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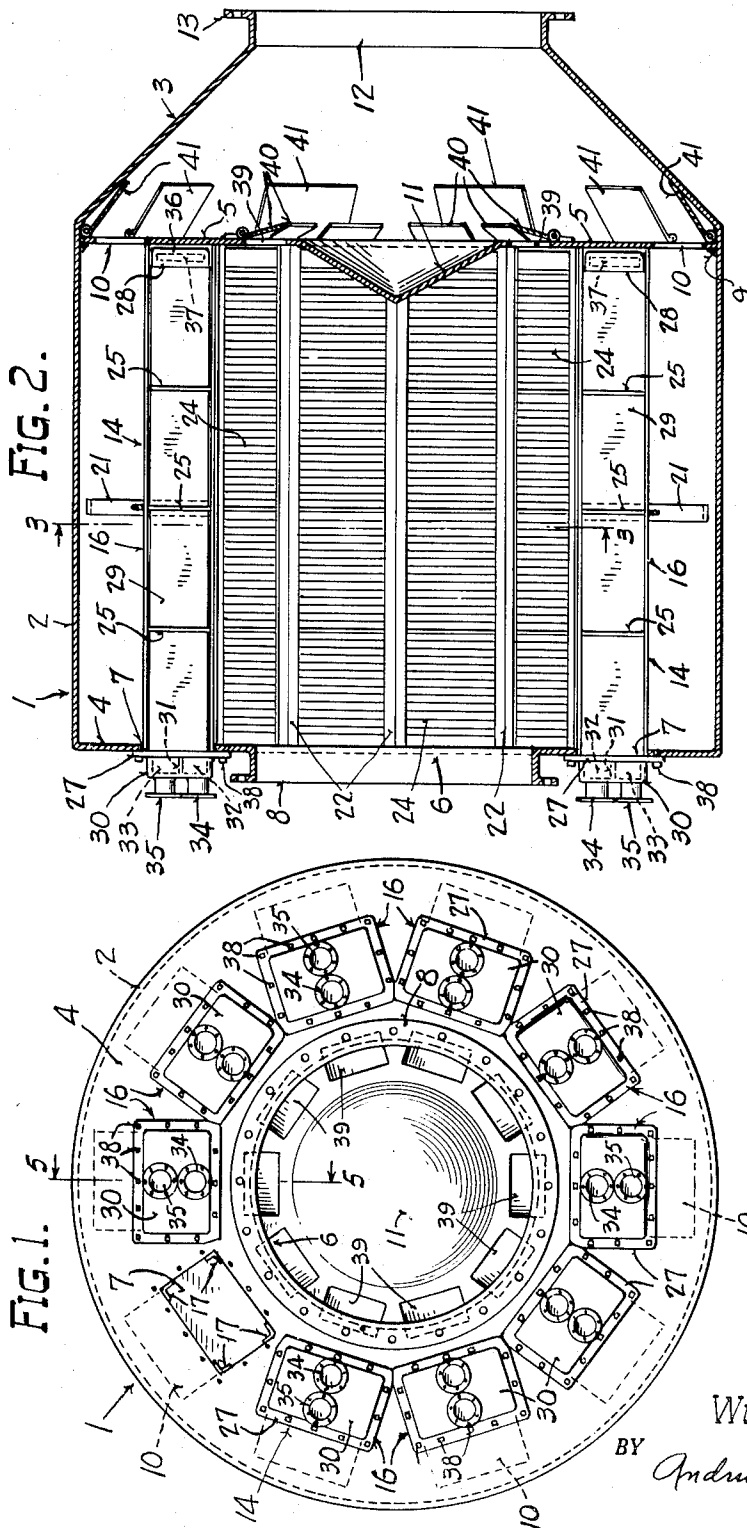
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HEAT EXCHANGER WITH REMOVABLE TUBE BANKS

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3 Sheets-Sheet 1



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FIG. 3.

