10*a* connects inlet header extensions 9*a* and 9*b* to the main inlet header 7, inlet header adapter 10*b* connects inlet header extensions 9*c* and 9*d* to the main inlet header 7, inlet header adapter 10*c* connects inlet header extensions 9*e* and 9*f* to the main inlet header 7.

A main outlet header 12 passes through an opening 18 in the outer casing 4 of the gas flow duct or chamber 2 of the heat exchanger 1 and extends radially to a point near the center A of the duct. Opening 8, referred to above, and opening 18 are located in the circular outer casing 4 at points which are diametrically opposed. Further, main inlet header 7 and main outlet header 12 lie in a diametrical plane passing through the two said openings, 8 and 18. A plurality of outlet header extensions 20 extend lengthwise in a radial plane within the casing of the heat exchanger from a point adjacent to the main outlet header 12. Said radial plane extends through the main outlet header 12.

In the heat exchanger shown in the drawings six of these outlet header extensions are incorporated. To further identify a specific outlet header extension the general reference numeral 20 has added thereto the letters *a* through *f*. The reference numeral 20*a* is applied to the outlet header extensions located adjacent the outer casting 4 and the remaining numerals 20*b*, 20*c*, 20*d*, 20*e*, and 20*f* are applied to each outlet header extension, respectively, as it is located progressively in toward the center A of the heat exchanger. While six outlet header extensions 20 have been shown, it is to be understood that any other desirable number may be used.

Outlet header adapters 22 connect the main outlet header 12 to the outlet header extensions 20. Each outlet header adapter 22 connects two outlet header extensions 20 to the main outlet header 12. An outlet header adapter 22 is a unit comprising two inlet pipes 24 connected to one outlet pipe 26. As viewed in Fig. 1, outlet pipe 26 of each outlet header adapter 22 is fixed to the outlet header 12 with the inlet pipes 24 of each outlet header adapter extending rearwardly, one over the other in a radial line. Inlet pipes 24 are fixed, one each to the forward end of an outlet header extension 20.

Three of these outlet header adapters 22 are incorporated in the heat exchanger shown in the drawings. Outlet header adapter 22*a* connects outlet header extensions 20*a* and 20*b* to the main outlet header 12, outlet header adapter 22*b* connects outlet header extensions 20*c* and 20*d* to the main outlet header 12, and outlet header adapter 22*c* connects outlet header extensions 20*e* and 20*f* to the main outlet header 12.

Each inlet header extension 9 is connected to an outlet header extension 20. A plurality of header extension

adapters 28 are fixed along the length of each inlet and outlet extension 9 and 20 on each side thereof. The header extension adapters 28 differ slightly for each inlet and outlet header extensions 9 and 20, which are not connected together. The header extension adapters 28 for each inlet and outlet header extension connected together are the same. To identify a specific inlet and outlet extension adapter the general reference numeral 28 has added thereto one of the letters *a* through *f*.

As noted in Fig. 6, the slight difference between each header extension adapter 28 is in the length of the adapter which is caused by the change in angle between the adapter and the extension to which it is connected. A header extension adapter is a unit comprising a single pipe 30 connected to two smaller pipes 32. This is clearly shown in Fig. 3 in which three adapters 28 are shown attached to an inlet header extension 9. Each outwardly extending pipe 32 of the inlet header extension adapters is connected by a fluid flow tube 40 to its respective pipe 32 of the outlet header extension adapters. These fluid flow tubes are formed so that they lie along an arc of a circle between the adapters. This provides an arcuate bank of fluid flow tubes extending from the header extension adapters on each side of each header extension 9 to the header extension adapters on each side of the header extensions 20. Said tubes in each bank are positioned together, each successive tube abutting the preceding tube. To identify a specific fluid flow tube the general reference numeral 40 has added thereto one of the letters *a* through *f*. For example, a fluid flow tube connecting an inlet header extension adapter 28*a* to an outlet header extension adapter 28*a* is given the reference numeral 40*a* and a fluid flow tube connecting an inlet header extension adapter 28*b* to an outlet header extension adapter 28*b* is given the reference numeral 40*b*. While these fluid flow tubes 40 may be connected to their respective header extension adapters by any means desired, the outwardly extending ends of pipes 32 of the adapters are provided with an inwardly tapered bevel to receive an outwardly tapered bevel at the end of the fluid flow tubes. This connection is then fixed by known means such as brazing or welding.

