

Oct. 26, 1943.

F. R. HIGLEY

2,332,969

HEAT EXCHANGER

Filed June 8, 1940

3 Sheets-Sheet 1

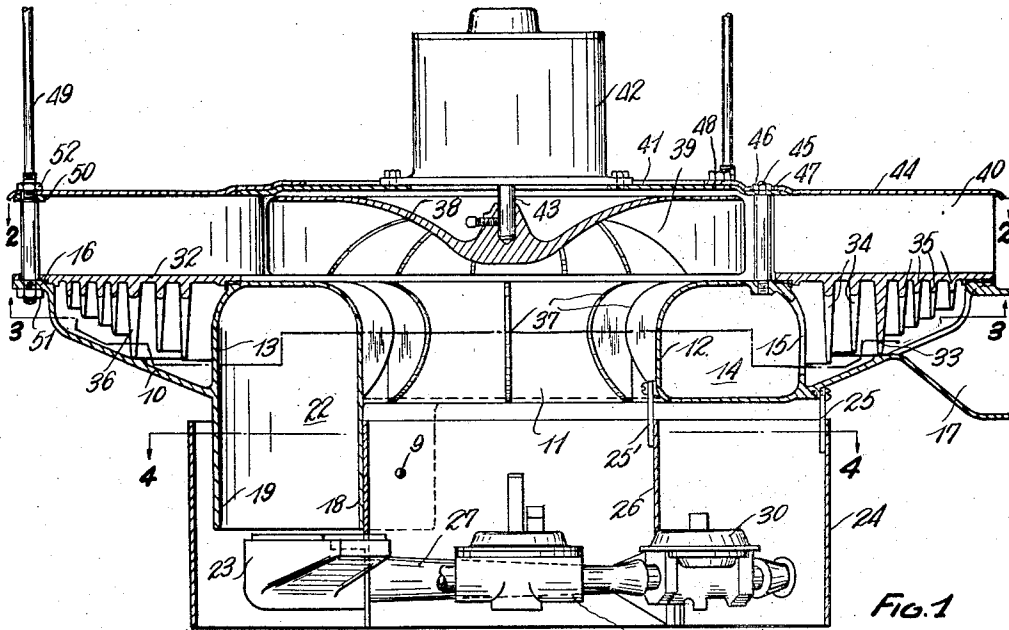


FIG. 1

