

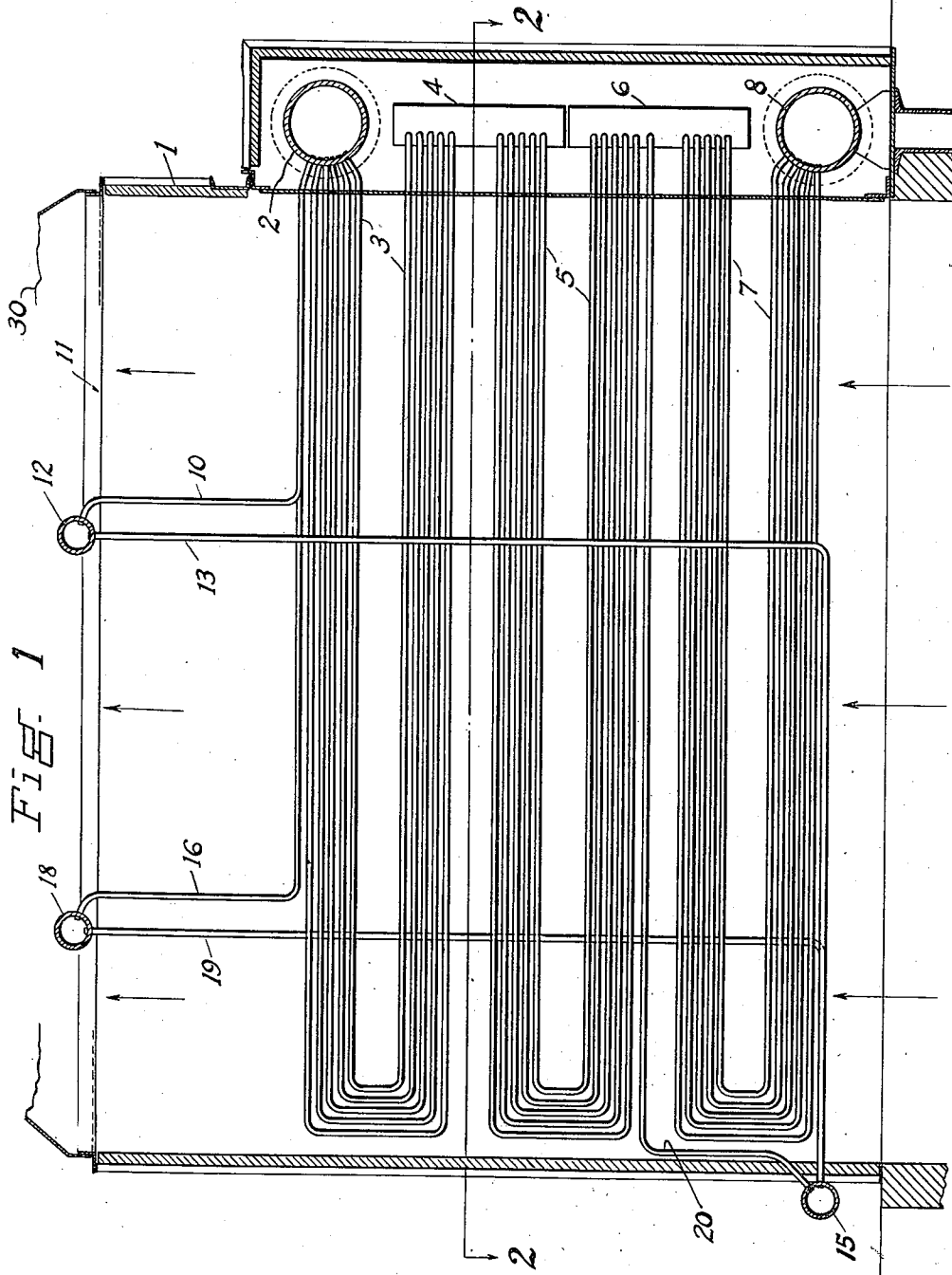
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2,033,077

