Feb. 24, 1959 K. G. ÅHLÉN 2,874,940

HEAT EXCHANGER

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Fig. 1.

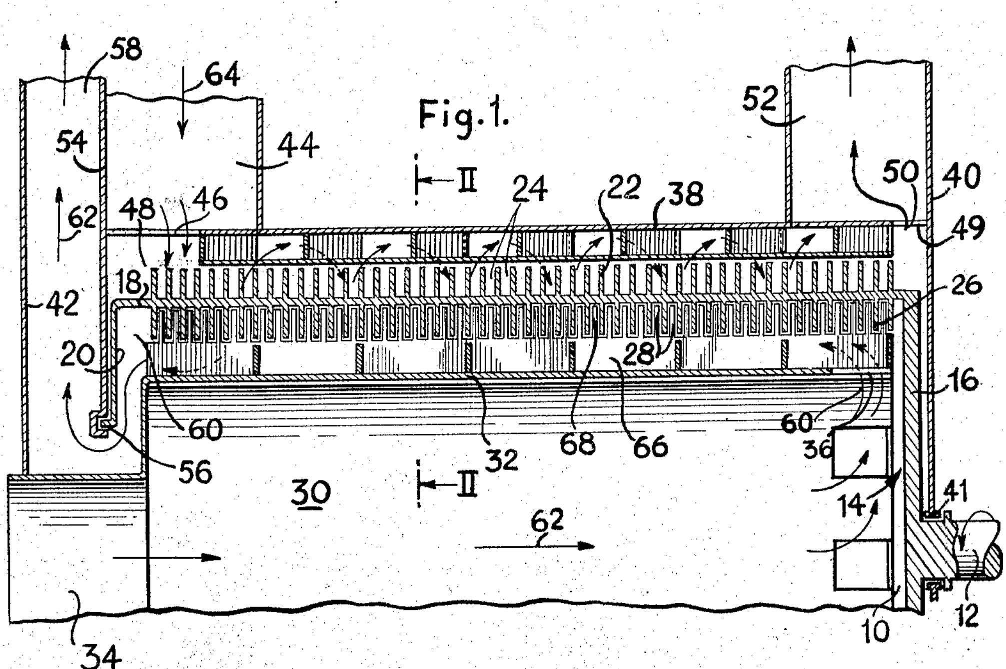

Fig. 4.

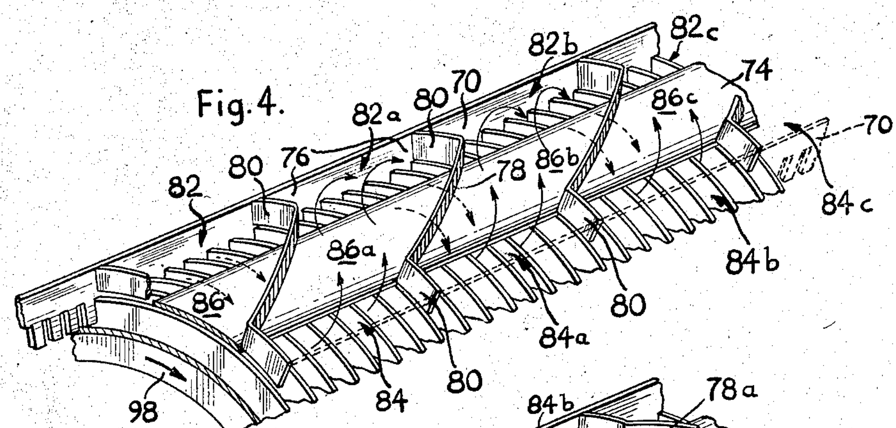

Fig. 7.

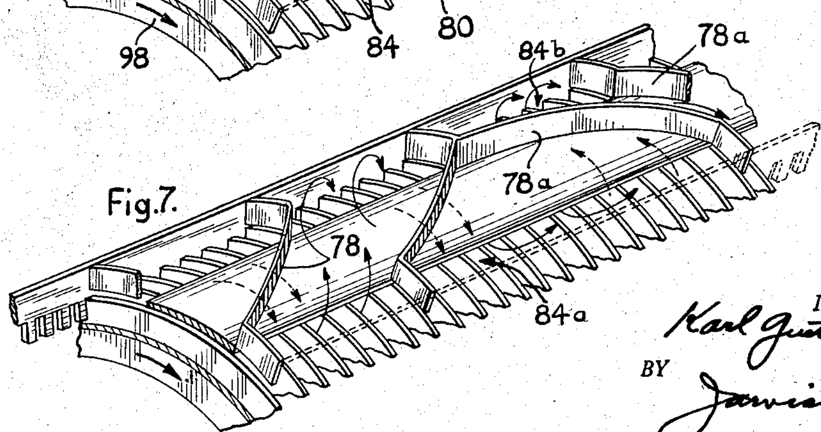

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Fig. 3.

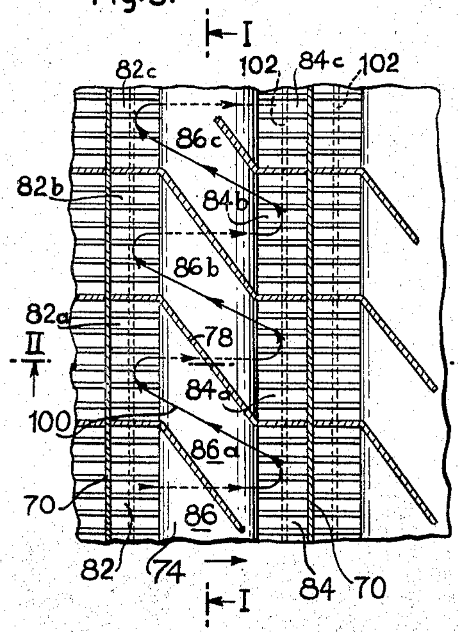

Fig. 5.