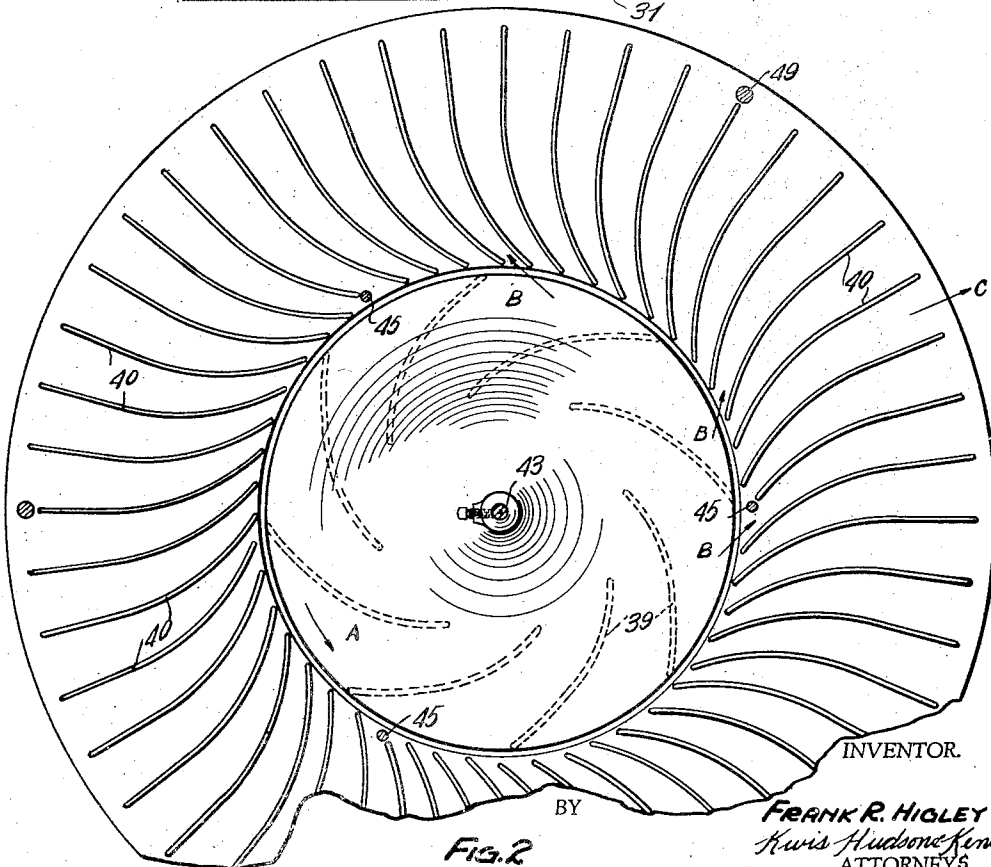


FIG. 2

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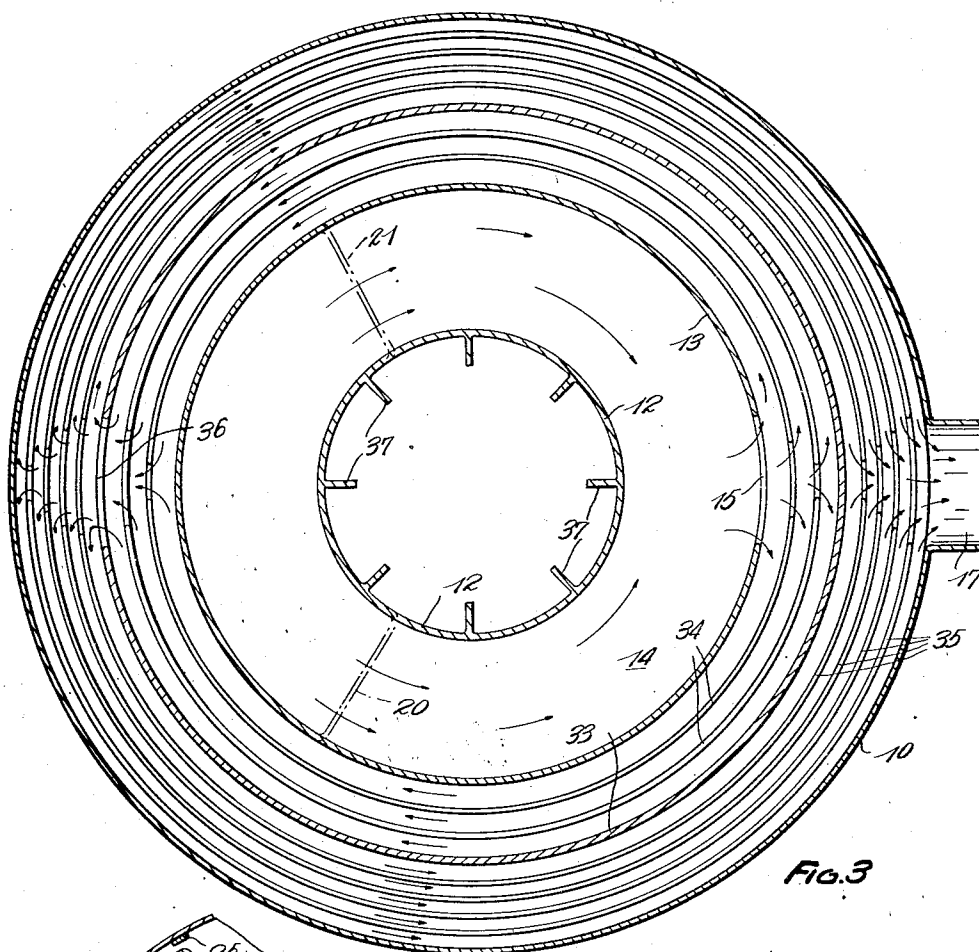