Each header extension adapter 28 has formed integrally therewith two bosses 44. One boss extends between the pipes 32 on one side of the adapter 28 and another boss extends between the pipes 32 on the other side. Each boss extends approximately the length of the pipes 32 and has a width which extends from the center of one pipe 32 to the center of the other integral pipe 32. Each boss presents a face 52 lying in a plane with the ends of pipes 32. A groove 48 extends the full width of each boss. A passageway 50 extends from the face 52 of each boss to the bottom of its groove 48. The passageway 50 as it intersects the face 52 of the boss is triangular in shape as at 54 and has an inwardly beveled face 56 for a reason to be hereinafter described. The passageway 50 as it intersects the bottom of groove 48 forms an aperture 58.

As viewed in Fig. 3 it can be seen that the header extension adapters are connected to a header extension so that the pipes 32 of adjacent adapters abut one another. All of the header extension adapters are mounted in this manner. When these adapters are first mounted they give an appearance between them as indicated to the right of Fig. 3 by the letter B.

In the construction of this heat exchanger it is desired that the space between the adjacent pipes 32, not integrally attached, and bosses 44 attached thereto, be built up to appear similar to a boss 44. This is done by the use of an insert 144 which is placed between the adjacent pipes 32 and their respective bosses 44. This insert 144 is curved as at 60 to have a snug fit with the exterior portions of pipes 32 and is of such a width so that it fits snugly between the ends of adjacent bosses 44. As viewed in Fig. 3 this insert has a groove 148 which extends the full width of the insert. A passageway 150 extends from the face 152 of the insert to the bottom of the groove 148. The passageway 150 as it intersects the face 152 of the insert is triangular in shape as at 154 and has an inwardly beveled face 156 for a reason to be hereinafter described. The passageway 150 as it intersects the bottom of groove 148 forms an aperture 158. The insert is shown in this position to the left of Fig. 3 where it has been affixed by any means desired. The insert is used on both sides of each adapter. While the boss 44 has been shown as integral, it is to be understood that it can also be made as insert 144.

A completed line of header extension adapters 28 and inserts 144 along an extension presents a long groove extending from the first tube to the last on both sides of the adapters. These grooves have a series of holes 58, 158 in the bottom thereof extending from one end to the other. The triangular openings at 54 and 154 have an outer edge of the beveled face 56 located in a line with the top or bottom of each of the pipes 32. Each triangular opening on bosses 44 or inserts 144 of the inlet header extension adapters is connected by a leak detection duct 62, having a triangular shaped cross section, to its respective triangular opening on bosses 44 or inserts 144 of the outlet header extension adapters.

Each leak detection duct 62 contains metallic fibers. These may be of metals such as silver or copper. This provides for heat transfer through the duct and for fluid flow along the duct. While these leak detection ducts 62 may be connected to their respective bosses or inserts by any means desired, the triangular openings at 54 are provided with an inwardly tapered bevel to receive the outwardly tapered bevel at the end of the leak detection ducts. This connection is then fixed by known means such as brazing or welding. These leak detection ducts 62 are formed so that they lie along an arc of a circle between adjacent fluid flow tubes 40. The side 70 of the leak detection ducts abutting the beveled edge of holes 50 and 150 which are aligned with the edges of pipes 32 is solid, the other two sides 72 which extend down into the V-shaped channel formed by adjacent fluid flow tubes 40 have slots 76 extending for a distance less than the width of the sides (see Fig. 5).