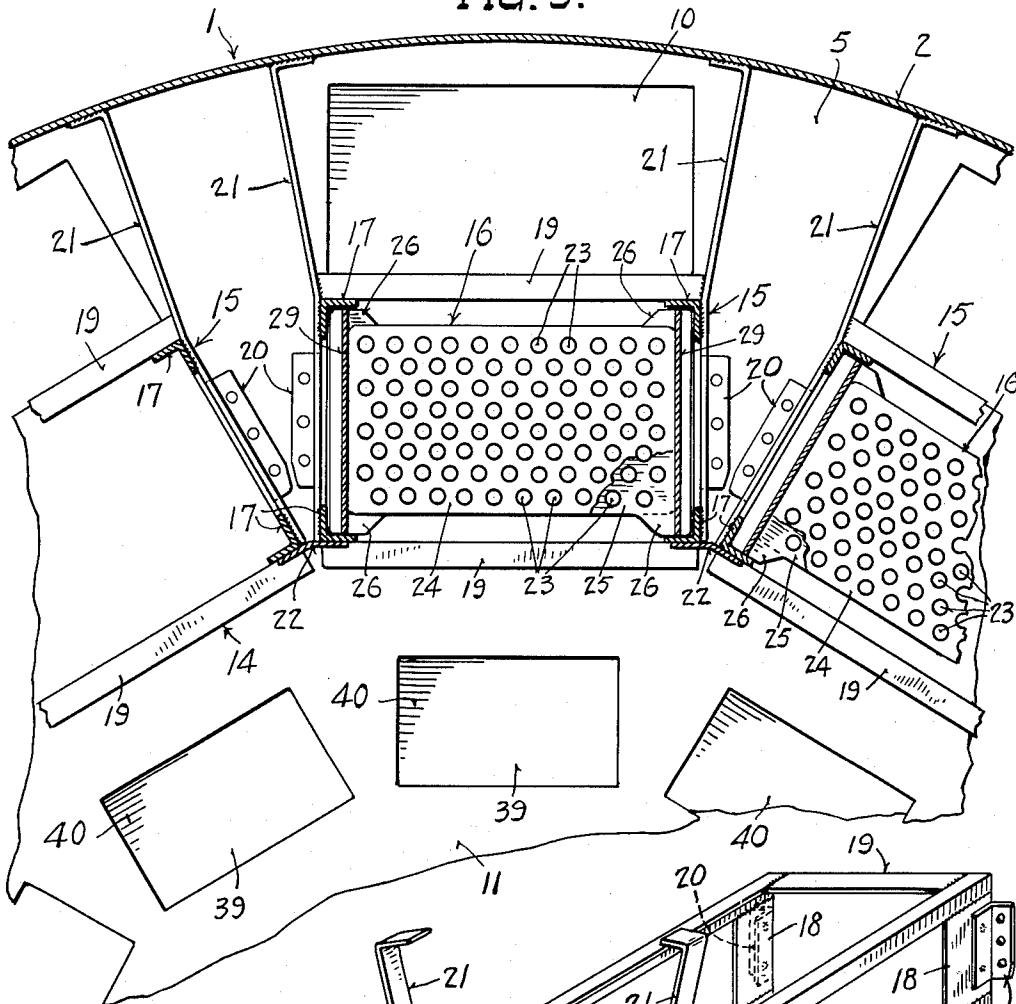
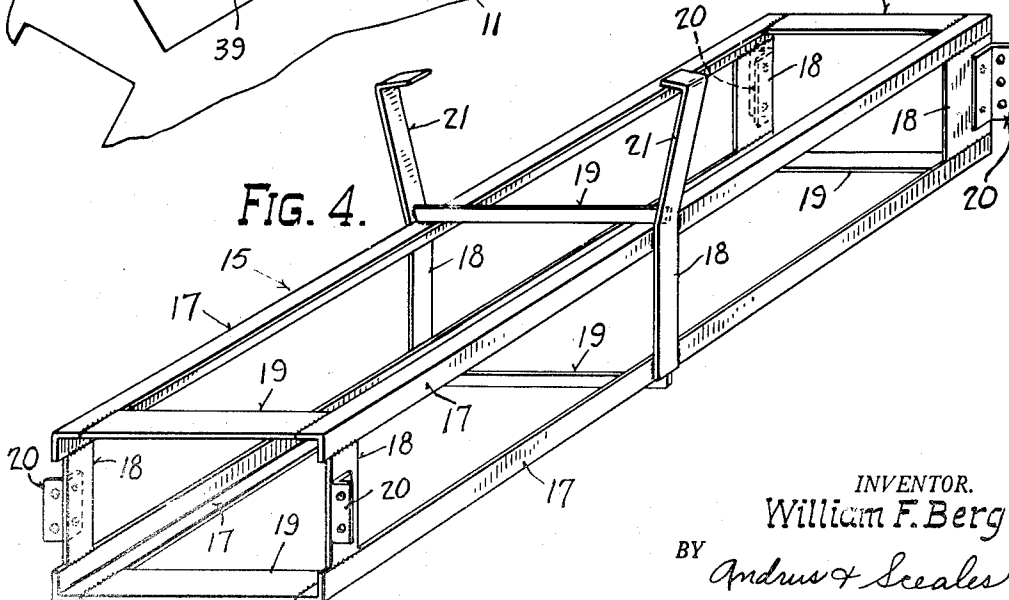