Fig. 3

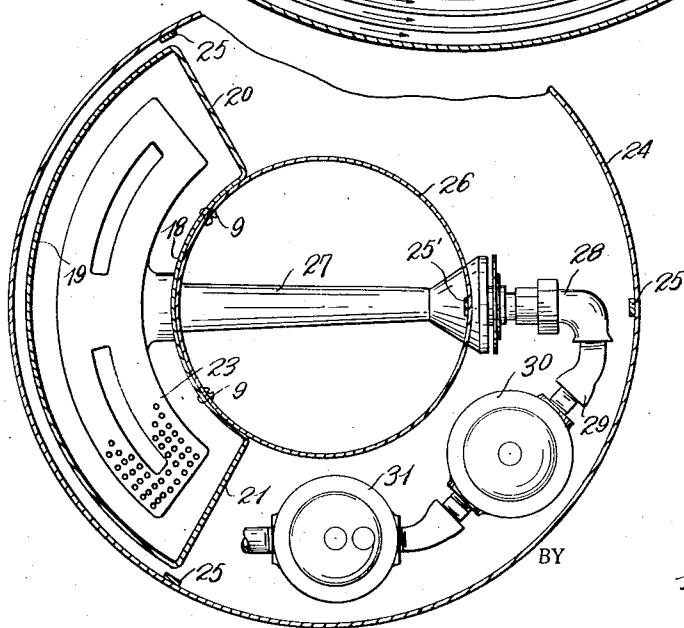


Fig. 4

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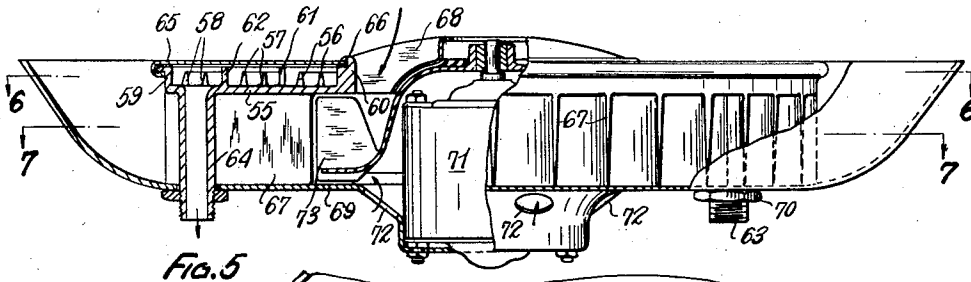