A collection tube 80 is fixed in each long groove extending along a completed line of header extension adapters 28 and inserts 144 and has holes 82 therein, one each which cooperates with each of the holes 58, 158 in the groove. These tubes 80 are closed at their rearwardly extending end and are all attached at their forwardly extending end to two main collector tubes 86. These tubes 86 extend one along each side of the main inlet header 7 and main outlet header 12 from the top to the bottom of the heat exchanger. The ends of tubes 86 are connected to a leak detection and receiver means 90. This means may be of any construction depending on the fluid to be received and detected.

A shell 64 is placed on each side of each arcuate bank of tubes. To identify a specific shell the general reference numeral 64 has added thereto one of the letters *a* through *f*. For example, the shell on each side of the bank of tubes 40*a* is given the reference numeral 64*a*. It can be seen that the various shells 64 will vary in length and arcuate shape depending on which bank of tubes they are placed and on which side of that bank. This is evident from Fig. 2 of the drawings. The shells 64 extend in length from the first tube in the bank to the last. The upper and lower ends 66 of each shell abut the portion of faces 52 and 152 which are located between a line passing through the tops or bottoms of the pipes 32 and the edge of the inwardly beveled faces 56 and 156, and the edges 59 and 159 respectively. With the shells positioned the ducts 62 are enclosed between the fluid flow tubes 40, shells 64 and faces 52 and 152 of the bosses 44 and the inserts 144. To aid in heat transfer, fins 102

extend lengthwise along the open side of each shell **64**. These fins **102** may be formed integral with the shell.

The header extensions **9** and **20** are mounted in the casing **4** of the heat exchanger in the following mnaner. A track **92** is affixed to the inner side of casing **4** directly over the line of extensions **9** and extends for the full length of the extensions. Hangers **94** are affixed to the top of extension **9***a* at a plurality of points. These hangers are of T-shaped cross section and the top of the T is supported in the track **94**. This connection positions the extensions radially but permits axial movement. Other extensions are linked to each other at the same number of points. Two tabs **96** depend from one extension and a single tab **98** extends from the adjacent extension to a position between the two tabs **96**. A pin **100** passes through all three tabs to provide the link. This linkage is provided between all extensions **9**. The extensions **20** are mounted in exactly the same manner as extensions **9**. However, the track **92** is affixed to the inner side of casing **4** directly under the line of extensions **20**.

Operation

In this cross flow heat exchanger, when in operation, one fluid is flowing through the main flow duct or chamber **2** and another fluid is flowing through the header system **3**. The flow through the fluid header system **3** enters the flow duct or chamber **2** through the main inlet header **7**. This fluid then passes to its inlet header extensions **9***a* through **9***f* by way of the inlet header adapters **10***a* through **10***c*. The fluid then passes from each inlet header extension to an outlet header extension by way of a plurality of fluid flow tubes **40**. The outlet header extensions **20** discharge into a main outlet header **12** by way of main outlet header adapters **22***a* through **22***c*. This fluid may be directed into the main inlet header **7** by any means desired and it may be directed from the main outlet header **12** in any manner desired.

In the event of a leak in any of the fluid flow tubes **40**, any of the fluid so escaping would pass into a leak detection duct **62** and be carried to one of the collection tubes **80**. From here the fluid will pass to a collector tube **86** and be directed to a leak detection and receiver means **90**.

The flow through the main flow duct or chamber **2** enters at its forward end and passes over the shells **64***a* through **64***f*, fins **102**, inlet and outlet header extensions **9***a* through **9***f* and **20***a* through **20***f*, the inlet and outlet headers **7** and **12**, and all adapters. The flow is discharged from the duct or chamber **2** at its rearward end into a duct member **6**. As mentioned heinbefore, the chamber **2** is mounted for expansion within duct **6**, and the extensions **9** and **20** are mounted for expansion within the chamber **2**.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claims.