FIG. 4.



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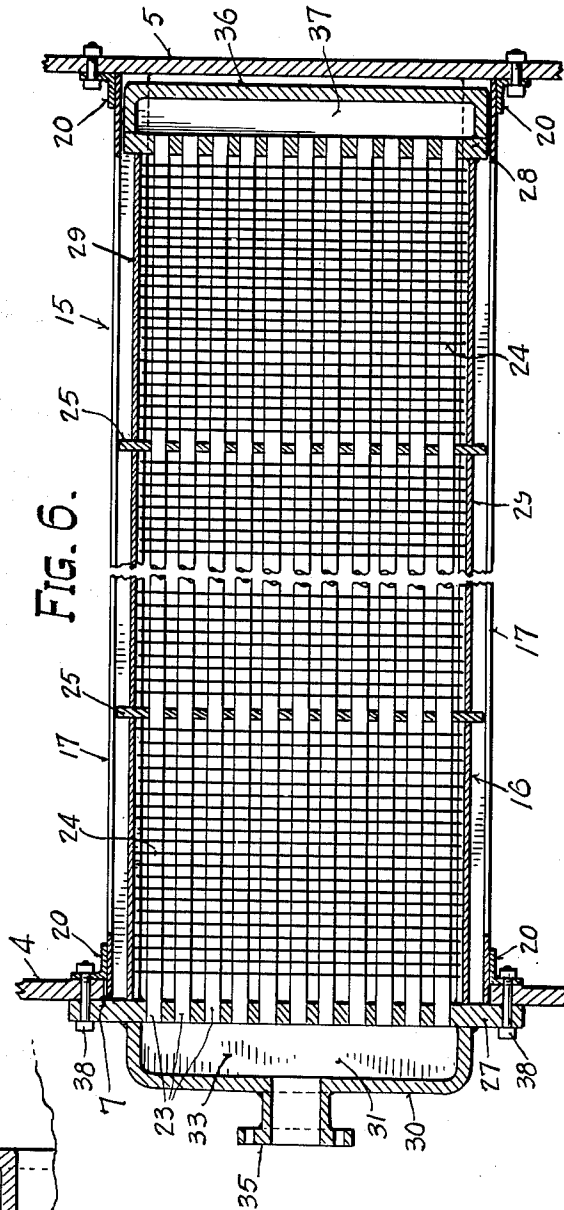
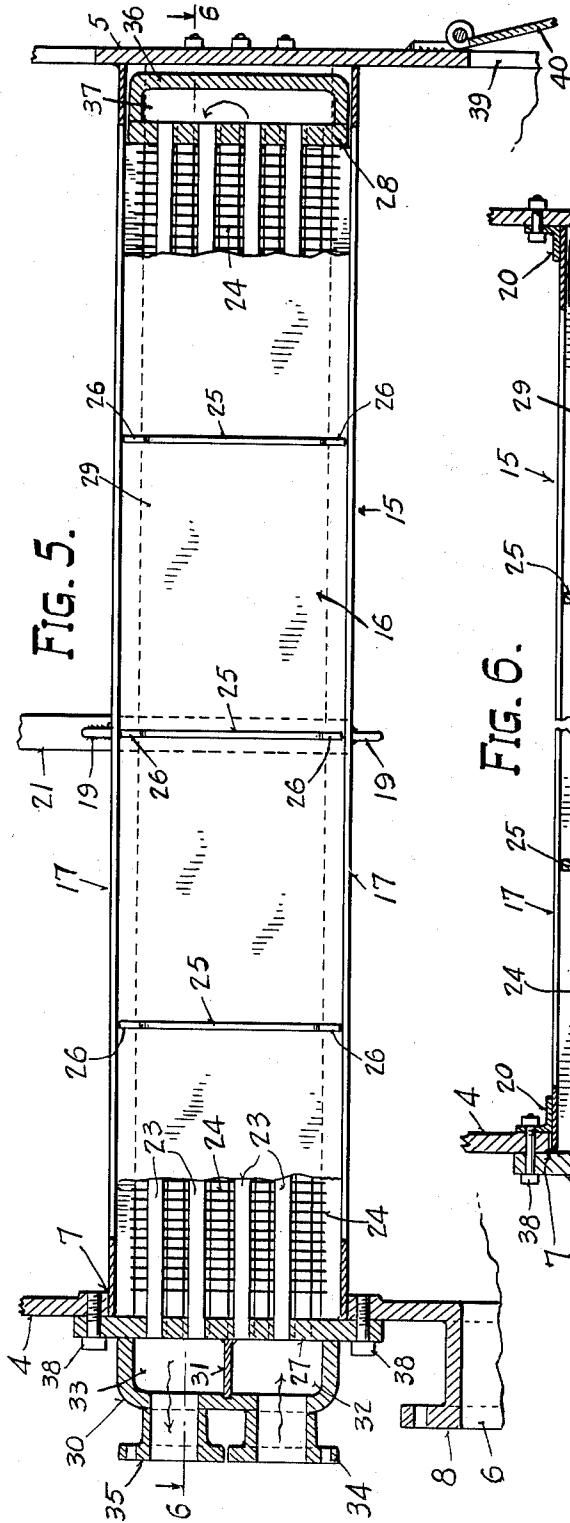
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3 Sheets-Sheet 3