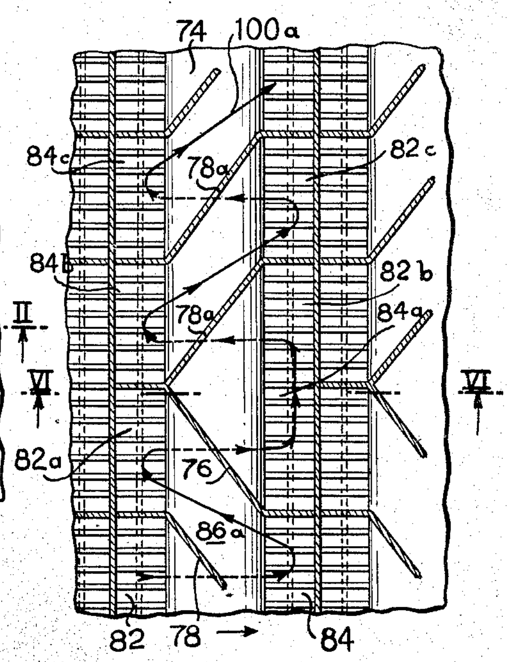

Fig. 2.

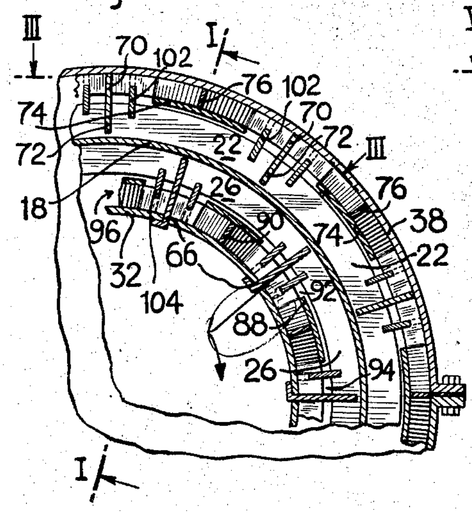

Fig. 6.

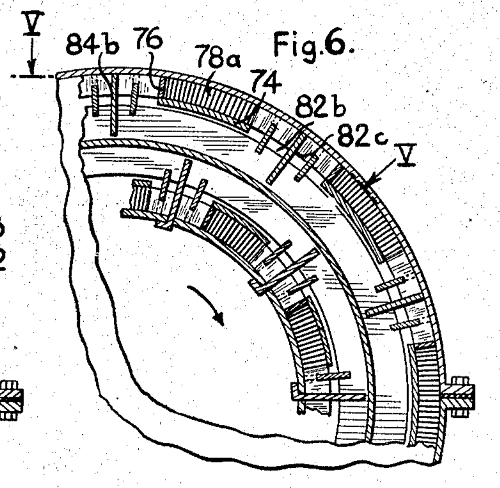

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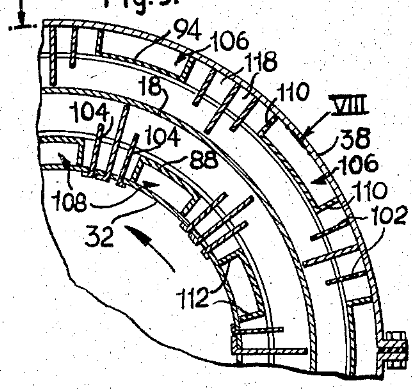
Fig. 9.



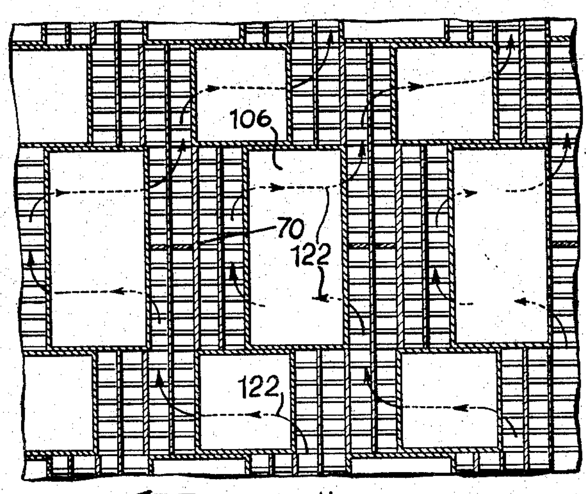
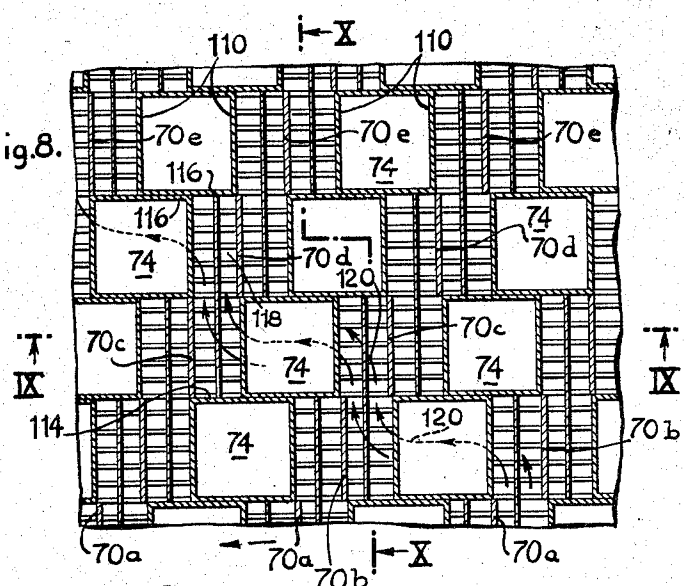


Fig. 11.

Fig. 8.



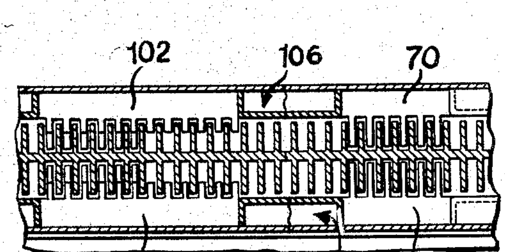


Fig. 10.