TUBE SUPPORT

Original Filed April 16, 1931 5 Sheets-Sheet 1



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TUBE SUPPORT

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Fig. 2

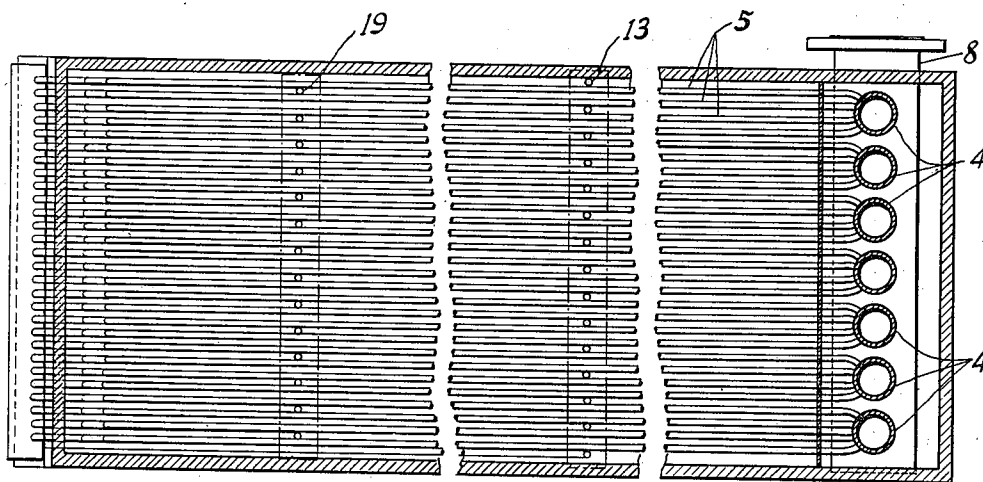
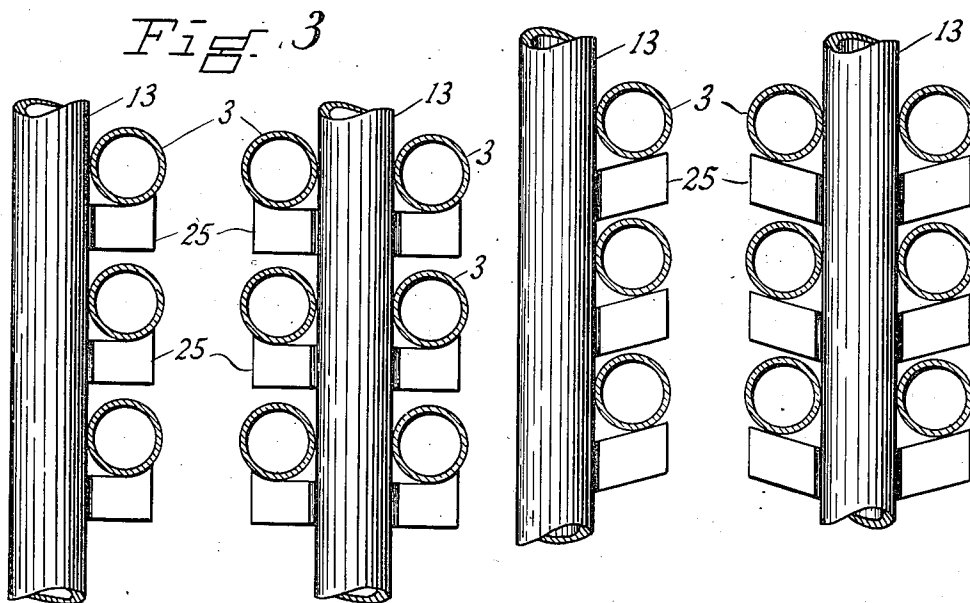


Fig. 4

Fig. 3



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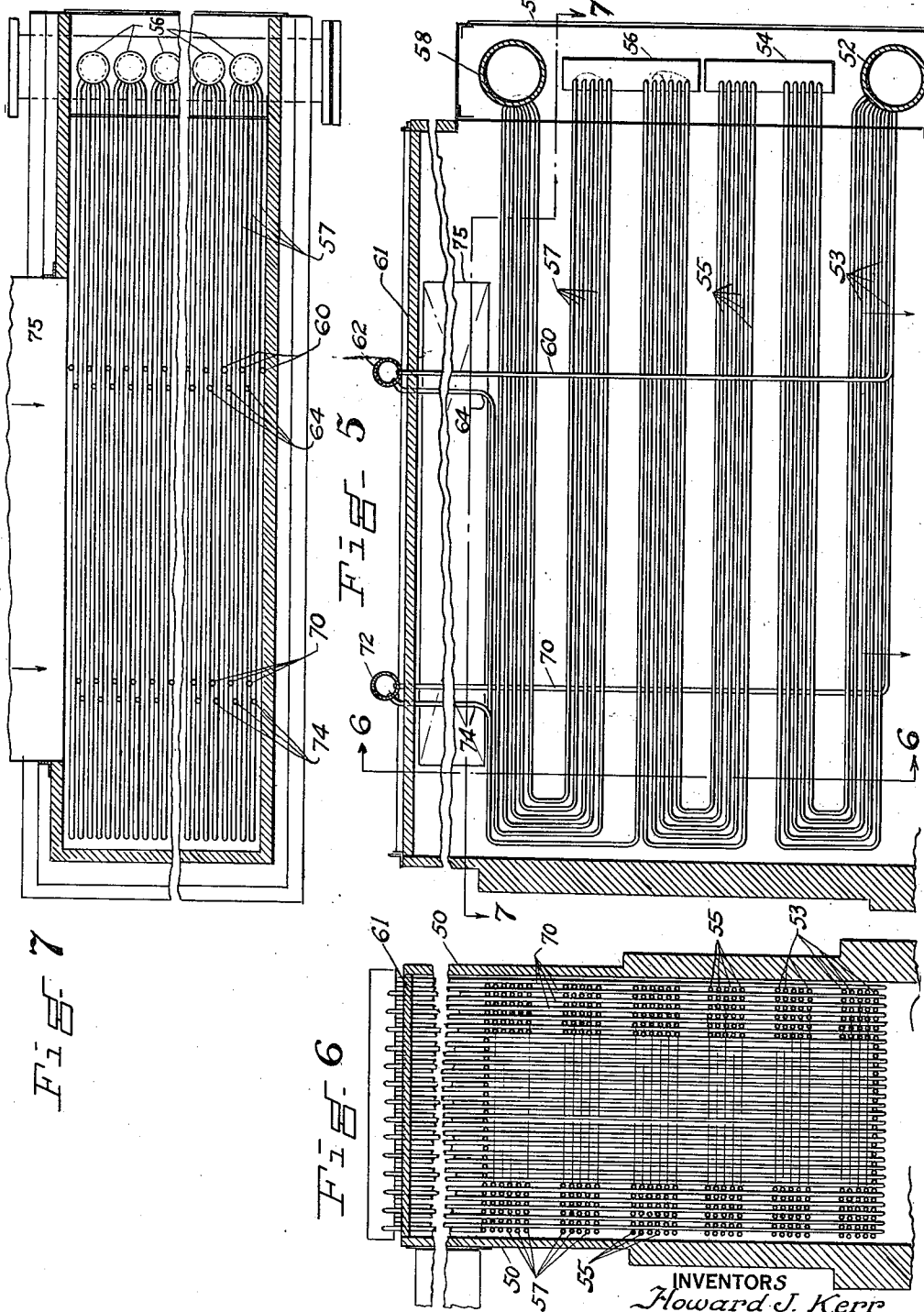
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TUBE SUPPORT