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HEAT EXCHANGER WITH REMOVABLE TUBE BANKS

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3 Claims. (Cl. 257—241)

This invention relates to heat exchangers and more particularly to an air cooler having a plurality of heat transfer core sections which are arranged in the form of an annular bank or ring within the cooler.

An object of the present invention is to provide a heat exchanger wherein the heat transfer surfaces are in the form of a plurality of circularly disposed longitudinal tube units and the fluid to be heated or cooled is directed radially through the units.

Another object is to provide a heat exchanger having a large face area for a given cross sectional area of the heat exchanger.

Another object is to provide a gas to liquid heat exchanger which will effectively cool a large mass of gas without producing an appreciable pressure drop in the gas being cooled.

Another object is to provide a heat exchanging apparatus wherein the temperature of the air being discharged from the apparatus may be conveniently controlled.

Still another object is to provide a heat exchanging apparatus having a plurality of independent heat transfer core sections which are removably secured to the exterior of the apparatus and may be readily withdrawn from the cooler for repair or cleaning.

A further object is to provide a simple and effective means of attaching a plurality of heat transfer core sections in the pattern of an annular bank within a heat exchanger.

Another object is to provide heat transfer sections in a heat exchanger wherein all of the fittings for connections are disposed outside the shell of the unit for ready assembly and disassembly.

The present invention is directed to a barrel-shaped air cooler which comprises a generally cylindrical shell having suitable openings in opposite ends thereof for the entry and discharge of a fluid such as air. The heat exchanging surface takes the form of an annular bank or ring which comprises a plurality of independent longitudinally disposed heat transfer core sections and is inwardly spaced from the shell about the air inlet. An end plate closes off the rear end of the heat transfer chamber and prevents the longitudinal passage of air therethrough. The air enters the hollow interior of the annular bank through the inlet in the shell and is directed radially outwardly through the bank of core sections and is cooled as it passes therethrough. After cooling, the air passes longitudinally in the annular space between the heat transfer bank and the shell, and then inwardly around the rear of the annular bank to the discharge outlet in the shell.

By providing the end plate with adjustable valves or flaps, a portion of the entering air may be by-passed directly through the hollow interior of the annular bank without passing radially through the heat exchanging core sections, and by varying the amount of by-passed air the temperature of the discharged air can be readily controlled.