I claim:

1. In combination, a fluid flow chamber, said chamber having an inlet end and an outlet end, a main inlet header extending into said chamber adjacent one end, a plurality of inlet header extensions extending lengthwise in said chamber, said inlet header extensions being connected to said main inlet header, a main outlet header extending into said chamber adjacent one end, a plurality of outlet header extensions extending lengthwise in said chamber, said outlet header extensions being connected to said main outlet header, each inlet header extension having a plurality of inlet header extension adapters fixed along its length, said inlet adapters presenting a plurality of pipes extending along a line on each side of each inlet header extension, each outlet header extension having a plurality of outlet header extension adapters fixed along its length, said outlet adapters presenting a plurality of pipes extending along a line on each side of each outlet header extension, the pipes in a line on one side of each inlet header extension being connected to the pipes in a line on one side of each outlet header extension by an arcuate bank of tubes, each arcuate bank of tubes having its tubes therein arranged so that each successive tube abuts the preceding tube, means providing a face along each side of each line of inlet and outlet header extension adapters extending between each of the pipes, a shell affixed to each side of each bank of tubes, each shell extending along its arcuate length from a face on one side of a line of cooperating inlet header extension adapters to a face on one side of a line of cooperating outlet header extension adapters, an arcuate space being formed between each adjacent tube in an arcuate bank, the portions of the face extending between each of the pipes at each end and a shell, a collection tube extending along each side of each line of inlet and outlet header extension adapters, an arcuate duct located in each arcuate space extending from the face at one end to the face at the other end, passageways connecting each collection tube to all the ends of the arcuate ducts located in a line on the same side of an inlet or outlet header extension adapter that the collection tube is located.

2. In combination, a fluid flow chamber, said chamber having an inlet end and an outlet end, a main inlet header extending into said chamber adjacent one end, a plurality of inlet header extensions extending lengthwise in said chamber, said inlet header extensions being connected to said main inlet header, a main outlet header extending into said chamber adjacent one end, a plurality of outlet header extensions extending lengthwise in said chamber, said outlet header extensions being connected to said main outlet header, each inlet header extension having a plurality of inlet header extension adapters fixed along its length, said inlet adapters presenting a plurality of pipes extending along a line on each side of each inlet header extension, each outlet header extension having a plurality of outlet header extension adapters fixed along its length, said outlet adapters presenting a plurality of pipes extending along a line on each side of each outlet header extension, the pipes in a line on one side of each inlet header extension being connected to the pipes in a line on one side of each outlet header extension by an arcuate bank of tubes, each arcuate bank of tubes having its tubes therein arranged so that each successive tube abuts the preceding tube, means providing a face along each side of each line of inlet and outlet header extension adapters extending between each of the pipes, a shell affixed to each side of each bank of tubes, each shell extending along its arcuate length from a face on one side of a line of cooperating inlet header extension adapters to a face on one side of a line of cooperating outlet header extension adapters, an arcuate space being formed between each adjacent tube in an arcuate bank, the portions of the face extending between each of the pipes at each end and a shell, said means for providing a face also providing a groove along each side of each line of inlet and outlet header extension adapters, a collection tube mounted along each groove, an arcuate duct located in each arcuate space extending from the face at one end to the face at the other end, passageways connecting each collection tube to all the ends of the arcuate ducts located in a line on the same side of an inlet or outlet header extension adapter that the collection tube is located.

3. In a combination, a fluid flow chamber, said chamber having an inlet end and an outlet end, a main inlet header extending into said chamber adjacent one end, a plurality of inlet header extensions extending lengthwise in said chamber, said inlet header extensions being connected to said main inlet header, a main outlet header extending into said chamber adjacent one end, a plurality of outlet header extensions extending lengthwise in said chamber, said outlet header extensions being connected to said main outlet header, each inlet header extension

having a plurality of inlet header extension adapters fixed along its length, said inlet adapters presenting a plurality of pipes extending along a line on each side of each inlet header extension, each outlet header extension having a plurality of outlet header extension adapters fixed along its length, said outlet adapters presenting a plurality of pipes extending along a line on each side of each outlet header extension, the pipes in a line on one side of each inlet header extension being connected to the pipes in a line on one side of each outlet header extension by an arcuate bank of tubes, each arcuate bank of tubes having its tubes therein arranged so that each successive tube abuts the preceding tube, means providing a face along each side of each line of inlet and outlet header of extension adapters extending between each of the pipes, a shell affixed to each side of each bank of tubes, each shell extending along its arcuate length from a face on one side of a line cooperating inlet header extension adapters to a face on one side of a line of cooperating outlet header extension adapters, an arcuate space being formed between each adjacent tube in an arcuate bank, the portions of the face extending between each of the pipes at each end and the shell, a collection tube extending along each side of each line of inlet and outlet header extension adapters, an arcuate duct located in each arcuate space extending from the face at one end to the face at the other end, passageways connecting each collection tube to all the ends of the arcuate ducts located in a line on the same side of an inlet or outlet header extension adapter that the collection tube is located, said passageways each passing through the adjacent means providing a face along each side of each line of inlet and outlet header extension adapters.