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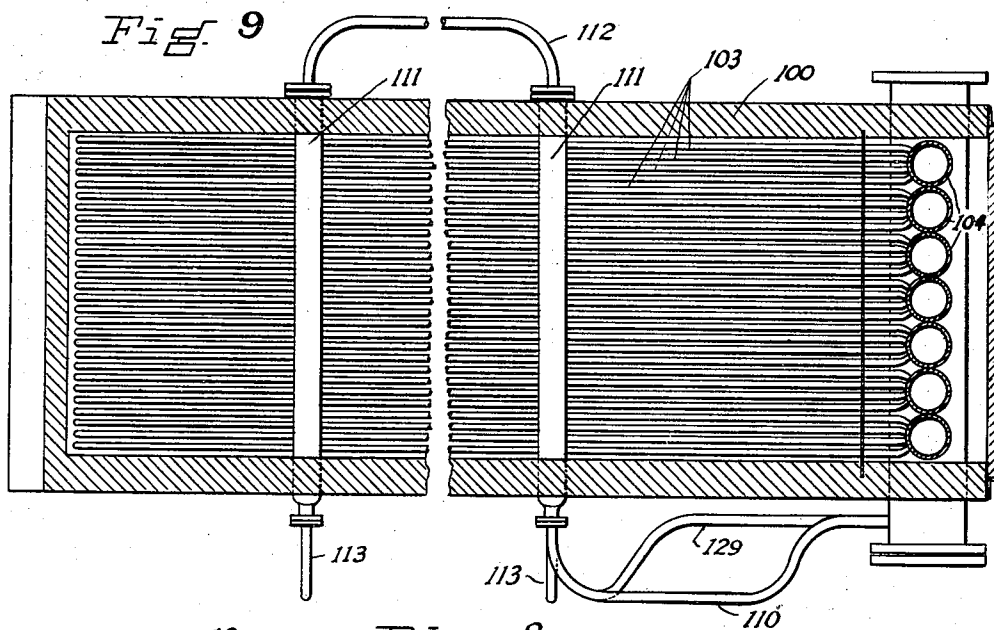
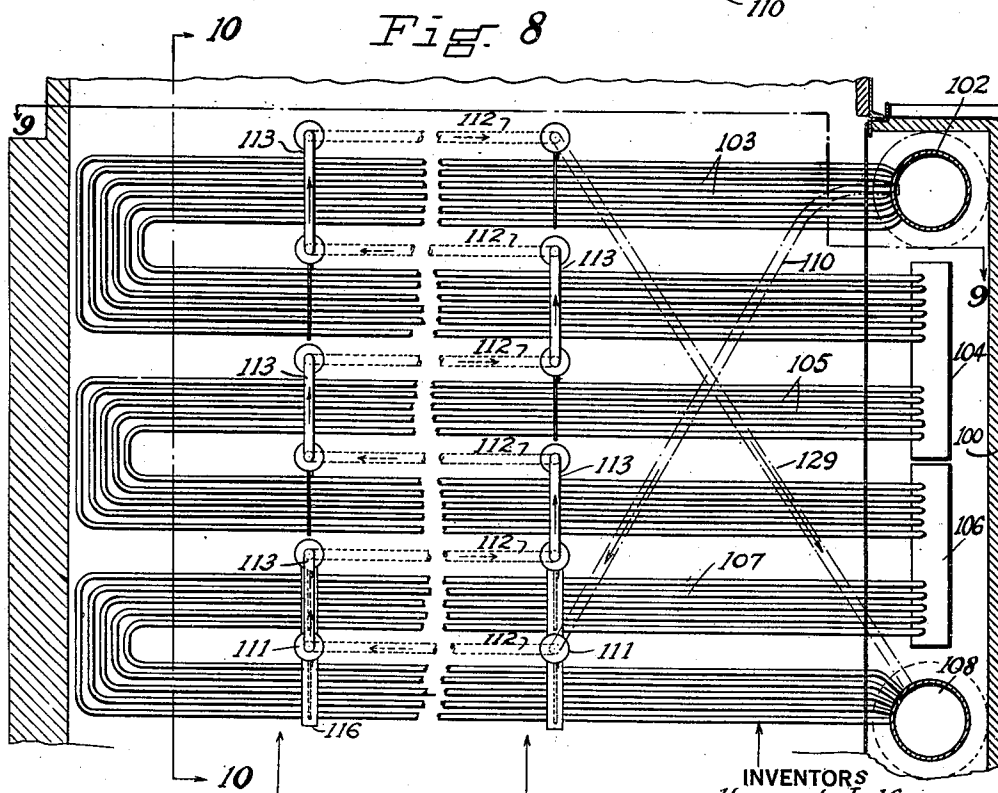
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TUBE SUPPORT