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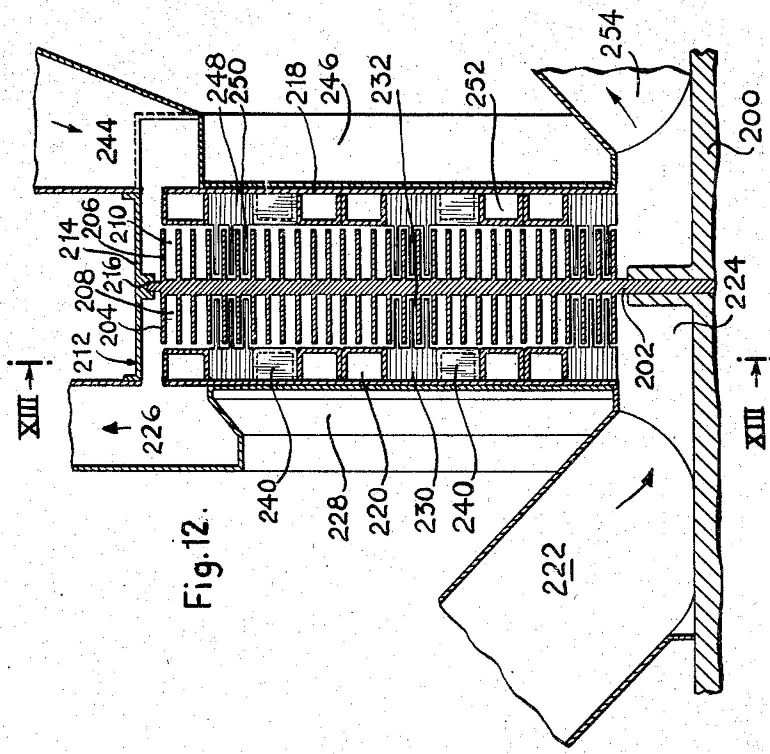

Fig. 12.

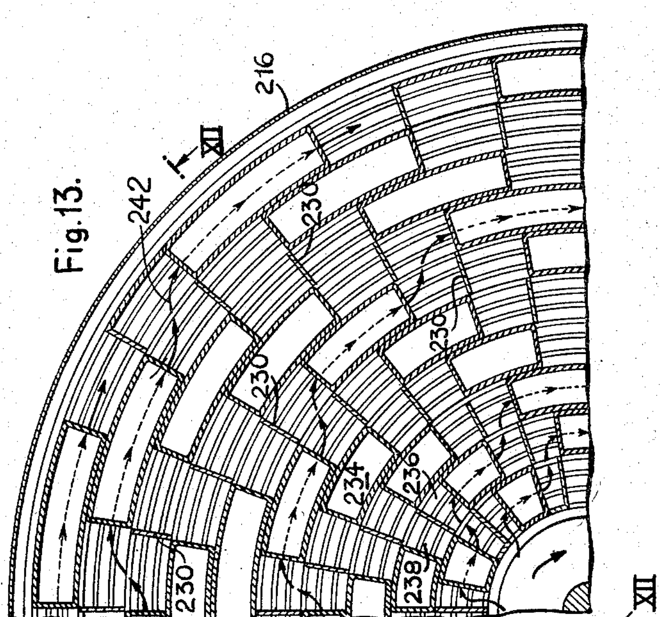

Fig. 13.

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HEAT EXCHANGER

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Application May 16, 1951, Serial No. 226,582

10 Claims. (Cl. 257—241)

The present invention relates to heat transfer and in its broader aspects has reference to heat transfer between a solid body and a fluid medium. More specifically, the invention relates to heat transfer between a solid body and a gaseous fluid medium and still more particularly the invention relates to indirect heat exchange between two different fluids, either or both of which may be liquid or gaseous, by heat transfer to and from the different fluids and a solid body with which the fluids are separately in surface contact.

The general object of the invention is to provide for heat exchange at high rates of transfer per unit area of heat exchanging surface, to provide for such transfer with minimum expenditure of power for effecting relative movement between the heat exchanging bodies and in certain of its aspects to utilize movement of the solid heat exchanging body to create, in whole or in part, the required flow of the fluid or fluids with which the solid body is in heat exchange relation.

In order to attain the above generally stated objects and other and more detailed objects hereinafter appearing, the invention contemplates the provision of a rotating solid body in the form of a rotor having a multiplicity of circular fins or ribs with intervening channels in the form of grooves concentric with the axis of rotation of the rotor, with which there is associated a rotationally stationary structure having baffle members projecting into the grooves and cover means for the grooves for controlling flow of fluid in the grooves, such structure further being combined with means providing transfer passages for conducting fluid to and from different grooves in accordance with novel principles hereinafter more fully described, which result in a novel character of flow which is productive of the improved results sought by the invention.

The invention is particularly adapted for heat exchange between two gaseous fluids for purposes such as the preheating of air to be used for combustion, by waste heat extracted from combustion gases exhausted from apparatus such as power boilers and internal combustion engines and gas turbines. The invention will therefore be described hereinafter, by way of example but without limitation, as applied to air preheating structure, but it will be understood that the principles of the invention are susceptible of use in many other applications and that for certain of such applications, the principles of the invention in its broader aspects may be carried out with only certain features of the structure hereinafter described in connection with the air preheater apparatus chosen by way of example.

For a better understanding of the more detailed nature of the invention, the manner in which it may be carried into practical effect, and the advantages to be derived from its use, reference may best be had to the ensuing portion of this specification, taken in conjunction with the accompanying drawings forming a part hereof, in which:

Fig. 1 is a more or less diagrammatic longitudinal section, on line **1—1** of Fig. 2, of an air preheating apparatus embodying the principles of the invention;

Fig. 2 is a fragmentary cross section taken on the line **2—2** of Fig. 1;

Fig. 3 is a fragmentary plan view taken on line **3—3** of Fig. 2, and with certain elements indicated in phantom for the sake of clarity;

Fig. 4 is a fragmentary perspective view of part of the structure shown in the preceding figures and with certain elements omitted for the sake of clarity;

Fig. 5 is a view, similar to Fig. 3, showing a different structural arrangement of certain of the parts for producing an altered character of fluid flow;

Fig. 6 is a fragmentary cross section taken on the line **6—6** of Fig. 5;

Fig. 7 is a fragmentary perspective view, similar to Fig. 4, of the arrangement shown in Fig. 5;

Fig. 8 is a view similar to Figs. 3 and 5 showing another arrangement of structure for producing fluid flow of different character than that shown in Figs. 3 and 5;

Fig. 9 is a fragmentary cross section taken on line **9—9** of Fig. 8;

Fig. 10 is a fragmentary longitudinal section taken on line **10—10** of Fig. 8;

Fig. 11 is a view, similar to Fig. 8, showing structure providing an altered character of fluid flow as compared with that of Fig. 8;

Fig. 12 is a longitudinal section similar to Fig. 1 showing apparatus embodying the invention and having a different form of rotor than that shown in Fig. 1, and

Fig. 13 is a fragmentary cross section taken on the line **13—13** of Fig. 12.