FIG. 5

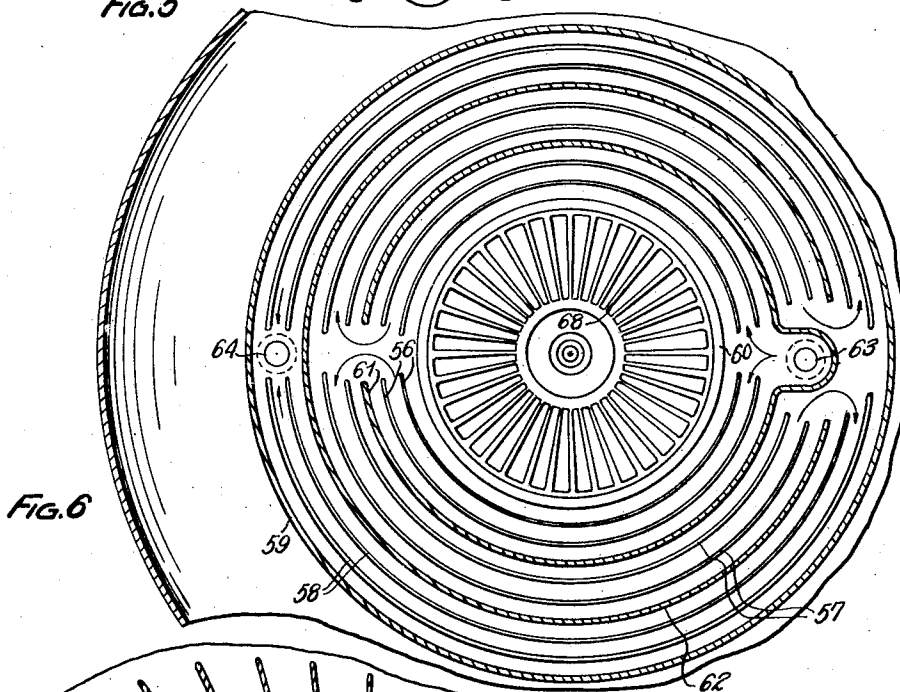


FIG. 6

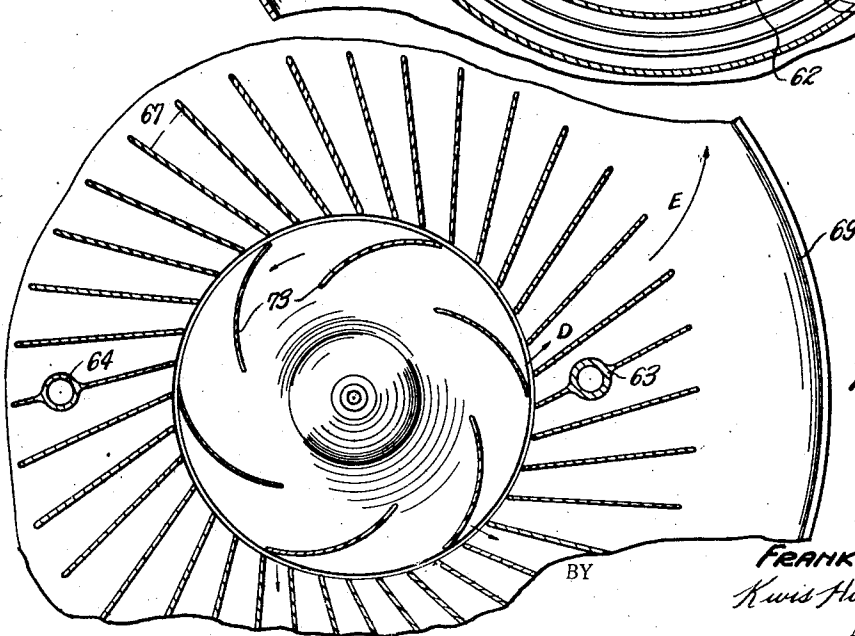


FIG. 7

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2,332,969

HEAT EXCHANGER

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Application June 8, 1940, Serial No. 339,517

7 Claims. (Cl. 126—110)

This invention relates to improvements in heat exchangers, more specifically heat exchangers wherein a central rotor is caused to circulate air or other fluid to be heated or cooled through a radial diffuser comprising fins that are heated or cooled, as the case may be, by another fluid circulated in contact with one wall of said diffuser.

In heat exchangers of this general type where central rotors are employed for circulating air or other fluid, the usual practice is to circulate the fluid to be treated over a coil of pipe. That practice is not efficient in certain respects because the rotor induced flow is interfered with to a large extent by such coiled pipe. In accordance with the present invention a radial diffuser or stator is employed which enables the rotor to build up static pressure and to move large quantities of air or other fluid with a high degree of efficiency, while at the same time effecting good heat transfer.

One of the objects of the present invention therefore is the provision of a heat exchanger which is highly efficient because of its capacity to handle large quantities of fluid in relation to the size of the apparatus.

Another object of the invention is the provision of a heat exchanger of the character stated that is adapted to be mounted centrally of a ceiling, floor, or wall panel of the space or compartment in which the air is to be conditioned.

Another object is the provision of a heat exchanger of simple design and small number of parts, with a consequent reduction of cost.

A further object of the invention is the provision of a heat exchanger so arranged and constituted as to lend itself to the employment of a heat transfer member of aluminum or the like having high thermal conductivity.

Other objects and features of novelty will appear as I proceed with the description of that embodiment of the invention which, for the purposes of the present application, I have illustrated in the accompanying drawings, in which

Fig. 1 is a central vertical sectional view of a heater embodying the invention.