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Fig 10

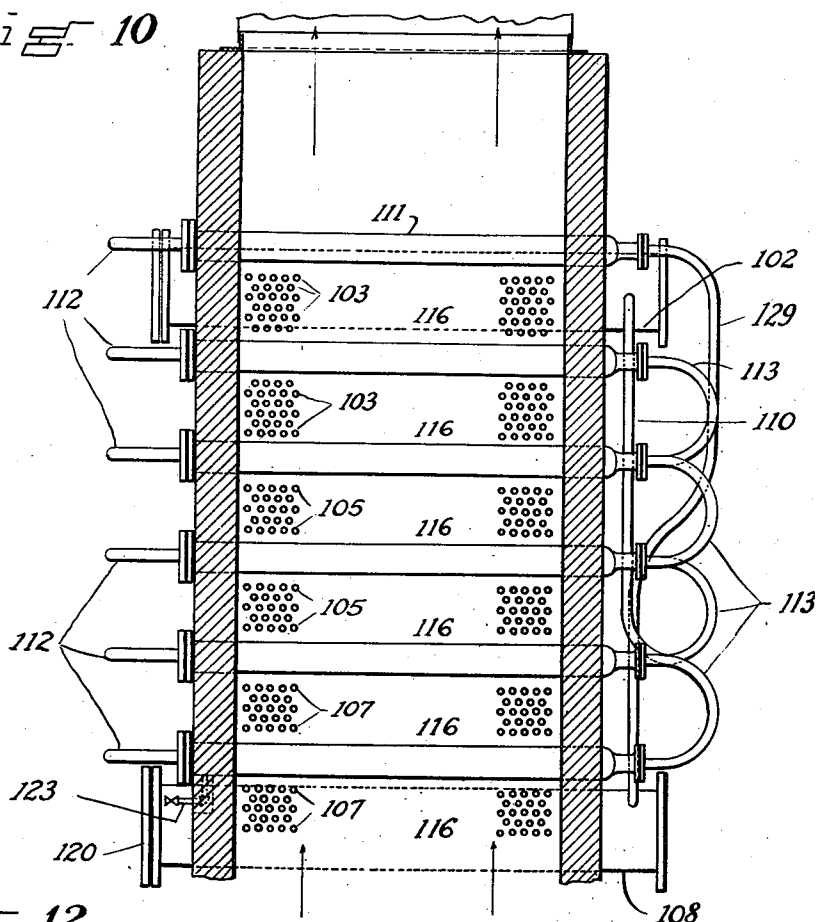


Fig 12

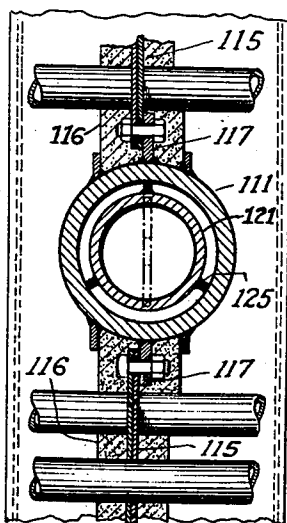
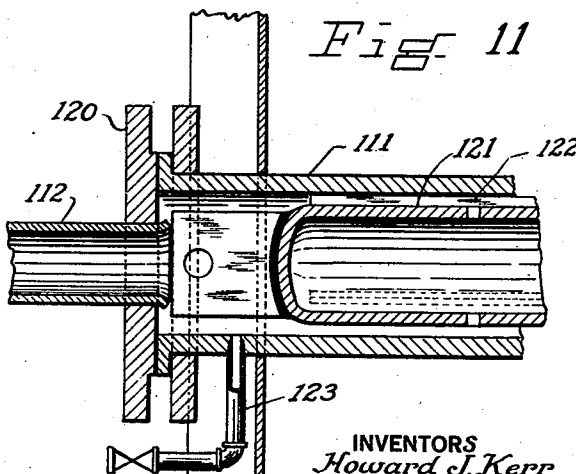


Fig 11



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TUBE SUPPORT

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20 Claims. (Cl. 257-240)

This invention relates to heat transfer devices, and more particularly to a heat transfer device in which groups of tubes of considerable length are supported within a casing in a region exposed to gases at such high temperatures that ordinary structural supports are unsuitable.

An object of the invention is to provide in a heat transfer device a support for elements exposed to gases at high temperatures, through which a heat absorbing medium is passed.

Another object of the invention is to provide in a tubular heat transfer device a group of fluid containing tubes which serve as a support for the other tubes making up the heat transfer elements of the device.

A further and more specific object of the invention is to provide in a tubular heat transfer device, characterized by a plurality of tubes of considerable length disposed interiorly of a casing, a group of tubes connected between headers associated with a second group of tubes forming a shorter path between the headers, the last named tubes serving as a support for the first named tubes.