Referring now more particularly to Figs. 1 to 4, the apparatus comprises a rotor indicated generally at **10**, having a shaft part **12** and a hollow drum **14** defined by a radial end wall **16**, a cylindrical wall **18** and a second radial wall **20**. The cylindrical wall **18** carries a multiplicity of external axially spaced radial fins or ribs **22**, providing between them a multiplicity of external annular channels or grooves **24**. The drum further carries a multiplicity of similar internal ribs **26** providing a multiplicity of internal annular grooves **28**.

Associated with the rotor there is provided a rotationally stationary structure comprising a hollow drumlike internal casing member indicated generally at **30**. Member **30** is mounted coaxially with the rotor and has a cylindrical casing wall **32** radially spaced from the inner ends of the internal ribs **26**. It further is provided with an inlet **34** at one end and outlets **36** at the other end.

The stationary structure further comprises an outer drumlike casing wall **38** surrounding the rotor and radially spaced from the external ribs **22**. The stationary structure further has end walls **40** and **42**, the former extending inwardly past the end wall **16** of the rotor to shaft part **12** of the rotor where a seal **41** may be employed, and the latter extending inwardly to the inlet portion **34** of member **30**. An inlet duct **44** for fluid communicates by way of opening **46** at one end of the rotor with the space **48** between rotor wall **18** and the outer casing **38**. This space communicates at the other end of the rotor by way of an opening **49** with the outlets **50** and **52**. The wall **54** extends inwardly to a seal diagrammatically indicated at **56** and with wall **42** providing an outlet duct **58** which communicates with the space **60** between the rotor wall **18** and wall **32** of member **30**.

In the embodiment of apparatus illustrated one of the fluids, as for example air to be heated, enters the member **30** through the inlet **34** and flows in the direction of arrows **62** through member **30**. From this space the air flows generally from right to left as viewed in Fig. 1, and in a manner hereinafter described more in detail, through the space **60** between the rotor drum **18** and the wall 32 of member 30, and from this space to the outlet duct 58.

Hot fluid, such as spent combustion gases, enters in the direction indicated by arrow 64 through inlet duct 44 and opening 46 to the space 48 between the rotor drum 18 and the outer casing wall 38. The gas flows generally from left to right as viewed in Fig. 1 through this space in a manner hereinafter to be described and through opening 50 to the outlet duct 52.

The wall 32 of member 30 carries a plurality of baffle members 66 extending axially of the rotor and peripherally spaced around the circumference of wall 32. These members are of comb-like form having a multiplicity of fingers 68 projecting into and substantially filling the cross sections of the grooves 28. Similar comb-like baffle members 70 extend inwardly from the outer casing wall 38 and are provided with fingers 72 substantially filling the cross sections of the external rotor grooves 24.

Externally of the ribs 22 and located peripherally in spaced relation between the baffle members 70, a plurality of cover members 74 extend axially in closely spaced relation to the crests of the ribs 22. These cover members are supported by means of partition or guide plates 76 carried by the casing wall 38, as will be more clearly seen from Fig. 3. These partitions extend peripherally from one baffle 70 to the next and comprise oblique central portions 78 overlying the cover members 74 and transverse end portions 80. The end portions 80 of these partitions extend beyond the edges of the cover members to the adjacent baffles and divide the spaces between the edges of the cover plates and the baffles into two series of axially aligned ports between each two adjacent baffles. One series of such ports is indicated at 82, 82*a*, 82*b* and 82*c*, and the other is indicated at 84, 84*a*, 84*b* and 84*c*, in Figs. 3 and 4. These ports provide communication between the sectors of the grooves 24 between the adjacent baffles and the space between the baffles which lies radially outside the cover members or plates 74, the latter space being divided by the partitions into a series of oblique transfer passages as indicated at 86, 86*a*, 86*b* and 86*c* in Figs. 3 and 4, these passages being defined by the cover plate 74, the radially outer parts of baffles 70, the outer casing wall 38 and the partitions 76.

Radially inside the rotor drum 18, a similar structure is provided comprising cover plates 88 disposed adjacent to the crests of the inner ribs 26 and series of partitions or guide plates 90 for supporting the cover plates and forming series of ports 92 and 94, and together with the cover plates 88, the inner casing wall 32 and adjacent inner baffles 66 providing oblique transfer passages 96 similar to passage 86. Transfer passages 86 and 96 differ in that they are oblique in opposite directions with respect to the rotor axis.

The operation of the apparatus described is as follows:

Considering first the gas entering through duct 44 and opening 46, this gas enters radially a group of grooves 24 through inlet ports 82 distributed around the periphery of the structure. It being assumed that the rotor is turning in the direction indicated by arrow 98 in Fig. 4, friction between the gas and the surface of the moving ribs causes the gas streams in the grooves to move peripherally in the direction of rotation of the rotor under the cover plate 74 until they are forced radially out of the grooves by the fingers 72 of the baffle members 70, which substantially block or dam the grooves.

If we now consider the action of the gas streams in the portion of the apparatus shown in Fig. 3, it will be apparent that the streams entering the grooves through port 82 and ejected from the grooves through port 84 flow obliquely through the transfer passage 86*a* and port 82*a* to an adjacent set of grooves through which the streams flow until ejected through port 84*a* into transfer passage 86*b* which carries the air to the inlet port 82*b* of a succeeding set of grooves. This action is repeated until the gas reaches the discharge end of the rotor and from Fig. 4 it will be evident that the gas column entering port 82, which is divided into individual streams in the grooves, travels in what may be said to be a generally helical path to flow along the rotor between two adjacent baffles. From the preceding description, it will be obvious that peripherally of the rotor there will be a series of such gas columns each confined between two adjacent baffles and moving in generally helical paths along the rotor.

