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**Eskeli**

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[54] **HEATING AND COOLING WHEEL**

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**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 216,938, Jan. 11, 1972.

[52] **U.S. Cl.** .......................... **62/401,** 62/87, 122/11, 165/88, 415/88, 415/114, 415/178, 416/96
[51] **Int. Cl.** .......................... **F25b 3/00**
[58] **Field of Search** ........... 415/114, 177, 178, 179, 415/199 A; 416/95, 96; 126/247; 62/401, 402, 403; 122/26

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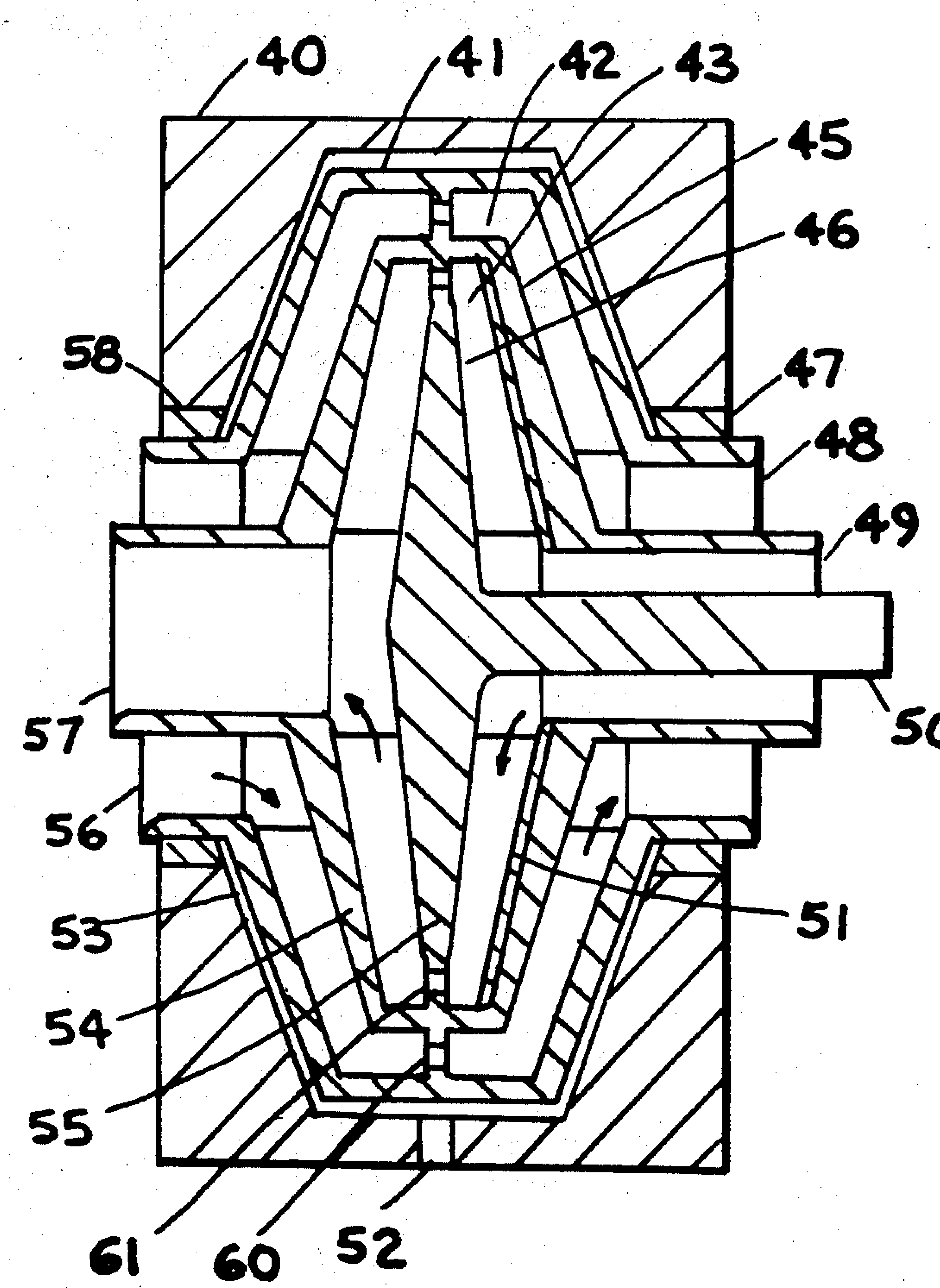
*Primary Examiner*—Albert W. Davis, Jr.
*Assistant Examiner*—S. J. Richter