Other objects will be apparent to those skilled in this particular art from the description in the specification in connection with the appended drawings in which—

Fig. 1 is a side view of a heat transfer device constituting an illustrative embodiment of the invention;

Fig. 2 is a fore-shortened plan view of the device taken along the line 2-2 of Fig. 1;

Figs. 3 and 4 illustrate modifications of structural details of the invention;

Fig. 5 is a fore-shortened side view of an illustrative modification of the invention;

Fig. 6 is a fore-shortened end view, in section, taken along the line 6-6 of Fig. 5;

Fig. 7 is a fore-shortened plan view, in section, taken along the line 7-7 of Fig. 5,

Fig. 8 is a fore-shortened side view of an illustrative modification of the invention;

Fig. 9 is a fore-shortened sectional plan view taken along the line 9-9 of Fig. 8;

Fig. 10 is an end view, in section, taken along the line 10-10 of Fig. 8;

Figs. 11 and 12 are enlarged structural details of the modification illustrated in Figs. 8, 9 and 10.

In the embodiments of the invention chosen for purposes of illustration is shown, in Fig. 1, a tubular heat transfer device enclosed within a casing 1. A group of tubes 3 is connected at the inlet end to an inlet header 2, extending across the interior of the casing in a long return bend loop,

and connected at the outlet end to the upper portion of a row of intermediate headers 4. A second group of tubes 5 extends across the interior of the casing, similar to the group 3 and is connected at the inlet end to the lower portion of the intermediate headers 4, and at the outlet end to the upper portion of a second row of intermediate headers 6. A third group of tubes 7 extends across the interior of the casing, similar to the other two groups, and is connected at the inlet end to the lower portion of the intermediate headers 6, and at the outlet end to an outlet header 8.

Alternate tubes of the uppermost row of group 3 are bent upward at a location where it is desirable to support the tubes, and extend in a vertical leg 10 connected to a header 12 suitably supported by roof beams 11. From the header 12 a row of tubes 13 extends vertically to the lowermost row of tubes 7, at which point they are bent at right angles and extend parallel and adjacent the tubes 7 to the ends of the loops thereof, where they are connected to a header 15. The other tubes forming the uppermost row of the group 3 are bent upward at another point, where it is desirable to support the tubes, in a vertical leg 16, connected to a header 18 suitably supported on the roof beams 11. Connected in header 18 and extending downward in a vertical leg 19 parallel to the leg 13 is another row of tubes similar to the tubes 13. Just beyond the lowermost row of the tubes 7, these tubes are bent at right angles and extend parallel and adjacent to the horizontal leg of the tubes 13, where they are connected to a header 15. A row of tubes 20 connects the header 15 with the lower intermediate headers 6, and completes the secondary flow path.

The tubes constituting the supporting members and their connections present a flow path, the cross-sectional area of which is equal to a single row of tubes of the main flow path. The vertical legs 13 and 19, forming the actual supports for the tubes of the several groups constituting the main flow path, extend alternately through the tubes, and lugs 25 on these vertical members engage and support each individual tube.

The fluid heated in its passage through these tube sections is mixed in the header 15 and is delivered to the intermediate headers 6, thoroughly mixed, where it is mixed with the fluid heated in the heat transfer sections 3 and 5. By virtue of this arrangement of parts and the mixing that takes place therein, the fluid delivered to the outlet header 8, is made up of fluid that has

been passed through two different sections of the heat transfer device but has been thoroughly mixed and is at an even temperature.

As best shown in Fig. 2, the vertical sections of the tubes 13 and 19 extend through the tube groups 3, 5 and 7. These tubes, as indicated in Fig. 3, have lugs 25 secured thereto, in good thermal contact therewith. These lugs are disposed below each of the several rows of the tube groups 3, 5 and 7, and individual tubes in these rows rest upon the lugs and are supported thereby. In connection with these supports, it is to be noted that the heat absorbing medium which flows through the main bank of tubular heat transfer elements 3, 5 and 7 is of the same character as that which flows through the tubes 13 and 19, so that, although the tube supporting members are located in a region of high temperature and are exposed to high temperature gases, by virtue of the heat absorbing fluid flowing in the tubes 13 and 19 the members making up the supporting structure will not be heated to destructively high temperatures.

The supporting details illustrated in Figs. 3 and 4 show forms of lugs secured to the supporting tubes, and their engagement with tubes making up one of the heat transfer groups. In Fig. 3 is illustrated a form of lug, the upper face of which is curved to conform with the curvature of the tube which rests upon it. These lugs 25 are illustrated in conjunction with the vertical tubes 13 supporting the tubes of the bank 3. The lugs 25, illustrated in Fig. 4, have straight faces and provide a line contact with the tubes of the bank 3 supported thereby. The tubes and lugs are otherwise similar to those illustrated in Fig. 3.

In the operation of this device, the fluid constituting the heat absorbing medium passed through the system, is admitted to the inlet header 2 and flows through the group of tubes 3 to a row of intermediate headers 4; from the intermediate headers 4, the fluid flows through the tubes 5 to a second row of intermediate headers 6, and from there flows through the group of tubes 7 to the outlet header 8. A portion of the fluid admitted to the inlet header 2 flows through the tubes 10 to the header 12, and from the header 12 through the tubes 13 to the header 15. Another portion of the fluid flows through the tubes 16, the header 18, and then through the tubes 19 to the header 15. The fluid admitted to the header 15 by the tubes 13 and 19 then flows through the tubes 20 to the intermediate header 6 and joins the fluid in the main flow path that flows through the group of tubes 7 to the outlet header 8.

The combustion gases constituting the heating element in the system are admitted to the bottom of the casing and pass successively across the tubes in the groups 7, 5, 3 and pass from the casing through the gas outlet 30, so that the fluid flowing through the tubes 3, 5, 7 flows in a direction generally countercurrent to the combustion gases.