4. In combination, a fluid flow chamber, said chamber having an inlet end and an outlet end, a main inlet header extending into said chamber adjacent one end, a plurality of inlet header extensions extending lengthwise in said chamber, said inlet header extensions being connected to said main inlet header, a main outlet header extending into said chamber adjacent one end, a plurality of outlet header extensions extending lengthwise in said chamber, said outlet header extensions being connected to said main outlet header, each inlet header extension having a plurality of inlet header extension adapters fixed along its length, said inlet adapters presenting a plurality of pipes extending along a line on each side of each inlet header extension, each outlet header extension having a plurality of outlet header extension adapters fixed along its length, said outlet adapters presenting a plurality of pipes extending along a line on each side of each outlet header extension, the pipes in a line on one side of each inlet header extension being connected to the pipes in a line on one side of each outlet header extension by an arcuate bank of tubes, each arcuate bank of tubes having its tubes therein arranged so that each successive tube abuts the preceding tube, means providing a face along each side of each line of inlet and outlet header extension adapters extending between each of the pipes, a shell affixed to each side of each bank of tubes, each shell extending along its arcuate length from a face on one side of a line of cooperating inlet header extension adapters to a face on one side of a line of cooperating outlet header extension adapters, an arcuate space being formed between each adjacent tube in an arcuate bank, the portions of the face extending between each of the pipes at each end and the shell, a collection tube extending along each side of each line of inlet and outlet header extension adapters, an arcuate duct located in each arcuate space extending from the face at one end to the face at the other end, passageways connecting each collection tube to all the ends of the arcuate ducts located in a line on the same side of an inlet or outlet header extension adapter that the collection tube is located, a means for receiving and detecting a fluid, the free ends of each collection tube being connected to said means.

5. In combination, a fluid flow chamber, said chamber having an inlet end and an outlet end, a main inlet header extending into said chamber adjacent one end, a plurality of inlet header extensions extending lengthwise in said chamber, said inlet header extensions being connected to said main inlet header, a main outlet header extending into said chamber adjacent one end, a plurality of outlet header extensions extending lengthwise in said chamber, said outlet header extensions being connected to said main outlet header, each inlet header extension having a plurality of inlet header extension adapters fixed along its length, said inlet adapters presenting a plurality of pipes extending along a line on each side of each inlet header extension, each outlet header extension having a plurality of outlet header extension adapters fixed along its length, said outlet adapters presenting a plurality of pipes extending along a line on each side of each outlet header extension, the pipes in a line on one side of each inlet header extension being connected to the pipes in a line on one side of each outlet header extension by an arcuate bank of tubes, each arcuate bank of tubes having its tubes therein arranged so that each successive tube abuts the preceding tube, means providing a face along each side of each line of inlet and outlet header extension adapters extending between each of the pipes, a shell affixed to each side of each bank of tubes, each shell extending along its arcuate length from a face on one side of a line of cooperating inlet header extension adapters to a face on one side of a line of cooperating outlet header extension adapters, an arcuate space being formed between each adjacent tube in an arcuate bank, the portions of the face extending between each of the pipes at each end and the shell, a collection tube extending along each side of each line of inlet and outlet header extension adapters, an arcuate duct located in each arcuate space extending from the face at one end to the face at the other end, each arcuate duct containing metallic fibers, passageways connecting each collection tube to all the ends of the arcuate ducts located in a line on the same side of an inlet or outlet header extension adapter that the collection tube is located.