Fig. 2 is a horizontal sectional view taken substantially on the line 2—2, Fig. 1, looking in the direction of the arrows.

Fig. 3 is a horizontal sectional view taken substantially on the line 3—3, Fig. 1, looking in the direction of the arrows.

Fig. 4 is a further horizontal sectional view taken substantially on the line 4—4 of Fig. 1 looking in the direction of the arrows.

Fig. 5 is a conventionalized elevational view partly in radial transverse section of another form of the invention adapted particularly for applications in which the heating or cooling fluid is other than products of combustion.

Fig. 6 is a sectional view of the invention disclosed in Fig. 5, the view being taken substantially on the line 6—6 of Fig. 5, and

Fig. 7 is a further sectional view taken substantially on the line 7—7 of Fig. 5.

Referring first to Figs. 1, 2 and 3, wherein is illustrated a gas fired heater embodying the invention, 10 is a ferrous metal casting of generally circular form in plan, which has a central opening 11 defined by a wall 12. A second wall 13, concentric with wall 12, together with the latter wall defines an annular chamber or passage 14 which has a gate 15 formed by interrupting the wall 13 at one point. Starting at the wall 13 the bottom of the casting is inclined upwardly and outwardly and terminates in a horizontal flange 16 which extends completely around the periphery of the casting. At a point opposite the gate 15 the casting is shaped to form a horizontal exit 17 for the combustion gases. On the side of the casting remote from the gate 15 the walls 12 and 13 are continued downwardly as shown at 18 and 19 and joined by radial walls 20 and 21 to form a combustion chamber 22 below which a burner 23 is mounted.

A cylindrical guard and concealing wall 24 is suspended concentrically beneath the casting 10 by means of a plurality of straps 25 secured to and depending from the casting to the lower ends of which the guard wall 24 is welded. A second cylindrical member 26 of smaller diameter is mounted concentrically within the guard wall 24 by suitable means which may comprise screws 9 threaded into the inner wall 18 of the combustion chamber and straps 25' similar to the straps 25 above mentioned. The member 26 is of approximately the same diameter as the wall 12 of the casting and is in substantial alignment therewith, the two elements 12 and 26 together defining an air inlet passage to the fan 38. A burner mixer tube 27 extends through the cylindrical member 26 and is joined by connections 28 and 29 with fuel control apparatus 30 and 31 situated between the cylindrical elements 24 and 26. The burner with its gas connections and control apparatus may be supported by suitable means from one or both of the cylindrical elements 24 and 26. The arrangement illustrated keeps the burner apparatus largely out of the main path of the entering air and prevents any currents of air from

passing over the burner aside from those which travel upwardly through the combustion chamber 22.

The casting 10 between the wall 13 and the flange 16 is open at the top and in this opening there is mounted an annular horizontal dividing or partition wall 32, formed preferably of non-ferrous high thermal conductivity metal, such as aluminum. The engaging surfaces of the casting and partition wall are machined so that tight joints result. About midway between the inner and outer edges of the partition wall 32 there is a depending fin or rib 33 which extends downwardly far enough to meet or substantially meet the inclined bottom wall of the casting 10, and on each side of this wide rib there are one or more narrower fins or ribs 34 and 35. Hereinafter the term fins is to be understood as a generic term applying to any or all of the parts 33, 34 and 35, while the term rib is to be understood as a specific term applying only to the part 33. The fins 34 and 35 are completely annular although reduced in depth at certain points, but the rib 33 has an opening 36 there-through forming a gate spaced 180° from the gate 15 and connecting the annular passages on the opposite sides of rib 33. As will be obvious, combustion gases rising from the burner 23 flow in both directions through the chamber or passage 14 and out through gate 15 into the annular passage between wall 13 and rib 33. Here they again divide and flow in opposite directions, wiping the fins 34 as well as the rib 33, until they meet at the opposite side of the unit and flow out through opening 36 into the annular passage on the outer side of rib 33. Here they again divide and travel in opposite directions toward the right, as viewed in the drawings, wiping over the wide rib 33 and the fins 35, and passing out through the exit 17.