[57] **ABSTRACT**

A method and apparatus for producing heating or cooling by passing two fluids in heat exchange relationship with each other within a rotating rotor wherein said fluids are compressed to a higher pressure. The first fluid is a compressible fluid, such as air, which when compressed will also have a temperature increase; the second fluid may be either a compressible fluid or may be a non-compressible fluid, which when compressed may not have a temperature raise or the temperature raise for said second fluid will be less than for said first fluid. Heat then will be transferred from said first fluid to said second fluid, so that when said fluids are discharged from said rotor, said first fluid will be at lower temperature at exit than it was at entry; also, said second fluid will leave said rotor at higher temperature than said fluid entered. For the first fluid, air or other compressible gases may be used; said air may be at ambient temperature. For said second fluid, air, water or other fluids may be used; said water or air may be at ambient or natural temperature. Said apparatus may be used for air conditioning where both fluid streams are air; also, it may be used to heat water.

**9 Claims, 4 Drawing Figures**



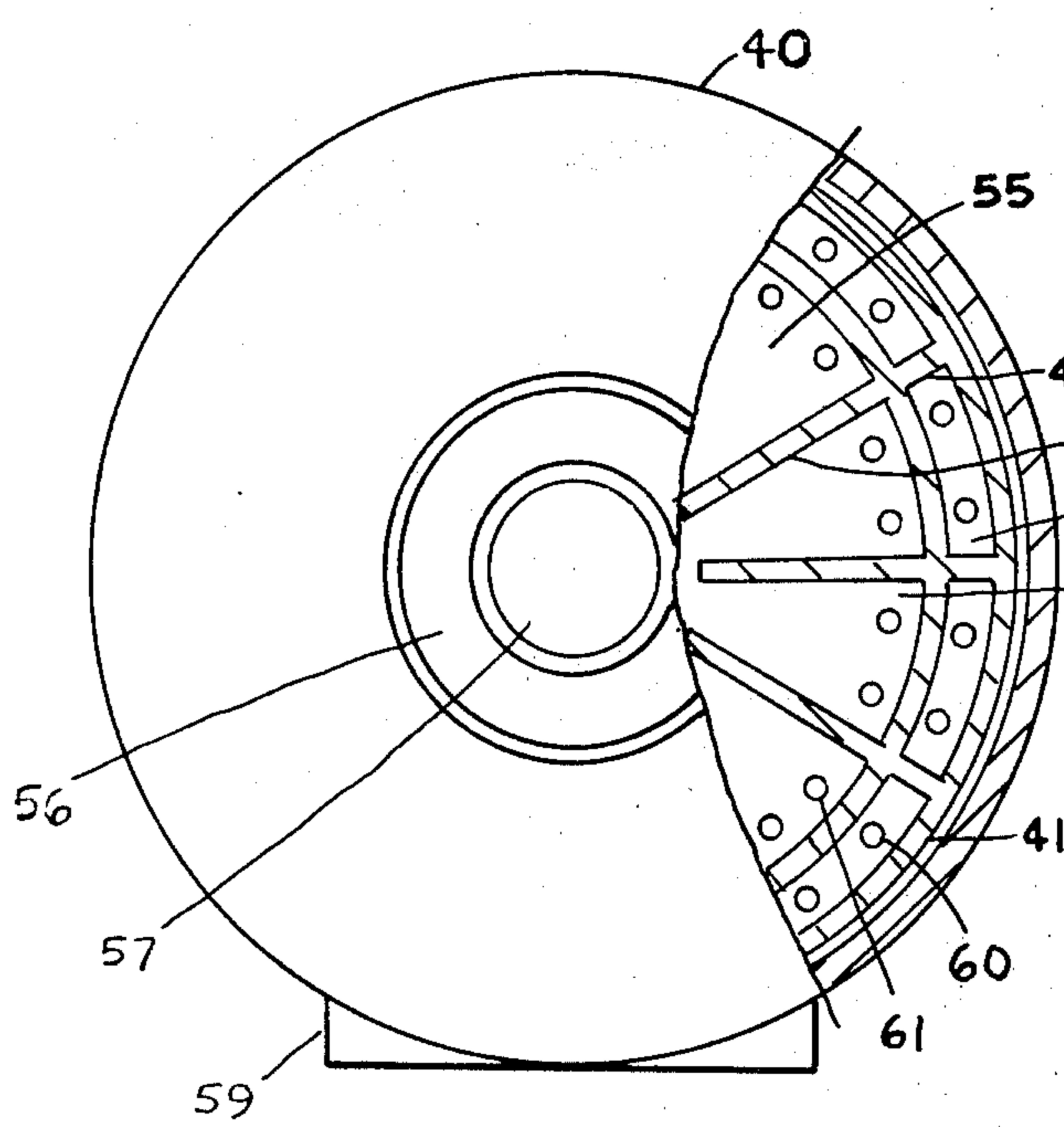



FIG 2

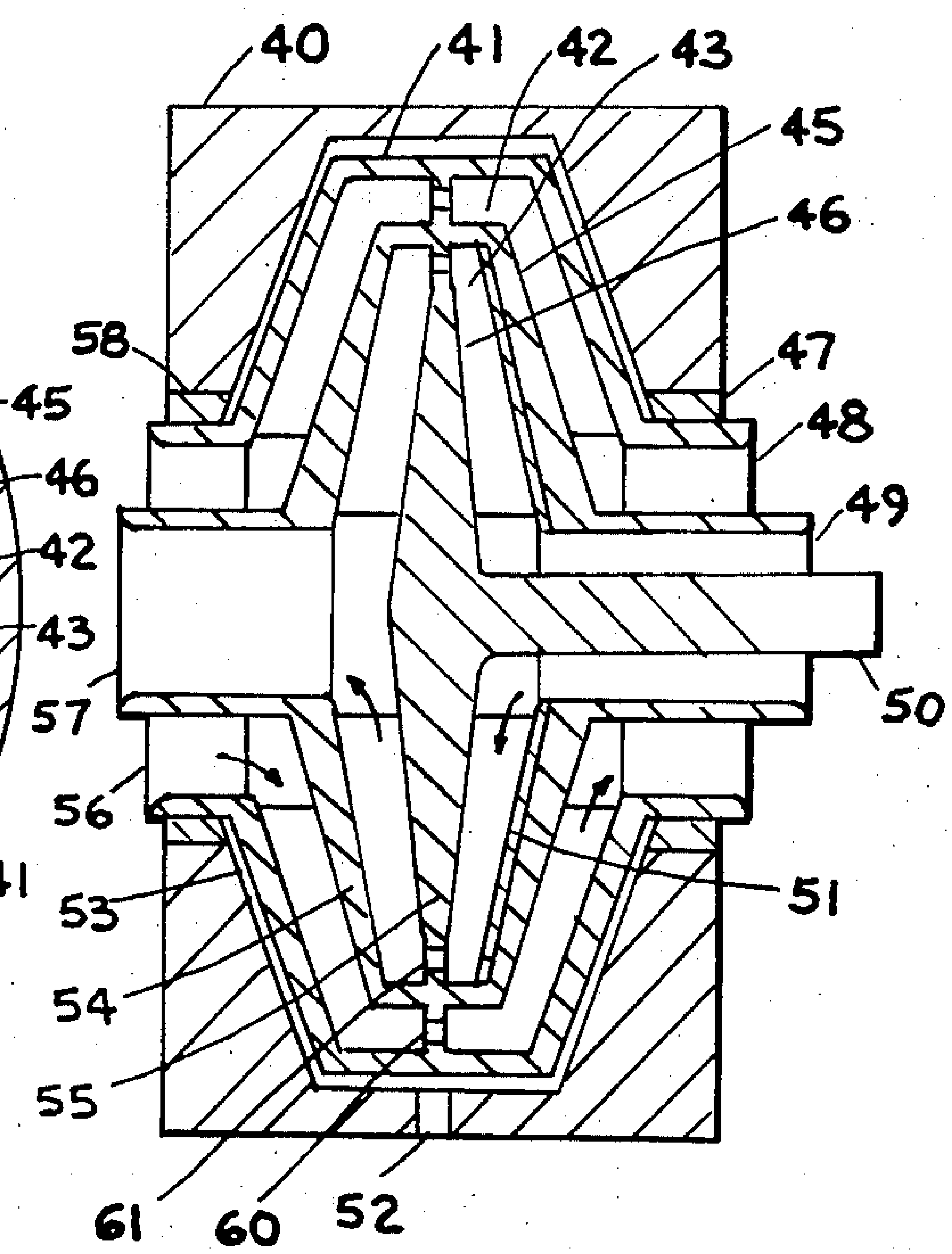



FIG 1

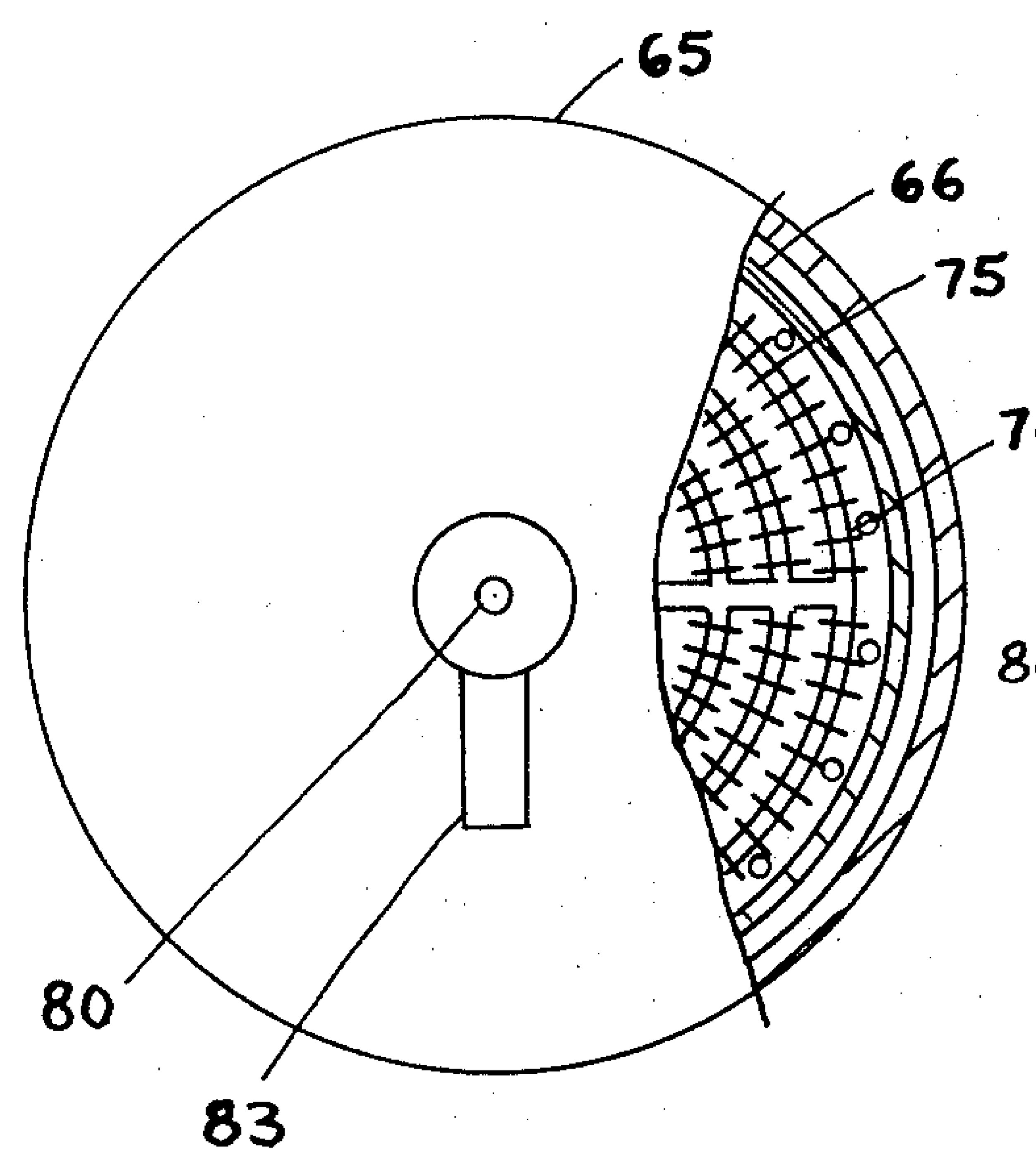



FIG 4

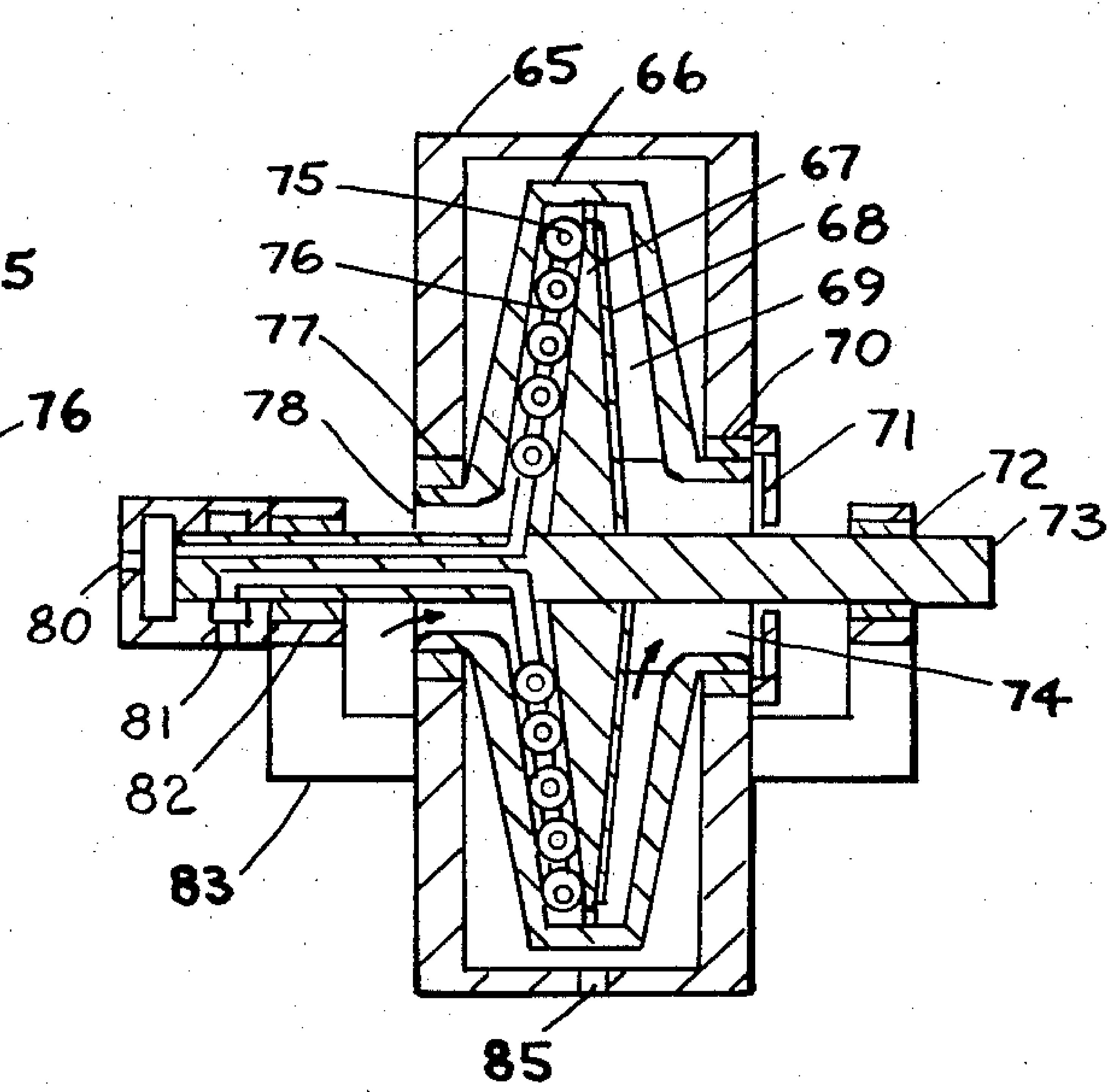



FIG 3

## HEATING AND COOLING WHEEL

Cross References to Related Applications: This application is a continuation-in-part application of "Heating and Cooling Wheel," filed Jan. 11, 1972, Ser. No. 216,938, the descriptive matter of which is incorporated herein by reference.