It is desirable for an air cooler to have a large face area per mass of air passing therethrough so as to keep

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the pressure drop of air passing through the cooler to a minimum. Ordinarily an increase in face area is accomplished by increasing the cross sectional area or diameter of the cooler and this increased cooler size is frequently objectionable for installation and economic reasons.

By providing the heat transfer surfaces in the form of an annular bank a greater heat transfer face area may be obtained for a given diameter shell than in an air cooler wherein the air passes straight through a heat transfer surface disposed in a plane normal to the general flow of air or through a herringbone type cooler. Additional face area can be attained in the present barrel-type cooler without enlarging the diameter of the shell by merely increasing the length of the heat transfer core sections.

Other objects and advantages will appear in the course of the following description.

In the drawings:

Figure 1 is a front elevational view of the heat exchanger;

Fig. 2 is a central vertical section of the heat exchanger;

Fig. 3 is a fragmentary transverse section taken along line 3—3 of Fig. 2 showing the disposition of core sections within the annular bank;

Fig. 4 is a perspective of one of the frames of the annular heat transfer bank;

Fig. 5 is a longitudinal section taken along line 5—5 of Figure 1 with a portion of the core section being shown in side elevation, and;

Fig. 6 is a longitudinal section taken along line 6—6 of Fig. 5 showing the structure of the core sections.

Referring to the drawings there is shown a fluid type heat exchanger having a hollow external casing or shell 1 which includes a generally cylindrical body section 2 and a generally conical end cap 3.

A pair of generally circular spider plates 4 and 5 are longitudinally spaced and secured edgewise by welding or the like to the inner surface of body section 2.

Front spider plate 4 is provided with an axial opening 6 through which a fluid to be heated or cooled, such as air, is admitted into the shell 1. Plate 4 is also provided with a plurality of circumferentially spaced generally rectangular flanged openings 7 which are spaced inwardly from the circumference of plate 4 and arranged about axial opening 6.

A flanged pipe connection 8 is welded within axial opening 6 and provides a means for attaching an air inlet pipe, not shown, to the heat exchanger.

The rear spider plate 5 is secured to the rear end of section 2 by a weld 9 and has a plurality of rectangular circumferentially spaced openings 10 adjacent its peripheral edge. The plate 5 is formed with a central conical portion 11 directed toward the inlet opening 6 to aid in deflecting the incoming air radially outward through the tube units as will be described.

End cap 3 is provided with an outlet opening 12 for the discharge of cooled air. A flanged pipe connection 13 is secured to cap 3 around opening 12 and provides a means for attaching an air discharge conduit, not shown, to cap 3.

A polygonal annular heat exchanging ring or bank 14 is disposed within shell 1 and spaced radially inward therefrom. The hollow interior of the bank 14 registers with the axial opening 6 in the spider plate 4. The heat exchanging bank 14 comprises, in general, a plurality of generally rectangular longitudinally disposed frames 15 which are secured in the form of a polygonal annulus or ring between spider plates 4 and 5 and register with openings 7 in plate 4, and a plurality of heat transfer core sections 16 which are inserted within shell 1 through openings 7 and are supported by the respective frames 15.

As shown in Fig. 4 each of the frames 15 includes four

longitudinal angle iron guide bars 17, disposed to define a rectangular frame, and which are connected at their ends and central portions by a plurality of side plates 18 and cross ties 19 to provide a rigid integral structure.

Frames 15 are aligned behind the corresponding openings 7 in plate 4, and the side plates 18 at the ends of each frame are attached to the respective plates 4 and 5 by angle brackets 20.

To further secure frames 15, a pair of radial braces 21 extend outwardly from the central portion of each frame and are welded to the inner surface of shell 1.

A plurality of longitudinal sealing strips 22 are secured between the inner guide bars 17 of adjacent frames 15 to seal off the space between frames to the passage of air.

The core sections 16 of heat transfer bank 14 which are supported by frames 15 include a cluster or bundle of longitudinally disposed tubes 23 within which a heating or cooling fluid, depending on the operation, is adapted to circulate. Tubes 23 may be constructed of any material which has generally high thermal conductivity properties and which is able to withstand attack from the particular fluids employed in the heat exchanger.