Vanes 37, formed integral with the wall 12 of the casting 10, extend into the central opening 11 and serve to increase the surface area of the heated wall 12 by means of which heat is imparted initially to the entering air.

Arranged centrally above this air intake opening 11 is a centrifugal fan 38, which rotates in the direction of arrow A, Fig. 2, and the blades 39 of which have a convex curvature on their forward surfaces. This rotor puts a suction drag on the air rising through the opening 11 and expels it centrifugally at all points in the circumference of the unit, the path of travel of any particle out of the rotor during the operation of the latter at the preferred speed being indicated approximately by the arrow B in Fig. 2. Inasmuch as the direction of the air delivered by the rotor depends to some extent upon the speed of the rotor, I prefer to employ a constant speed motor 42, as for example a synchronous motor. The direction of discharge from the rotor then remains constant regardless of the load imposed upon the motor. Vanes 40 project upwardly from the partition wall 32 with which they are integral. These vanes are preferably quite numerous and therefore greatly increase the effective surface of the partition wall 32 on its upper surface, thereby giving that surface the capacity to transmit heat to the air more rapidly than heat is absorbed by the lower surface of the partition. In the present instance the vanes 40 at their inner ends are arranged at substantially the same angle as the arrow B, so that minimum resistance is presented to the air as it is delivered by the rotor. The vanes 40

are curved however throughout approximately two-thirds of their length and are formed to gradually direct the air flow to a radial direction C, the outer one-third of the length of each fin or vane being straight and disposed in a radial position.

All of the vanes 40 plus the partition wall 32 and the cover presently to be described together form a radial diffuser and stator which, in the present invention, has in addition to the usual functions of diffusers and stators the function of transferring heat. It serves to build up pressure, which is important for the circulation of air to be treated, and it does not interpose obstacles to air flow to anything like the extent of the usual pipe coil or other conventional radiator. In order to better distinguish the invention from the prior constructions, the term "diffuser" as hereinafter employed is to be understood as a chamber extending about a centrifugal impeller within which kinetic energy is converted to pressure energy.

A pressed sheet or cast metal cover plate 41 arranged centrally extends over the fan 38 and has a depressed rim which rests upon the inner ends of the vanes 40. Motor 42 is secured centrally to this plate and has a depending shaft 43 extending through an opening in the plate. The hub of the fan is secured to this shaft. An annular cover plate 44 extends over and engages the upper edges of the vanes 40 and is formed along its inner portion to overlie a portion of the plate 41.

The plate 41 is held in position by stud bolts 45, preferably three in number, which have reduced lower ends that are threaded into tapped holes in the casting 10 and reduced upper ends which pass through holes in plate 41 and receive nuts 46 that are threaded down against the plate to hold it in place. Suitable holes 47 are formed in the plate 44 to clear the nuts 46. The inner edges of the annular plate 44 are fastened to plate 41 by short machine screws 48.

The heater is supported at spaced points of its periphery by a plurality of rods 49, preferably three in number, which extend downwardly through suitable holes in the plate 44 and washers 50 welded to the plate, and thence downwardly through holes in the partition wall 32 and in the flange 16 of the casting 10. Nuts 51 threaded on the lower extremities of the rods support the casting 10, and nuts 52 on the rods above the plate 44 serve to press that plate down tightly against the vanes 40 and through the intermediacy of the vanes to cause the partition 32 to tightly engage the flange 16. The bolts 45 and the rods 49 are lined up with certain of the vanes 40, which vanes are shortened sufficiently for the purpose, in order to present as little resistance as possible to air flow.

Access may be had to the fins 33, 34 and 35 for the purpose of cleaning products of combustion therefrom, by unthreading nuts 52 and removing screws 48, after which the annular plate 44 may be pushed up on the rods 49 out of the way of the workmen and the casting may be lifted also along these rods until the fins are exposed.

While in the foregoing embodiment of the invention the hot gases are caused to flow in semi-circular paths back and forth through the casting 10, it will be appreciated that other constructions providing paths of somewhat different character may be used if desired without departing from the spirit of the invention so long as they cause the hot gases to wipe the partition

wall 32 and the fins thereupon in such manner that a good rate of transfer of heat from the gases to the partition wall is effected. It will also be appreciated that while the disclosed relation of gas passages and air passages is preferred, it is nevertheless within the purview of the invention to position the annular gas passages above the air passages instead of below them.