The action with respect to flow through the grooves between the inner flanges 26 is the same as being described and for the apparatus assumed, the air enters through duct 34 and is divided into a number of air columns each flowing between adjacent baffles in a generally helical path along the rotor to the outlet duct 58.

While both the gas and the air flow peripherally in the direction of the rotor, while in the grooves, it will be evident from Fig. 1 that the general flow relation between the two fluids is counterflow, the hottest gas being in heat exchange relation with that part of the rotor in contact with the hottest air and the coolest gas being in heat exchange relation with that part of the rotor to which the coolest entering air is admitted.

The action of the apparatus has been described above as applied to the preheating of combustion air by combustion gases and in such applications it is ordinarily preferable to pass the gases through the external grooves of the drums and the air through the internal grooves since the volume of gas passing through the apparatus in such applications is usually larger than the volume of air. Also, the external groove structure is more readily cleaned of solids such as soot and ash deposited by the relatively dirty combustion gases. Insofar as the basic operation is concerned, it will, however, be evident that if desired the hot medium may be passed through the internal grooves, and the medium to be heated passed through the external grooves, the choice being governed by the nature and characteristics of the media employed and the desired heat exchange between them.

As is well known, the rate of heat transfer between a fluid and a solid body is, among other things, a function of the relative velocity between the two and by the present arrangement a high relative velocity between the rotor and the gaseous fluids can readily be maintained. Also, by limiting the uninterrupted flow of the fluids in individual grooves to sectors of predetermined length, the character of the flow can be controlled so as to produce a high rate of heat transfer not only because of high relative velocity, but also because of the fact that the absolute velocity of the fluid can be maintained at a sufficiently low value to prevent turbulence of an undesired nature. If the velocity is sufficiently low, generally laminar flow can be maintained except at the surface layers where small secondary eddies rotating about axes normal to the general line of flow are produced. These eddies are desirable from the standpoint of heat transfer and do not create much resistance to flow, and since the grooves are preferably generally relatively deep and narrow, the eddy like turbulence of the surface layers is sufficient to bring most of the fluid stream into heat exchange contact with the solid surface. If the stream in a given groove is permitted to be accelerated to too great an absolute velocity, so that its velocity relative to that of the walls of the groove is low, by being permitted to travel too long a path in a given groove, not only is the temperature difference and the rate of heat transfer accordingly reduced, but also there may be induced a rotary turbulence in the plane of rotation, which is undesirable. Further, by ejecting the fluid from the grooves after a predetermined length of travel and transferring the fluid to another set of grooves, it is further ensured that all of the fluid in a given stream or column is brought into intimate heat exchange relation with heat transfer surface.

The number, spacing and cross sectional shape and area of the grooves may vary widely depending upon the nature of the heat exchange conditions to be met, the character of the fluid or fluids involved, entering temperatures and desired leaving temperatures, volumes to be handled, pressures and other specific factors. These factors will also affect the length of the paths of flow of the streams in individual grooves, the grouping of the grooves, which may, for example be such in an extreme case that each "group" may consist of but a single groove. In the embodiment being described the grooves have, for the sake of simplicity, been shown of equal cross section between equally spaced ribs. It will be evident, however, that in cases where a gas is materially cooled and contracts materially during its flow through the apparatus, and it is desired to maintain a relatively constant velocity of flow, the ribs may be spaced closer together at the colder end than at the hot end to compensate for the contraction.

Also, in apparatus where the path of flow is relatively long and through a large number of groove sectors, the cumulative effect of the friction may result in a higher than desired velocity through the apparatus when a given fluid column travels in all cases through the grooves in the direction of movement of the rotor, as illustrated for example in Fig. 4. This condition can readily be avoided by apparatus operative to reverse the direction of flow in any selected number of sectors so that in such sectors the fluid flow in the grooves is counter to the direction of movement of the rotor and in Figs. 5 to 7, one suitable embodiment of apparatus for effecting this is illustrated. In substantially all particulars the arrangement is the same as that previously described and corresponding parts are correspondingly numbered. The difference between the constructions is that for any selected space, or spaces, as shown more particularly in Figs. 5 and 7, the direction of slant of the oblique portion **78** of the partition members **76** is reversed as indicated at **78***a* so that if we compare Figs. 3 and 5, and Figs. 4 and 7, respectively, it will be seen that the fluid flowing from the grooves through outlet port **84***a*, flows axially in the arrangement of Figs. 5 and 7 to inlet port **82***b*, which is in effect an axial continuation of the outlet port **84***a*. From inlet port **82***b*, the fluid flows through the grooves counter to the direction of rotor movement to outlet port **84***b* which in this embodiment is on the same side of the cover member **74** as the inlet ports **82** and **82***a*. In the embodiment illustrated, the counter flow is carried through a plurality of groups of grooves, but it will be evident that this specific arrangement may be varied at will with respect to the number and arrangement of passes through the grooves in which the fluid flows counter to the direction of rotor rotation, as compared with the passes in which the flow is in the same direction. In any case, it will be apparent that in those passes where the flow is counter to the direction of rotor rotation, friction will exert a decelerating effect and by proper selection for a given design the rate of flow of fluid through the apparatus as a whole may readily be governed to suit the specific conditions.

As noted above, the grooves are preferably relatively deep and narrow and the ratio of depth to width of the grooves may in many instances be as much as ten to one, or even materially greater. With such relatively deep and narrow grooves, the rate of heat transfer in the grooves is improved by the provision of auxiliary guide fingers shown at **102** and **104** in Fig. 2, which fingers extend only partially of the full depth of the grooves and are located so that they serve to divide and guide the fluid entering and leaving the groove sectors through the respective inlet and outlet ports. These fingers may be parts of comb like members similar to the baffle members **70** and supported in any suitable fashion as parts of the stationary structure, it being noted that in the present embodiment these guide members must be radially spaced from the cylindrical walls **32** and **38** respectively, of the stationary structure since the fluid must flow across the tops of these guide members in its flow between the several ports and the transfer passages. For the sake of clarity, these guide members have been shown in phantom view in Fig. 3 and have been omitted from the showing in Fig. 4. The number and specific arrangements of the guide fingers at any particular port or series of ports may be varied to suit the individual conditions required in order to obtain a more advantageous distribution of flow of the fluid throughout the depth of the groove.