Some of the material used with the device of this invention was also used in "Gas Compressor," filed Nov. 27, 1972, Ser. No. 309,909, the descriptive matter of which is incorporated herein by reference.

## BACKGROUND OF THE INVENTION

This invention relates generally to heating and cooling apparatus, wherein cooling or heating is produced when a fluid is circulated within a system.

The art of providing cooling, refrigeration or heating has seen a variety of devices. In some of these devices, such as heat pumps, a fluid is expanded in an expansion device, allowed to evaporate producing cooling, and is then compressed and condensed thereby completing the cycle. In air conditioning, by circulating the air through the evaporator coil, cooling is produced, and by circulating the air over the condenser, heating is produced.

The main disadvantage of these conventional systems is that they require relatively large amounts of power for their operation. Also, a separate fluid, such as a halogenated hydrocarbon, is required within said device as the heat exchange fluid which is sometimes a vapor and sometimes a liquid within the said system; use of such fluid requires sealing against leakage and adds to cost.

## BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a cross section of one form of the device, and FIG. 2 is an end view of the unit shown in FIG. 1 with a section removed to show interior.

FIG. 3 is a cross section of another form of the device, and FIG. 4 is an end view of the device shown in FIG. 3, with a portion removed to show interior details.

## DESCRIPTION OF PREFERRED EMBODIMENTS

It is an object of this invention to provide a method and apparatus for providing heating or cooling as normally required for air conditioning, heating or for refrigeration.