Obviously, the rotor 38 will tend to have maximum discharge adjacent its disc portion, so that when disposed as in Figure 1, with the disc uppermost, a characteristic of the discharged stream will be maximum flow at the top. Equally obviously, the lower part of the stream, closest to the wall 32, will receive maximum heat. Thus any tendency toward stratification of the stream discharged from the apparatus will be toward maximum flow at the upper portion and maximum temperature at the lower portion. Such stream characteristic will tend to project the hot stream farther into the space to be heated and with less tendency to rise than would otherwise be the case.

In Figs. 5, 6 and 7 I have illustrated a second form of the invention in which the heat exchanger is designed either to heat or to cool air passed through the device by the rotor. In this modification, as in the one first described, there is an annular heat exchange member with a partition wall 55 upon one surface of which are ribs or fins which extend around the member, and upon the other surface of which there are a multiplicity of vanes that are wiped by the air as it flows through the apparatus. In order to attain the highest efficiency this heat exchange member should be constructed of a material of high thermal conductivity, as for example aluminum.

On one side of partition wall 55 this annular member is formed with fins 56, 57 and 58, with an outer rim 59, an inner wall member 60 and two ribs 61 and 62. These ribs and fins act to guide the hot or cool fluid which is caused to flow over one surface of partition wall 55 and act also to abstract or give up heat, as the case may be. As here shown they are generally circular, but the fins 56, 57 and 58 are interrupted at diametrically opposite points, the rib 61 is diverted a sufficient amount to include an intake conductor 63 and at a diametrically opposite point is interrupted, while the rib 62 is interrupted at the right-hand side only of the apparatus as viewed in Fig. 7. The hot or cold liquid or other fluid enters through the conductor 63, divides and flows in two semi-circular paths towards the left, then flows through the interrupted part of rib 61 at the left of the figure into the middle pass between ribs 61 and 62, where it divides and flows towards the right. At the right-hand side the two streams again meet and flow through the interrupted part of rib 62 into the outer pass, where it again divides and flows back to the left and leaves through the exit conductor 64.

An annular cover plate 65 which may be a stamping or other ferrous metal member, closes the compartment just described, engaging the two ribs 61 and 62 in order to form separate paths for guiding the fluid as previously described. This cover plate as illustrated herein may be merely a flat plate which, after being placed in position, is held and sealed at its inner perimeter by a lip 66 that is spun down against the plate. The periphery of the plate may then be turned down and under a projecting shoulder on the rim 59, as illustrated in Fig. 5.

Extending from the opposite surface of the partition wall 55 are a multiplicity of vanes 67 that are relatively deep as compared with the fins and ribs 56, 57, 58, 61 and 62. These vanes may be of the form illustrated in Fig. 2, or they may be straight as shown in Fig. 7. In either event however their inner ends are disposed in the direction of rotor discharge, so that at their inner ends at least they will interpose as little resistance as possible to the flow of fluid delivered by the rotor, the angular direction of which is indicated by the arrow D.

Integral with the annular member above described, I may form a circular grill 68. A sheet metal plate 69 forms a closure for one side of the apparatus. It tightly engages the vanes 67, being held in place partly at least by nuts 70 on the threaded extremities of the conductors 63 and 64. The plate 69 is provided with a central depression in which is supported the motor 71, and around this depression at intervals there are small ports 72 through which air may enter. This air, together with other air entering through the grill 68, is subjected to centrifugal force by the blades of a rotor 73 which causes the air to be delivered into the stator-diffuser comprising the vanes 67. For some purposes, particularly where the apparatus is set into a wall panel, the periphery of the plate 69 may be extended and dished so that the air will be directed out into the room or other space to be conditioned. In this case air entering through the grill 68 may be recirculated air, while that entering through openings 72 may be fresh air.