It is to be noted in connection with the flow of the fluid through the tubes 10, 13 and the tubes 16, 19 and their common connector 20, that the paths are of shorter length than the paths between the headers 2 and 8 through tubes 5, 7, so that the resistance to the flow of fluid through the paths 10, 13 and 16, 19 is less than through the main circuit, and the velocity of the fluid flowing therethrough will be correspondingly greater, with an accompanying increase in

the rate of heat transfer. In view of this fact, the lugs 25, although contacted by combustion gases at high temperature, by virtue of their connection in good thermal contact with the tubes 13, 19 through which the heat absorbing medium is passed, will be prevented from reaching a destructively high temperature.

In the embodiment of the invention illustrated by Figs. 5, 6 and 7, a tubular heat transfer device, similar in character to the one described in connection with Figs. 1 and 2, is shown enclosed within a casing 50. In this embodiment of the invention, a group of tubes 53 is connected at the inlet end to an inlet header 52 which is disposed in the bottom of the casing. The outlet end of the tubes 53 is connected to the lower portion of an intermediate header 54. These tubes extend across the interior of the casing in a long return bend loop similar to the one shown and described in connection with Fig. 1. A second group of tubes 55 has its inlet end expanded in the upper portion of the intermediate header 54 and extends across the interior of the casing in a long return bend loop, and its outlet end is expanded in the lower portion of an intermediate header 56. A third group of tubes 57 extends across the interior of the casing in a long return bend loop, as described in connection with the other groups, and has its inlet end expanded in the upper portion of headers 56 and its outlet end connected to the outlet header 58. These banks of tubes in connection with their headers constitute the main flow path of the device.

Alternate tubes of the lowermost row of the group 53 extend across the casing for a suitable distance, at which point they are bent upward between alternate pairs of adjacent tubes of the groups 53, 55, 57, to form a vertical leg 60 which extends through the roof 61 of the casing 50 and is connected to a header 62. A row of tubes 64 is connected at one end in the header 62 and extends along the uppermost row of the tube bank 57 to the end thereof, where it is bent downward to the uppermost row of the tube bank 55 along which it runs, forming a part thereof, to be connected to the intermediate headers 56 joining the main flow system. The other tubes of the lower row of the group 53 extend therealong a suitable distance beyond the tubes forming the vertical leg 60, at which point they are bent upward to form a vertical leg 70 extending through the tube banks 53, 55, 57 spaced apart longitudinally from the tubes forming the leg 60. The tubes 70 extend through the roof of the casing 61 and are connected to a header 72. A group of tubes 74 is also connected to the header 72, and these tubes extend downward through the casing to the top row of the bank of tubes 57 where they are bent at right angles and extend along adjacent and alternate the tubes 64, 60 and are connected to the headers 56.

The vertical tubes 60 and 70 have lugs welded thereto, in good thermal contact therewith, as shown in the detail Fig. 3. These tubes extend between alternate tubes of the tube banks 53, 55, 57, as shown in Figs. 6 and 7, and the lugs thereon engage the lower portion of adjacent tubes in these banks and serve as a support therefor.

In the operation of this device, the heat absorbing medium passed through this system is admitted to the header 52 and flows through the group of tubes 53 to an intermediate header 54; from there it flows through the group of tubes 55 to a second intermediate header 56, and thence through the tubes 57 to the outlet header 58. A

portion of this heat absorbing fluid, however, flows through the tubes 60, 70, respectively, to headers 62, 72, and thence through the tubes 64, 74 to the second intermediate header 56 where it joins the heat absorbing fluid passed through the main flow path.

In this modification of the invention, the combustion gases constituting the heating element in the device are admitted to the casing at the top thereof, through the gas inlet 75, and flow successively down and across the tubes 57, 55, 53, after which they pass from the casing through a suitable gas outlet (not shown). The heat absorbing fluid flowing through the tubes 60, 70 meets with less resistance than the fluid flowing in the main flow path, as the secondary path is shorter. By virtue of this path of comparatively low resistance, the fluid flowing through these tubes flows at a greater velocity with a correspondingly higher rate of heat transfer advantage, so that the lugs attached to the tubes 60, 70, as shown in Figs. 3 and 4, despite the fact that they are contacted by combustion gases at high temperature, do not themselves reach a destructively high temperature as they are kept cool by the flow of the heat absorbing medium through the tubes 60, 70 to which they are attached.

In the embodiment of the invention illustrated in Figs. 8, 9 and 10, in Fig. 8 is shown a side view of a heat transfer device located within a casing 100. In this embodiment of the invention, a group of tubes 103 is connected to an inlet header 102 at the inlet end; this group of tubes extends across the casing in a long return bend loop and is connected at the outlet end to the upper portion of a row of intermediate headers 104. A second group of tubes 105 extends across the interior of the casing, similar to the group 103, and is connected at the inlet end to the lower portion of the intermediate header 104 and at the outlet end to the upper portion of a second row of intermediate headers 106. A third group of tubes 107 extends across the interior of the casing, similar to the other two groups, and is connected at the inlet end to the lower portion of the intermediate headers 106 and at the outlet end to the outlet headers 108, completing the primary flow path. Also connected to the inlet header 102 is a tube 110 which extends outside of the casing to a header 111 having its ends supported by the casing walls. This header is connected successively by a series of horizontal connections 112 and vertical connections 113 to a series of similar headers, spaced apart at locations where support of tubes is necessary, with a pair of headers extending across the upper portion of each leg of the several tube loops.