It is also an object of this invention to provide a method and a device wherein, for air conditioning systems, the air being circulated within a space to be air conditioned, is also being circulated within the device, without intermediate fluids such as Freon or other similar fluids.

It is also an object of this invention to provide a method and apparatus wherein either one, or both of the fluid streams passing through the device, are self propelled within the device; the transport of the fluids being provided by suitable arrangement of the heat transfer surfaces relative to the fluid streams thus providing density differences within the device to provide said self propelling feature.

Referring to FIG. **1**, therein is illustrated a cross section of one form of the device. First fluid, which is the compressible fluid, is passed in heat exchange relationship with a second fluid, which may be either compressible or non-compressible fluid. The device shown in FIG. **1** is especially arranged to employ fluids that are both compressible, with said first fluid in outer rotor passage, and said second fluid in inner rotor passage. **40** is casing, **41** is rotor, **50** is rotor shaft, **47** and **58** are rotor bearings and seals, **52** is a hole that communicates with the space between rotor and casing. The fluid stream to be heated enters said rotor **41** via opening **49**, and passes through passage **43** to outlet opening **57**; said fluid stream is being compressed by the centrifugal action of said rotor on said fluid when passing outward within said rotor; vanes **46** are placed in said passage to assure that said fluid will rotate with said rotor and also to serve as heat exchange members. Another stream of fluid enters said rotor **41** via openings **56**, passes outward within said rotating rotor **41** via passages **42**; said fluid stream being compressed by centrifugal action on said fluid by said rotor; said fluid passage being provided with vanes **45** to assure that said fluid will rotate with said rotor and also to serve as heat exchange members. The fluid entering said rotor via opening **56**, being in the outer fluid passage, will have a higher tangential velocity and therefore experience a higher centrifugal force, than the fluid entering via opening **49**. **55** and **54** are dividing walls, and **53** is rotor outer wall. **51** indicates a layer of thermal insulation that is applied to rotor dividing wall to prevent heat transfer in the area indicated by **51**. Heat transfer will take place through wall **54** in the area indicated by **54**, and this heat transfer will remove heat from said first fluid, and add heat to said second fluid, **60** and **61** are openings in fluid passages **42** and **43** to restrict fluid flow to maintain a predetermined radial velocity for the said fluids.

In FIG. **2**, an end view of the unit shown in FIG. **1**, is illustrated, with a section removed to show interior details. **40** is casing, **45** is a vane in outer fluid passage **42**, **43** is inner fluid passage, **55** is dividing wall, **41** is rotor, **60** and **61** are fluid openings, **57** and **56** are fluid openings to rotor, and **59** is unit base.

In FIG. **3**, another form of the device is shown, this unit being specially arranged to employ a gaseous first fluid and a liquid second fluid, and intented to heat said second fluid, and to remove heat from said first fluid. Said first fluid is self propelling within the rotor, and the second fluid, being a liquid, is normally pumped through the heat exchanger coils. **65** is casing, **66** is rotor, **67** is rotor dividing wall, **68** is thermal insulation, **69** is vane within rotor passage, **70** is a rotor seal, **71** is shutter for the first fluid passage and is adjustable, **72** is rotor shaft bearing, **73** is rotor shaft, **74** is first fluid exit, **85** is casing vent, **83**, is bearing support, **82** is bearing, **80** and **81** are second fluid entry and exit, **78** is first fluid entry, **77** is rotor seal, **76** is second fluid distribution conduit, **75** is heat exchanger.

In FIG. **4**, an end view of unit shown in FIG. **3**, is illustrated with a section removed to show internal details. **65** is casing, **66** is rotor, **75** is heat exchanger, **76** is second fluid distribution conduit, **80** is second fluid entry, **83** is shaft bearing support.

In operation, one of the fluid streams will be the compressible fluid, supplying heat to said second fluid. The second fluid may be either a compressible fluid, or be a non-compressible fluid, as desired. Within the rotor, said first fluid, being more compressible, will have a higher temperature gain, than said second fluid; both fluids being compressed by centrifugal action on said fluids by said rotor. Alternately, said first fluid will be arranged to be in a rotor passage that is further outward from the center of rotation and thus will have greater compression than said second fluid, with heat then being transferred from said first fluid to said second fluid. Referring to FIG. **3**, said first fluid enters said rotor via opening **78**, and is then passed outward within said rotating rotor, and is compressed by said rotor. Due to compression, the temperature of said first fluid tends to increase, and heat is then transferred to said second fluid within heat exchanger placed within said rotor at the inlet side of said rotor, item **75** in FIG. **3**. During said compression of said first fluid, heat is removed continuously from said first fluid with an increase in pressure that is greater for a predetermined rotor speed than would be for an isentropic compression for said first fluid. On the exit side of the rotor, indicated by item **69** in FIG. **3**, the expansion of said first fluid is isentropic, with no heat transfer, and thus the pressure differential between periphery and exit **74** follows laws pertaining to isentropic compression:

To control radial velocity, shutter **71** has been provided; this is adjustable, so that the first fluid velocity may be set to suit. Also, this shutter may be used to control air flow, if said device is connected directly to duct system in a building.