6. In combination, a fluid flow chamber, said chamber having an inlet end and an outlet end, a main inlet header extending into said chamber adjacent one end, a plurality of inlet header extensions extending lengthwise in said chamber, said inlet header extensions being connected to said main inlet header, a main outlet header extending into said chamber adjacent one end, a plurality of outlet header extensions extending lengthwise in said chamber, said outlet header extensions being connected to said main outlet header, each inlet header extension having a plurality of inlet header extension adapters fixed along its length, said inlet adapters presenting a plurality of pipes extending along a line on each side of each inlet header extension, each outlet header extension having a plurality of outlet header extension adapters fixed along its length, said outlet adapters presenting a plurality of pipes extending along a line on each side of each outlet header extension, the pipes in a line on one side of each inlet header extension being connected to the pipes in a line on one side of each outlet header extension by an arcuate bank of tubes, each arcuate bank of tubes having its tubes therein arranged so that each successive tube abuts the preceding tube, means providing a face along each side of each line of inlet and outlet header extension adapters extending between each of the pipes, a shell affixed to each side of each bank of tubes and extending from said inlet end to said outlet end of said chamber, each shell extending along its arcuate length from a face on one side of a line of cooperating inlet header extension adapters to a face on one side of a

line of cooperating outlet header extension adapters, an arcuate space being formed between each pair of adjacent tubes in an arcuate bank, the portions of the face extending between each of the pipes at each end and a shell, means for detecting a leak from a tube into one of said arcuate spaces.

7. In combination, a fluid flow chamber, said chamber having an inlet end and an outlet end, a main inlet header extending into said chamber adjacent one end, an inlet header extension extending lengthwise in said chamber, said inlet header extensions being connected to said main inlet header, a main outlet header extending into said chamber adjacent one end, an outlet header extension extending lengthwise in said chamber, said outlet header extension being connected to said main outlet header, said inlet header extension being connected to said outlet header extension by a bank of tubes, a shell affixed to one side of said bank of tubes, face means located at each end of said bank of tubes, a space being formed between a pair of tubes in said bank, the shell covering one side of said bank and the face means at each end of the pair of tubes, means connected to said space for detecting a fluid leak into said space.

8. In combination, a fluid flow chamber, said chamber having an inlet end and an outlet end, a main inlet header extending into said chamber adjacent one end, an inlet header extension extending lengthwise in said chamber, said inlet header extensions being connected to said main inlet header, a main outlet header extending into said chamber adjacent one end, an outlet header extension extending lengthwise in said chamber, said outlet header extension being connected to said main outlet header, said inlet header extension being connected to said outlet header extension by a bank of tubes, a shell affixed to one side of said bank of tubes, face means located at each end of said bank of tubes, a space being formed between a pair of tubes in said bank, the shell covering one side of said bank and the face means at each end of the pair of tubes, means connected to said space for detecting a fluid leak into said space, metallic fibers being contained in said space to provide for fluid flow through said space and heat transfer across said space from the tubes to the shell.

9. In combination, a cylindrical fluid flow chamber having an inlet end and an outlet end, a main inlet header extending radially into said chamber adjacent one end thereof, a plurality of inlet header extensions lying in the radial plane including said inlet header and extending lengthwise of said chamber from the inlet end to the outlet end thereof, said inlet header extensions being connected to said inlet header at spaced points along the length thereof, a main outlet header extending radially into said chamber adjacent said one end thereof, a plurality of outlet header extensions lying in the radial plane including said outlet header and extending lengthwise of said chamber from the inlet to the outlet end thereof, said outlet header extensions being connected to said outlet header at spaced points along the length thereof, each inlet header extension having a plurality of inlet header extension adapters fixed along its length presenting a plurality of pipes extending along a line on each side of each inlet header extension, each outlet header extension having a plurality of outlet header extension adapters fixed along its length presenting a plurality of pipes extending along a line on each side of each outlet header extension, the pipes in a line on the same side of each inlet header extension being connected to the pipes in a line on the corresponding side of each outlet header extension by an arcuate bank of tubes.

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