Attached to each header by means of a rib member 117 welded thereto, in good thermal contact therewith, is a metallic plate supporting member 115. Each support 115 extends downward through one leg group of the group of tubes 103, 105, 107 and serves as a support for the tubes in the leg through which it extends. Each support is covered with refractory covering 116, and the lower portion thereof, in all except the lowermost member, may be secured to the header 111 disposed below it by means of a second rib member 117 welded to the upper portion of that header.

Figs. 11 and 12 show enlarged views of one of the lowermost headers 111. In Fig. 11 is shown a connector 112 connected by means of a flange 120 to the header 111. The interior of the header contains a displacer 121 concentric therewith, leaving an annular space 122 between the outside surface of the displacer and the inside surface of the header

through which the fluid admitted by the connector 112 passes. As shown in Fig. 12, the displacer 121 is held in place by three spacer members 125, disposed 120° apart, which leaves an adequate annular space through which the fluid may pass.

In the operation of this device, a portion of the fluid admitted to the inlet header 102 passes through the tubes 103 to the intermediate header 104 from where it passes through the tubes 105 to the second intermediate header 106 and then passes through the tubes 107 to the outlet header 108. Combustion gases pass successively across the tubes 107, 105, 103, so that the fluid admitted to the system passes through the tubes in a generally counterflow direction to the combustion gases. A portion of the fluid admitted to the inlet header 102, instead of flowing through the tube banks just enumerated, flows through the connector 110 to the lowermost header 111; from there the fluid flows through the annular space therein, as shown in Figs. 11 and 12, to the other side thereof and through the horizontal connector 112 to the second header 111, and after flowing through this header the fluid flows upward successively through the vertical connector 113, through another header to the horizontal connector 112, and so on, to the uppermost header 111, from where it goes to the outlet header 108 through the connector 129. This passage of the fluid is indicated by arrows through the enumerated connectors and headers in Fig. 8.

The headers 111 to which the supporting members 115 are secured, must necessarily be of substantial size in order to withstand the weight of the tubes which they ultimately support. The displacer 121 is therefore placed within this header to increase the velocity of the fluid passing therethrough, and hence increase the heat transfer effectiveness of that heat absorbing medium. The transfer of heat from the header 111 to the fluid contained therein is therefore high, so that the metallic supporting member 115, which is in good thermal contact therewith, although exposed to the heat of combustion gases at comparatively high temperature, is kept within safe temperature limits.

As an additional safety feature, the direction of flow of the fluid through these headers 111 is generally parallel to the gases of combustion, so that the supports exposed to combustion gases at the highest temperature are secured to headers through which the heat absorbing medium at the lowest temperature is passed.

This invention, certain embodiments of which have been specifically described, provides heat transfer devices in which tubes containing a heat absorbing medium are supported by members contacted by gases at high temperature through which the same heat absorbing medium is passed as through the tubes constituting the main flow path of the device. The supporting members present a path of less flow resistance to the heat absorbing medium than the tubes of the main flow path, so that the fluid flows therethrough with increased velocity, to the betterment of the rate of heat transfer. The supporting structure, although contacted by gases at high temperature, is kept below a destructively high temperature and presents additional heat transfer surfaces.

Specific illustrative embodiments of the invention have been described in some detail, but it is understood that changes, substitutions, additions and omissions may be made within the spirit of the invention as defined by the appended claims.

What we claim is:

1. In a heat transfer device, a casing, a group of fluid containing tubes formed into a series of horizontal return bend loops located within said casing, a second group of tubes having vertically disposed sections between the tubes of the first named group and with lugs thereon engaging the tubes of the first named group.
2. In a heat transfer device, a casing, a group of fluid containing tubes located interiorly of the casing and supported by members disposed at right angles thereacross by means of metallic members in good thermal contact therewith, and fluid connections to said supporting members and tubes providing a flow in parallel of the same fluid through the tubes and supporting members.
3. In a heat transfer device, a pair of headers, a tubular fluid conduit element having its end portions connected to said headers and having substantially horizontal superposed portions exposed in operation to a high temperature heating medium, and a second tubular fluid conduit element connected to one of said headers and having a substantially vertical portion adjacent the superposed portions of said first mentioned element and having a supporting connection with each of said superposed portions.
4. In a heat transfer device, a pair of headers, a tubular fluid conduit element having its end portions connected to said headers and having horizontally arranged superposed portions exposed in operation to a high temperature heating medium, a second tubular fluid conduit element connected to one of said headers and having a substantially vertical portion adjacent the superposed portions of said first mentioned element and having a supporting connection with each of said superposed portions and means for supporting said second mentioned element at a level above the level of the horizontal portions of said first mentioned element.
5. In a heat transfer device, a pair of headers, a tubular fluid conduit element having its end portions connected to said headers and having horizontally arranged superposed portions exposed in operation to a high temperature heating medium, a second tubular fluid conduit element exposed in operation to said high temperature heating medium and having a substantially vertical portion adjacent to and intermediate the length of the superposed portions of said first mentioned element and having a supporting connection with said first mentioned element at vertically spaced points and means for supporting said second mentioned element at a level above the level of the horizontal portions of said first mentioned element.
6. In a heat transfer device, inlet and outlet headers, a tubular fluid conduit element having its end portions connected to said headers and having horizontally arranged intermediate looped portions exposed in operation to a high temperature heating medium, a second tubular fluid conduit element connected to said headers and having horizontal portions adjacent the horizontal portions of said first mentioned element, vertical plates secured to the horizontal portions of said second mentioned element and engaging the horizontal portions of said first mentioned element, a displacement body in the horizontal portions of said second mentioned element and arranged to increase the fluid velocity therethrough, and means for supporting said second mentioned element.
7. In a heat transfer device, a group of parallel looped tubular fluid conduit elements having vertically spaced horizontally arranged portions exposed in operation to a high temperature heating medium, a tubular fluid conduit element having a horizontal tube supporting portion extending transversely of and intermediate the horizontal portions of said group of elements, vertical plates secured to the upper and lower sides of said horizontal portion of said second element and respectively supporting the vertically spaced horizontal portions of said group of elements, and means for supporting said second element.
8. In a heat transfer device, a pair of inlet and outlet headers, an intermediate header positioned between said inlet and outlet headers, a tubular fluid conduit element having its ends connected to said inlet and intermediate headers and having horizontally arranged intermediate portions exposed in operation to a high temperature heating medium, a second tubular fluid conduit element having its ends connected to said intermediate and outlet headers and having horizontally arranged intermediate portions exposed to said high temperature heating medium, a third tubular fluid conduit element having its ends connected to said inlet and intermediate headers and having a substantially vertical portion in supporting engagement with the intermediate portions of said first and second conduit elements, and means for supporting the vertical portion of said third element.
9. In a heat transfer device, a bank of tubular fluid conduit elements having vertically spaced horizontally arranged portions exposed in operation to a high temperature heating medium, one of said conduit elements having a vertical portion extending transversely of the horizontal portions of an adjacent element and supporting the same, and means for supporting the vertical portion of said supporting conduit element.
10. In a heat transfer device, a plurality of vertically spaced rows of tubular fluid conduit elements having horizontally arranged portions exposed in operation to a high temperature heating medium, tubular elements in one of said rows having vertical portions extending transversely of the horizontal portions of elements in the remaining rows and supporting the same, and means for supporting the vertical portions of said supporting elements.
11. Fluid heating apparatus comprising a horizontally extending return bend tube having its looped portion arranged in a vertical plane, a fluid cooled support for said tube comprising a vertically extending supporting tube positioned alongside said return bend tube and extending past successive horizontal portions of said tube, and means for supporting said horizontal tube portions at vertically spaced points along said supporting tube.
12. Fluid heating apparatus comprising a group of horizontally extending return bend tubes having their looped portions arranged in vertical planes, fluid cooled supports for said tubes comprising suspended vertically extending supporting tubes positioned between adjacent tubes of said group and extending past successive horizontal portions of each of said group tubes, and means for supporting said horizontal tube portions at vertically spaced points along said supporting tubes.
13. Fluid heating apparatus comprising in combination a main set of tubes arranged for a fluid flow in parallel therethrough, some of said

tubes extending transversely across the remaining tubes, and supporting means carried by said transversely extending tubes and directly engaging other tubes to effect their support.

5 14. Fluid heating apparatus comprising in combination a main set of return bend tubes arranged for a fluid flow in parallel therethrough, some of said tubes extending transversely across the remaining tubes, and supporting means carried
10 by said transversely extending tubes at vertically spaced points and directly engaging the under sides of other tubes to effect their support.

15 15. Fluid heating apparatus comprising a header, a row of horizontally extending return bend tubes connected to said header and having their looped portions arranged in vertical planes, other tubes connected to said header and arranged to extend vertically past successive horizontal portions of said return bend tubes, and means for
20 supporting said horizontal tube portions at vertically spaced points along said vertically extending tubes.

16. Fluid heating apparatus comprising a header, nested rows of horizontally extending return
25 bend tubes connected to said header and having their looped portions arranged in vertical planes, other tubes connected to said header and bent to extend vertically past successive horizontal portions of the return bend tubes in said nested rows, and means for supporting said horizontal
30 tube portions at vertically spaced points along said bent tubes.

17. A fluid heater comprising heat transfer surface including vertically spaced horizontally
35 extending tube portions and other tube portions extending vertically across the horizontally extending tube portions, means for passing the same heat absorbing fluid through all of said tube portions, and means at vertically spaced points

on said vertically extending tube portions for supporting said horizontally extending tube portions.

18. In a heat transfer device, a pair of headers, a tubular fluid conduit element having its end
5 portions connected to said headers and having horizontally arranged superposed portions exposed in operation to a high temperature heating medium, a second tubular fluid conduit element connected to at least one of said headers
10 and having a substantially vertical portion adjacent the superposed portions of said first mentioned element and having a supporting connection with each of said superposed portions.

19. A fluid heater comprising a header, a group
15 of horizontally extending return bend tubes connected to said header, a second header extending transversely of said return bend tubes adjacent the return bend ends thereof, conduit means connecting said second header to said first header,
20 and a hanger member suspended from said second header and in supporting engagement with said return bend tubes adjacent the return bend ends thereof.

20. A fluid heater comprising a casing, a pair
25 of headers, a group of horizontally extending return bend tubes within said casing and having their opposite ends connected to said headers, a third header having its ends supported by said casing and extending transversely of said tubes
30 above and adjacent the return bend ends thereof, conduit means separately connecting said third header to at least one of said first mentioned headers, and a hanger plate suspended from said
35 third header and in supporting engagement with said return bend tubes adjacent the return bend ends thereof.

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