Where the vanes 67 deliver air in a non-radial direction, as they do in cases where the vanes are straight as herein illustrated, the direction of the discharge of air from the apparatus is varied further by the dished outer portion of plate 69 as indicated by the arrow E.

Having thus described my invention, I claim:

1. In a heat exchanger, a housing adapted to be supported from above having a lower annular portion around which hot fluid is adapted to flow and an upper annular portion through which a fluid to be heated is adapted to flow outwardly in all directions, said exchanger comprising an annular partition wall between said portions formed of non-ferrous metal of high thermal conductivity and having a rib extending downwardly to the base of the housing, whereby said rib transfers heat, guides the hot fluid in its flow through the said annular portion and also constitutes a support for the partition wall.

2. In combination, a heat exchange member comprising an annular partition having on one side thereof integral fins running around the member, certain of said fins being deeper than the other and constituting ribs adapted to serve as guiding means for directing hot fluid in curved paths around the member, said member having on its opposite side integral vanes extending from the periphery toward the center of the member over which air to be heated is adapted to wipe in moving outwardly from the center of the member, a cover plate for engaging said vanes along their edges opposite said partition and a closure for the finned side of said heat exchange member engaging said ribs, said closure having entrance and exit openings for hot fluid, and means for forcing air outwardly through said vanes.

3. In a heater, a casting of generally circular form, means for suspending the casting, said casting having an annular cavity therein open at the top, a second casting comprising an annu-

lar partition member closing said cavity and provided with a plurality of depending fins extending into said cavity and formed to guide hot fluid in paths running around the annular member, said first named casting having an intake for admitting hot gases to said cavity and a discharge port for exhausting them therefrom, said second casting having a series of integral vanes extending upwardly from said partition member, a cover for the upper edges of said vanes, a rotor positioned concentrically within said vanes and adapted to take air from below and discharge it through said vanes, two concentric cylindrical members hung from said first named casting, a gas burner arranged between said concentric cylindrical members, and means for conducting products of combustion from said gas burner into said intake.

4. In a heater, a casting of generally circular form, means for suspending the casting, said casting having an annular cavity therein open at the top, a second casting comprising an annular partition member closing said cavity and provided with a plurality of depending fins extending into said cavity and formed to guide hot fluid in paths running around the annular member, said first named casting having an intake for admitting hot gases to said cavity and a discharge port for exhausting them therefrom, said second casting having a series of integral vanes extending upwardly from said partition member, a cover for the upper edges of said vanes, a rotor positioned concentrically within said vanes and adapted to take air from below and discharge it through said vanes, two concentric cylindrical members hung from said first named casting, a gas burner and fuel control mechanism therefor located between said concentric cylindrical members, and means for conducting products of combustion from said gas burner into said intake.

5. In a heat exchanger, an annular conductor for hot gases having a plurality of interconnected concentric passes, ferrous means for housing the innermost pass, means for housing the remainder of said passes comprising an annular casing having a ferrous metal wall and a wall of thermal conductivity greater than that of the ferrous metal wall, vanes on the opposite side of said latter wall, means for feeding hot gases into said innermost pass and discharging them from the outermost pass, and concentric impeller means for drawing fluid into the exchanger axially and discharging it centrifugally through said vanes.

6. In an apparatus of the class described, an annular heat exchanger, means arranged adjacent said heat exchanger to provide an air diffusion passage bounded on one side by a face of said exchanger and discharging peripherally thereof, and a centrifugal blower rotor arranged concentric of said heat exchanger to receive air from the central opening of the latter and force said air into said diffuser in contact with said heat exchanger face, said heat exchanger having vanes extending into said diffuser and disposed each with its inner extremity in the direction of rotor discharge and thence with curvature in one direction until its outer extremity is radial.

7. In apparatus of the class described, a centrifugal rotor disposed with its axis upright and arranged to take air centrally and discharge it peripherally, a stationary diffuser disposed about said rotor to receive air therefrom and discharge it peripherally and comprising an upper confining member and spaced therebelow an annular heated member, whereby characteristics of the discharge from said diffuser will include a tendency toward maximum velocity at the upper part of the stream and maximum temperature at the lower part of the stream.

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