To increase the effective heat transfer area of core sections 16 of a plurality of longitudinally spaced transverse fins 24 are secured to tubes 23. Fins 24 may be constructed of any material having a high heat conductivity and which may be readily attached to tubes 23.

To support the tubes 23 over their length each core section 16 is provided with a plurality of transverse support plates 25. Plates 25 are formed with a plurality of suitable circular openings which receive tubes 23. The corner extremities of each plate 25 are provided with projection or legs 26 which are adapted to engage the respective guide bars 17 of frame 15 so that the core section 16 may slide easily into position within frame 15.

The tubes 23 are secured at the front and rear end of core section 16 to a front tube plate 27 and a rear tube plate 28 respectively. Plates 27 and 28 are generally rectangular in shape and provided with a plurality of suitable openings within which the respective ends of tubes 23 are secured, by either welding, brazing, soldering or the like, depending on the metals employed.

Plates 27 are of greater size than the respective rectangular openings 7 in plate 4 so that the outer periphery of plates 27 will bear against plate 4 when core sections 16 are inserted into the annular heat transfer bank 14 through the openings 7.

The sides of each core section 16 are enclosed by a plurality of side plates 29 which are secured by welding to the respective tube plates 27 and 28 and to the support plates 25. Side plates 29 serve to seal off the space between core sections 16 to the passage of air and direct the air radially outward through the sections 16. It may be desirable to provide plates 29 with suitable expansion joints, not shown, to compensate for expansions of the plates 29 during operation of the heat exchanger.

A generally rectangular header box 30 is secured by welding to the outer face of front tube plate 27 and serves to distribute the cooling liquid or water to and from tubes 23. A rib 31 divides header box 30 into two chambers, an inlet chamber 32 and an outlet chamber 33. The tubes 23 in the inner half of the bundle register with inlet chamber 32 while the tubes in the outer half of the bundle register with outlet chamber 33. A fitting 34 is secured within a suitable opening in the outer face of header box 30 and establishes communication between chamber 32 and a suitable source of cooling liquid, and a second fitting 35 similarly provides communication between outlet chamber 33 and a suitable drain system. These fittings are all located outside of shell 1.

A header cap 36 is secured to the rear tube plate 28 and defines a return chamber 37. Water entering inlet chamber 32 through fitting 34 passes through the tubes 23 in the inner half of the bundle to return chamber 37 and thence is returned through the tubes in the outer half

of the bundle to the outlet chamber 33. By providing chambers 32, 33 and 37 with ribs similar to rib 31 the number of passes that the water makes through the core section 16 can be correspondingly increased. The number of passes required depends on the type of operation in which the heat exchanger is employed.

The core sections 16 are inserted into shell 1 through openings 7 to comprise the heat transfer bank 14. Legs 26 ride on guide bars 17 of frame 15 and each core section is pushed inwardly until the peripheral edge of tube plate 27 bears against spider plate 4. A plurality of bolts 38 serve to secure the peripheral edge of each plate 27 to plate 4.

The inner or rear end of each core section 16 is not attached to any member but merely rest on the frame 15 and is free to float with the expansion and contraction of the core section during operation of the heat exchanger.

Each core section 16 is independently mounted within bank 14 with the respective tube plates 27 of each core section being removably secured to plate 4 by bolts 38. Thus each core section may be readily removed from the bank for cleaning or repair without disturbing the remaining core sections or altering the apparatus by merely unfastening bolts 38.

The air to be cooled enters the hollow interior of the bank 14 through opening 6 in spider plate 4 and is directed radially outward through the core sections 16 of the bank and across the finned tubes 23. Heat is transferred from the air to the cooling medium within tubes 23. The cooled air then passes longitudinally within the annular space between the bank 14 and the body section 2 through openings 10 and is discharged from the shell through outlet 12.

To control the temperature of the air being discharged through outlet 12 a valving arrangement is provided to permit any desired amount of the entering air to pass directly through shell 1 without passing through the core sections 16. This is accomplished by providing end plate 11 with a plurality of generally rectangular circumferentially spaced openings 39 and a plurality of hinged, adjustable valves or flaps 40 to close said openings. The valves 40, when open, permit air to pass longitudinally through annulus 14 to the discharge outlet 12.

In addition a plurality of generally rectangular hinged flaps 41 are employed to control the flow of air through opening 10 in rear spider plate 5.