The flow of the fluids in the unit shown in FIG. **1**, is similar to that described hereinbefore. The passage of heat from said first fluid to said second fluid is arranged to occur so that said first fluid will release heat during compression, while said second fluid will receive heat during expansion. Thus, both fluids will be self propelling. Openings **60** and **61** are located at periphery, to allow control of radial velocity of said fluids; the size of said openings **60** and **61** can be made to suit the amount of fluid being flown through said rotor. Alternately, a shutter may be used for one or both of these fluid streams similar to item **71**, in FIG. **3**. Also, the shutter and the openings at periphery may be both used, if desired, to control said radial fluid velocities.

The unit shown in FIG. **1**, may be directly connected to building duct system, to provide both heating and cooling. One of the fluid streams in such arrangement will be building air from ducts, and the other fluid stream will be outside air. These two streams may be swithed from one rotor passage to another, and also be mixed, if desired, to obtain a precise degree of heating and cooling. The duct arrangements and damper arrangements with associated controls, are not further being described herein, since they are assumed to be within existing art. The self propelling feature, wherein said air will pass from rotor entry to rotor exit, will usually be sufficient to provide for passing said outside air through said rotor; for the building air, a fan to circulate said building air through the duct work may be required. Alternately, the exit opening from the rotor, may be made larger in diameter, as shown by item **74** in FIG. **3**, to provide additional pressure differential for the building air.

Work input to the device is low, since both fluids enter and leave the rotor near the center of rotation. Work is required to accelerate the fluids when passing from center toward rotor periphery, and work is recovered by the rotor when the fluids travel from the periphery toward rotor center. Referring to FIG. **1**, the fluid streams when both gaseous, will be self propelling through the rotor, so that thus the work input will consist of friction losses in seals and bearings, some work required if a vacuum pump is used, to evacuate the space around rotor, and losses due to residual fluid velocities leaving the rotor at center; all these work quantities are very low resulting in a unit that is very economical to operate. In the unit shown in FIG. **3**, work is required to pump the liquid through the resistance of the rotor coil, and also for a vacuum pump, seal and bearing losses and losses due to first fluid residual velocity leaving the rotor; since the first fluid is self propelling, the total work input to obtain heating or cooling is very low, and is almost negligible when expressed per amount of cooling or heating generated.

As noted, the casing space between rotor and casing may be evacuated to eliminate fluid friction on rotor external walls. Alternately, the rotor walls may be closely fitted to casing as shown in FIG. **1**, item **53**, thus allowing the rotating rotor to partially evacuate the said space and thus reduce fluid friction on said rotor.

What is claimed is:

**1.** A rotary heat exchanger comprising:

a. structural support for supporting rotating shafts;

b. a power input shaft journalled in bearings in said structure for rotation;

c. a rotating rotor mounted on said power input shaft so as to rotate in unison therewith, said rotor having an axis of rotation, structural walls, a radial center, and a periphery said rotor having:

i. first fluid passageway comprising:

I. first entry port having a first area of opening and disposed near the center of said rotor so as to have a small first diameter and a first radius with respect to a central longitudinal axis of said power input shaft and said rotor;

II. at least one first radially extending passageway having first means for ensuring that a first fluid therewithin rotates at substantially the same rotational speed as said rotor for effecting centrifugal compression and effecting a high pressure, compressed fluid at elevated temperature at the outermost periphery of said rotor; said first means serving as cooling means and being heat conductive for cooling said first fluid during centrifugal compression thereof; said first means being disposed adjacent a second fluid passageway for conducting heat to a second fluid in said second fluid passageway;

III. a first peripheral portion communicating with said first radially extending passageway and peripherally disposed in said rotor for collecting said high pressure compressed fluid;

IV. at least one second radially extending passageway communicating with said first peripheral portion and extending inwardly toward the center of said rotor; said second radially extending passageway having second means for recovering the work associated with deceleration of a compressed first fluid; and