Also in certain instances it may be desirable to provide inlet ports of greater peripheral extent than that of the outlet ports, rather than ports of equal area as shown in the apparatus illustrated.

It will further be apparent from the nature of the apparatus described that in addition to acting as a heat exchanger the apparatus may also provide all of the power required to create the flow of the fluid media and for example when used as an air preheater may provide the only means required to produce the necessary forced draft flow of the combustion air and also the force required to exhaust the spent combustion gases. Thus th apparatus may enable separate forced draft and exhaust fans to be eliminated entirely, or meterially reduce the power requirements for such fans by acting as a compound fan for both purposes.

In both of the embodiments above described, the stationary structure is arranged so that the fluid columns flow in generally axial direction from end to end of the rotors. This arrangement, however, may be varied and in Figs. 8 to 10, another embodiment is illustrated in which a different path of flow for the air columns is provided. In this example, the general arrangement of rotor and stationary structure are as shown in Fig. 1, and corresponding parts are similarly designated. In the present construction, the baffle members providing the fingers extending into the grooves, do not extend from end to end of the rotor but are peripherally offset as indicated at **70***a*, **70***b*, **70***c*, **70***d* and **70***e* in Fig. 8. Each of these offset baffles is coextensive with a group of grooves, the number of which may be chosen at will, axially coextensive with the baffles. A series of sets of box like cover members **106** and **108**, the bottoms of which provide respectively the cover members **74** and **88** located respectively over the inner and outer rotor grooves. The end walls **110** and **112** of these box like members define peripherally the limits of the inlet and outlet ports communicating with the groove sectors while the side walls **114** and **116** define the axial extent of the ports. Due to the peripherally offset relation of adjacent ones of the several series of the box members the outlet ports communicate with one group of grooves which are axially in communication with the inlet ports of the next adjacent group of grooves by way of axially extending transfer passages **118**, each defined by a baffle member, the side walls of two of the adjacent box members, and the inner or outer casing wall **32** or **38** as the case may be.

From Fig. 8, the nature of the flow of the fluid columns is indicated by arrows **120**, from which it will be seen that the several columns progress successively through peripherally offset sectors of axially successive groups of grooves, the general direction of the path of flow being helical around the rotor drum rather than generally axially thereof, as in the arrangement shown in Fig. 1.

In the present arrangement, auxiliary guide fingers **102** and **104** are shown and it will be noted that in the present construction these guide fingers can be extended for support by the casing parts **38** and **32**, respectively, since the flow through the transfer passage is lengthwise of these guide members rather than across the tops of them, as in the previously described embodiments.

In the arrangement shown in Fig. 8, the fluid flow in the grooves is always in the direction of movement of the rotor and for reasons previously explained it may be desirable to provide for counter flow of the fluid in one or more groups of grooves. An arrangement for effecting this is shown in Fig. 11, wherein certain of the baffle members **70** and box members **106** are shown in offset relation such that the direction of flow of the fluid columns is peripherally reversed as indicated by arrows **122**.

In Figs. 12 and 13, the invention is shown embodied in a rotor of different form than that shown in the previously described embodiments.

In this form of the apparatus the rotor shaft **200** carries a radially extending disc **202** which in turns supports a multiplicity of radially spaced concentric cylindrical ribs **204** and **206** on the opposite sides of the disc respectively and providing a multiplicity of annular cylindrical channels of groove like form **208** and **210**, respectively. The stationary structure indicated at **212** comprises an outer cylindrical shell **214** between which and disc **202** a seal diagrammatically indicated at **216** is provided, and end walls **218** and **220**. The structure forms an inlet duct **222** for fluid such as air to be heated, which communicates with the annular space **224** immediately around the rotor shaft on one side of the disc **202**. The structure further provides an outlet duct **226** having an annular portion **228** extending around the periphery of the casing adjacent to the end wall **220** and the flow of air from duct **222** to **226** is generally outward from the central inlet space **224** to the periphery of the rotor duct and the annular duct **228**. The end wall **220** carries a plurality of sets of baffle members **230** which provide fingers **232** extending into and substantially damming the grooves **208**, the sets of baffles at the same radius being peripherally offset with respect to adjacent sets of baffles at greater radius, as seen more clearly in Fig. 13, and between adjacent baffles of each set are box like cover members **234** which are likewise in sets, with adjacent sets of different radius peripherally offset relative to each other.

These cover members **234** are similar in form and function to the box like cover members illustrated in Fig. 8, and have side walls defining inlet and outlet ports **236** and **238** communicating with the sectors of the grooves between adjacent baffles of the same set. As further will be seen from Fig. 13, the relative peripheral location of the cover members of the adjacent sets is such that the inlet ports leading to one group of grooves is radially in registry with a group of outlet ports leading from a radially adjacent set of grooves, to provide radially extending transfer passages **240** for carrying fluid discharged from the sectors of one group of grooves to peripherally offset sectors of the adjacent group of grooves lying radially outside the group from which the fluid is discharged.

By comparison of Figs. 13 and 8, it will be evident that the arrangement is the same in principle in both, the difference being that the several columns of fluid in the arrangement of Fig. 13 flow in generally spiral direction radially of the rotor, as indicated by arrows **242**, instead of generally helically of the length of the rotor as in the construction of Fig. 8.

In the present embodiment the structure provides an inlet duct **244** for fluid, such as combustion gases, this duct having an annular portion **246** for distributing the gas to the radially outermost grooves. The casing wall **218** carries baffles **248** provided with fingers **250** extending into grooves **210** and box like cover members **252**, similar to the cover members **234** carried by the end wall **220**. The arrangement of these baffles and cover members is similar to that of the structure shown in Fig. 13 and need not be described in detail, the difference between the arrangement at the two sides of the disc **202** being that in one case the fluid flow is in generally outward direction while in the other case the flow is in generally spiral inward direction to the outlet duct **254**. As in the previous embodiments, this arrangement provides for counter flow. Preferably, as described, the fluid to be heated, which exands, flows outwardly, while the heating fluid which contracts due to being cooled, flows inwardly.