Flaps 40 and 41 may be operated manually by ropes or chains or electrically or by any other desired means.

It may be preferred to operate corresponding radial flaps 40 and 41 together. That is, as flaps 40 in end plate 11 are opened to allow air to by-pass core sections 16, flaps 41 are closed to reduce the flow of air through the core sections. Thus when flaps 40 are completely open, flaps 41 are entirely closed and all the air will by-pass the core sections. Conversely when end plate flaps 40 are closed, flaps 41 are open and all the air will be directed across the core sections.

By arranging the heat transfer core sections in the shape of a ring or annulus the present invention provides a maximum face area for a given shell diameter and thereby reduces the pressure loss of the air passing through the unit.

The present invention may be adapted for use in large or small installations and will function effectively to cool great or small masses of air. Furthermore, the temperature of the air being discharged from the unit may be accurately controlled through use of the by-pass valves 40 and 41.

As described, the air or gas to be cooled enters opening 6 in shell 1 and passes radially outward across the core sections 16, and is discharged through opening 12. However the apparatus will operate with equal effectiveness if the air is introduced into shell 1 through opening 12 and passes radially inward across core sections 16 and is discharged through opening 6.

It is contemplated that a number of heat transfer banks

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14 having equal or unequal cross sectional areas may be employed within a given shell and arranged therein in a parallel relation, in series, in a staggered relation or in any desired configuration to effect the heat transfer for a given operation.

The exchanger can still remain in operation if it is necessary to remove one or more units for repair or cleaning purposes.

Various embodiments of the invention may be employed within the scope of the following claims.

I claim:

1. A heat transfer apparatus comprising a generally cylindrical casing having a centrally disposed fluid inlet opening at one end and a centrally disposed fluid outlet opening at the other end, an annular member secured at its periphery to said casing and located adjacent said outlet opening, an inner set of circumferentially spaced openings disposed in said annular member to provide for passage of untreated fluid through said member, an outer set of circumferentially spaced openings disposed outwardly from the first set to provide for passage of treated fluid through said annular member, closure means pivoted to said annular member adjacent both said first and said second spaced openings to permit opening and closing of said openings and thereby control the flow of treated and untreated fluid through the outlet and the temperature of the fluid discharged from the apparatus, a pair of longitudinally spaced spider plates assembled with said casing, longitudinally extending frame members of generally rectangular shape assembled annularly and secured at their respective ends to said spider plates to provide a plurality of independent frame members spaced annularly about the inside of said casing and removed inwardly from the casing wall to provide a longitudinal passage between the casing and frames extending the length of the casing to the outer set of spaced openings, the exit end of each frame member being secured to said annular member and the entry end of each frame being secured

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to the entry end of the casing, means to seal off the longitudinal passage at the entry end of the casing, heat exchange core units removably disposed in each frame and with each unit being independent of the other units, baffle means extending centrally from said annular member and toward the inlet opening to direct a portion of the fluid entering the casing radially across said units, and a longitudinally extending strip secured to the inner portion of adjacent frame members and extending between said adjacent frame members to seal off the passage of fluid between the core units and effectively direct the fluid across the core units.

2. The apparatus of claim 1, and a pair of radial braces extending outwardly from the central portion of each frame member and secured to the inner surface of the casing to strengthen the central portion of said frames.

3. The apparatus of claim 1 in which the sealing strip comprises a longitudinally disposed strip secured to the inner adjacent frame members and extending therebetween to seal off the space between the core units to the passage of fluid and thereby effectively direct fluid across the core units, and a pair of radial braces extending outwardly from the central portion of each frame and secured to the inner surface of the casing to strengthen the central portion of said frames.

References Cited in the file of this patent

UNITED STATES PATENTS

1,737,189	Haber	Nov. 26, 1929
1,784,956	Benjamin	Dec. 16, 1930
2,038,002	Ris	Apr. 21, 1936
2,336,840	Brehob	Dec. 14, 1943
2,421,371	Budlane	June 3, 1947
2,423,175	Churchill et al.	June 1, 1947
2,521,866	Ott	Sept. 11, 1950
2,615,687	Simons	Oct. 28, 1952
2,650,073	Holm	Aug. 25, 1953