V. a first discharge port having a second area of opening that is operably sufficient for automatic flow of a first fluid and having a second diameter and a second radius with respect to said central longitudinal axis that are greater, respectively, than said first diameter and said first radius for effecting automatic flow of said first fluid and less than the respective diameter and radius of said peripheral portion for consuming less power and for effecting greater efficiency in operation; said first discharge port communicating with said second radially extending passageway for discharge of a first fluid therefrom;

ii. second fluid passageway comprising:

I. a second entry port having a third area of opening and disposed near the center of said rotor so as to have a small third diameter and third radius with respect to a central longitudinal axis of said power input shaft and said rotor;

II. at least one third radially extending passageway having third means for ensuring that a second fluid therewithin rotates at substantially the same rotational speed as said rotor; said third means serving as heating means and being heat conductive for heating said second fluid by heat conducted from said first fluid both during compression of said first fluid and at said first peripheral portion;

III. a second peripheral portion communicating with said third radially extending passageway and peripherally disposed in said rotor for collecting said second fluid;

IV. at least one fourth radially extending passageway communicating with said second peripheral portion and extending radially inwardly toward the center of said rotor; said fourth radially extending passageway having fourth means for recovering the work associated with deceleration of a second fluid; and

V. a second discharge port having a fourth area of opening and having a fourth diameter and a fourth radius with respect to said central longitudinal axis that are less than the respective diameter and radius of said second peripheral portion for consuming less power and effecting greater efficiency of operation; said second discharge port communicating with said fourth radially extending passageway for discharge of said second fluid therefrom; and

iii. heat conductive walls intermediate said first and second peripheral portions of, respectively, said first and second fluid passageways and said first and third means for conducting heat from said high pressure, compressed fluid at elevated temperature to said second fluid;

d. a compressible first fluid being automatically passed through said first fluid passageway in said rotor without requiring energy exteriorly of said rotor; said first fluid being heated by centrifugal compression and transferring heat to said second fluid through at least said heat conductive wall intermediate said first and second peripheral portions and said first and third means such that said compressible first fluid is at a lower temperature at its outlet from said rotary heat exchanger than it was at its inlet thereto; and

e. a second fluid being flowed through said second fluid passageway and being heated in at least its said peripheral portion by heat transferred from said first fluid such that said second fluid is at a higher temperature at its outlet from said rotary heat exchanger than it was at its inlet thereto.

**2.** The rotary heat exchanger of claim **1** wherein said second peripheral portion has a radius that is less than is the radius of said first peripheral portion; and said heat conductive wall extends intermediate said first and third radially extending passageways for transferring heat from said first fluid during centrifugal compression thereof and into said second fluid.

**3.** The rotary heat exchanger of claim **2** wherein said first fluid is flowed through the outermost first peripheral portion such that it is subjected to a greater centrifugal force field than is said second fluid which flows through the interiorly disposed second peripheral portion of the second fluid passageway and heat is transferred from said first fluid to said second fluid.

**4.** The rotary heat exchanger of claim **1** wherein said first fluid is a gas and said second fluid is a gas and said fourth diameter and said fourth radius of said second discharge port are greater, respectively, than said third diameter and said third radius of said second entry port for effecting automatic flow of said second fluid also.

**5.** The rotary heat exchanger of claim **1** wherein said second fluid is a liquid when entering said rotary heat exchanger and wherein said second fluid passageway includes sufficient restriction that said second fluid is heated sufficiently within said rotary heat exchanger to at least partially vaporize it.

**6.** The rotary heat exchanger of claim **1** wherein said structure includes a casing that encloses said rotor.

**7.** The rotary heat exchanger of claim **1** wherein said second entry port and said second discharge port have substantially the same third and fourth diameters and the same third and fourth radii; and said first and second fluids are flowed countercurrently to each other; and wherein a heat conductive wall is provided intermediate the heated said second fluid and said first fluid downstream of said second peripheral portion with respect to said second fluid such that said second fluid is heated downstream of said second peripheral portion for effecting automatic flow of said second fluid.

**8.** The rotary heat exchanger of claim **1** wherein said second fluid passageway comprises a finned tube heat exchanger disposed within said first fluid passageway; said finned tube heat exchanger being connected in fluid communication with said second entry port and said second discharge port.

**9.** The rotary heat exchanger of claim **1** wherein said first and second fluid passageways include restrictive passages to regulate the respective radial velocities of said fluids when passing through said rotor and said rotating rotor is of circular configuration in cross section taken transversely to said axis of rotation with its structural walls being thicker near the center than at the periphery and decreasing monotonically toward the periphery.

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