It will be evident that in the embodiment just described, the arrangement of the baffles and the cover members may be made so as to provide flow of fluid counter to the direction of rotation of the rotor in as many of the sectors as is desired in order to provide the desired rate of flow. Variation in relative size of inlet and outlet ports and the provision of auxiliary guide fingers are, for the sake of clarity, omitted from the figures. Other features of design previously described may equally well be applied to the embodiment under consideration.

In all of the previously described embodiments, movement of the rotating body is utilized to induce flow of the fluid or fluids and the rotary movement of the fluid and solid bodies is concurrent.

However, the basic principles of the invention are equally applicable, with improved results, in cases where in order to secure an even higher rate of heat transfer between fluid and solid bodies, the fluid is forced by mechanical means such as a fan to flow counter to the direction of rotation of the solid body. For such a method of operation, it is evident that the structures hereinbefore described, except for the modifications illustrated in Figs. 5, 7 and 11, are suitable without change, it only being required that appropriate fan or equivalent means of any desired conventional kind be provided to effect the necessary flow of fluid in the direction opposite that indicated by the arrows in the several figures.

Even the modifications of Figs. 5, 7 and 11 would be operative with forced flow counter to the direction of rotation of the solid body, but in such cases the reversal of flow at intermediate places effected by these structures would serve no useful purpose and would in fact be detrimental.

Superficially, it might appear that forced flow counter to the direction of rotation of the solid body is at variance with the basic principles of the invention as hereinbefore described, but such is not the case, since high relative velocities between the heat exchanging bodies may be secured with relatively low absolute velocities of the fluid bodies. Low absolute velocity of the fluid avoids creating the undesirable turbulent rotary flow of the fluid in the plane of rotation hereinbefore discussed, even though the relative velocity between the fluid and solid bodies is high. This, together with the fact that only relatively low absolute velocity of the fluid must be generated, insures a relatively very low power requirement for the rate of heat exchange obtained.

While for purposes of explaining the invention, apparatus has been shown for heat exchange between two gaseous fluids both of which are caused to flow in accordance with the novel principles of the invention, it will be understood that such principles are equally applicable for heat exchange between gaseous and liquid fluids, between different liquids, and for heat transfer between a fluid and a solid body. Further, it will be apparent that if desired one of the two fluids between which heat is exchanged may flow in conventional fashion in heat exchange relation with the solid body which may have plain surface or extended surface of known kind in heat exchange with such fluid.

It is accordingly to be understood that within the scope of the invention many variations in design and arrangement are possible and that certain features herein disclosed may be used to the exclusion of others, the invention being defined by and including all forms of apparatus within the purview of the appended claims.

What is claimed:

1. Heat exchange apparatus comprising a rotor having a plurality of transverse parallel ribs providing a multiplicity of open peripherally continuous circular groove-like channels concentric with the axis of rotation of the rotor for flow of fluid in paths of flow in said channels lying in planes normal to said axis and stationary structure including inlet and outlet openings for fluid and having a wall concentric with and cooperating with said rotor to provide for flow of said fluid between said openings through said channels in heat exchange relation with the rotor, said structure including longitudinal baffles, each baffle having one longitudinal edge abutting said wall and the opposite longitudinal edge having fingers extending into and obstructing said channels, longitudinally extending cover means for said channels disposed between adjacent said baffles, means forming transfer passages connecting different channels at places adjacent to said baffles and at opposite sides of said cover means for flow of fluid progressively through different channels and means to drive said rotor.

2. Heat exchange apparatus comprising a rotor having a plurality of transverse parallel ribs providing a multiplicity of open peripherally continuous circular groove-like channels concentric with the axis of rotation of the rotor for flow of fluid in paths of flow in said channels lying in planes normal to said axis and stationary structure including inlet and outlet openings for fluid and having a wall concentric with and cooperating with said rotor to provide for flow of said fluid between said openings through said channels in heat exchange relation with said rotor, said structure including a plurality of peripherally spaced longitudinal baffles, each baffle having one longitudinal edge abutting said wall and the opposite longitudinal edge having fingers extending into and obstructing said channels to provide a plurality of channel sections in each channel, longitudinally extending cover means for said channels disposed peripherally between adjacent baffles, means forming transfer passages connecting different sections of different channels at places adjacent to said baffles and at opposite sides of said cover means for flow of fluid progressively through sections of different channels and means to drive said rotor.

3. Heat exchange apparatus comprising a rotor having a plurality of transverse parallel ribs providing a multiplicity of open peripherally continuous circular groove-like channels concentric with the axis of rotation of the rotor for flow of fluid in paths of flow in said channels lying in planes normal to said axis and stationary structure including inlet and outlet openings for fluid and having a wall concentric with and cooperating with said rotor to provide for flow of said fluid between said openings through said channels in heat exchange relation with the rotor, said structure including longitudinal baffle members, each baffle member having one longitudinal edge abutting said wall and the opposite longitudinal edge having a series of axial aligned fingers providing baffles extending into and obstructing a series of said channels, longitudinally extending cover means for said channels disposed peripherally between and peripherally spaced from adjacent baffles to provide ports communicating with the channels adjacent the baffles, means forming transfer passages defined in part by said cover means, connecting ports with different channels at opposite sides of said cover means for flow of fluid progressively through the several channels and means to drive said rotor.

4. Heat exchange apparatus comprising a rotor having a plurality of transverse parallel ribs providing a multiplicity of open peripherally continuous circular groove-like channels concentric with the axis of rotation of the rotor for flow of fluid in paths of flow in said channels lying in planes normal to said axis and stationary structure including inlet and outlet openings for fluid and having a wall concentric with and cooperating with said rotor to provide for flow of said fluid between said openings through said channels in heat exchange relation with the rotor, said structure including a plurality of longitudinally peripherally spaced baffles, each baffle having one longitudinal edge abutting said wall and the opposite longitudinal edge having axially aligned fingers providing baffles extending into and obstructing said channels, longitudinally extending cover means for said channels disposed peripherally between and peripherally spaced from adjacent baffles to provide ports communicating with the channels adjacent the baffles, means including said cover means and partitions disposed obliquely with respect to the planes of the channels forming oblique transfer passages connecting ports communicating with certain of said channels at one side of said cover means with ports communicating with other channels at the other side of said cover means and means to drive said rotor.

5. Heat exchange apparatus comprising a rotor having a plurality of transverse parallel ribs providing a multiplicity of open peripherally continuous circular groove-like channels concentric with the axis of rotation of the rotor for flow of fluid in paths of flow in said channels lying in planes normal to said axis and stationary structure including inlet and outlet openings for fluid and having a wall concentric with and cooperating with said rotor to provide for flow of said fluid between said openings through said channels in heat exchange relation with said rotor, said structure including a plurality of longitudinal peripherally spaced sets of baffles, said baffle having one longitudinal edge abutting said wall and the opposite longitudinal edge having fingers extending into and obstructing said channels, the baffles of one set being peripherally offset with respect to the baffles of the adjacent sets, longitudinally extending cover means for said channels disposed peripherally between and peripherally spaced from adjacent baffles of each set to provide ports communicating with the channels adjacent the baffles, means forming transfer passages connecting ports communicating with different channels at opposite sides of said cover means for flow of fluid progressively through different channels and means to drive said rotor.

6. Heat exchange apparatus comprising a rotor having a plurality of transverse parallel ribs providing a multiplicity of open peripherally continuous circular groove-like channels concentric with the axis of rotation of the rotor for flow of fluid in paths of flow in said channels lying in planes normal to said axis and stationary structure including inlet and outlet openings for fluid and having a wall concentric with and cooperating with said rotor to provide for flow of said fluid between said opening through said channels in heat exchange relation with said rotor, said structure including a plurality of longitudinal peripherally spaced sets of baffles, said baffles having one longitudinal edge abutting said wall and the opposite longitudinal edge having fingers extending into and obstructing said channels, the baffles of one set being peripherally offset with respect to the baffles of the adjacent sets, longitudinally extending cover means for said channels disposed peripherally between and peripherally spaced from adjacent baffles of each set to provide ports communicating with the channels adjacent the baffles, means forming transfer passages connecting ports communicating with different channels at opposite sides of said cover means for flow of fluid progressively through different channels, at least certain of said transfer passages connecting ports situated ahead of said baffles with ports situated behind adjacent baffles, considered in the direction of rotation of the rotor and means to drive said rotor.

7. Heat exchange apparatus comprising a rotor having a wall and a plurality of transverse ribs extending from the opposite sides of said wall to provide on each

side of the wall a series of peripherally continuous open groove-like circular channels concentric with the axis of rotation of the rotor, stationary means including inlet and outlet openings for fluid and having walls concentric with and cooperating with said rotor to provide for flow of fluid in paths of flow in said channels between said openings lying in planes normal to said axis, said stationary means including longitudinal baffles, certain of said baffles having one longitudinal edge abutting one of said last named walls and the other of said baffles having one longitudinal edge abutting the other of said last named walls and the opposite longitudinal edges of said baffles having fingers extending into and obstructing said channels, longitudinally extending cover means for said channels disposed between adjacent baffles, means forming transfer passages connecting different channels at places adjacent to said baffles and at opposite sides of said cover means for flow of fluid progressively through different channels on each side of said first named wall and means to drive said rotor.

8. Heat exchange apparatus comprising a rotor having a wall and a plurality of transverse ribs extending from the opposite sides of said wall to provide on each side of the wall a series of peripherally continuous open groove-like circular channels concentric with the axis of rotation of the rotor, stationary means including inlet and outlet openings for fluid and having walls concentric with and cooperating with said rotor to provide for flow of fluid in paths of flow in said channels between said openings lying in planes normal to said axis, said stationary means including a plurality of longitudinal peripherally spaced baffles, certain of said baffles having one longitudinal edge abutting one of said last named walls and the other of said baffles having one longitudinal edge abutting the other of said last named walls and the opposite longitudinal edges of said baffles having fingers extending into and obstructing each of said channels to divide the same into a plurality of sections, longitudinally extending cover means for said channels disposed between adjacent baffles, means forming transfer passages connecting different sections of said channels at places adjacent to said baffles and at opposite sides of said cover means for flow of fluid in each side of said first named wall progressively through peripherally displaced sections of different channels on the same side of said first named wall and means to drive said rotor.

9. Heat exchange apparatus comprising a rotor drum having a plurality of transverse open circular groove-like channels concentric with the axis of rotation of the drum and providing for flow of fluid in paths of flow in said channels lying in planes normally to said axis, said channels comprising a first series of inner channels extending radially inwardly from the wall of the drum and a second series of outer channels extending radially outwardly from the wall of the drum with said wall defining the bottoms of both series of channels, stationary structure including inlet and outlet openings for fluid and having inner and outer walls concentric with and cooperating with said drum to provide for flow of fluid in paths of flow in said inner and outer channels between said openings, said stationary structure including longitudinal inner and outer baffles, said inner baffles having one longitudinal edge abutting said inner wall and the opposite longitudinal edge having fingers extending into and obstructing said inner channels, said outer baffles having one longitudinal edge abutting said outer wall and the opposite longitudinal edge having fingers extending into and obstructing said outer channels, longitudinally extending inner and outer cover members for said inner and outer channels disposed between adjacent inner baffles and between adjacent outer baffles, means providing inner transfer passages connecting different inner channels at places adjacent said inner baffles at opposite sides of said inner cover means for flow of a first fluid medium progressively through different channels of said first series, means providing outer transfer passages connecting different outer channels at places adjacent said outer baffles at opposite sides of said outer cover means for flow of a second fluid medium progressively through different channels of said second series and means to drive said rotor drum.

10. A structure as defined in claim 9 in which said transfer passages are arranged for flow of each of the fluids from channel to channel progressively of the length of the drum and in countercurrent relation with respect to each other lengthwise of the drum.

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