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Lawson

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[54] **CONCENTRIC CYLINDER HEAT EXCHANGER**

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[52] **U.S. Cl.** **165/156;** 165/141; 138/38

[51] **Int. Cl.²** **F28D 7/00**

[58] **Field of Search** 165/140, 141, 156; 138/38–42

[56] **References Cited**

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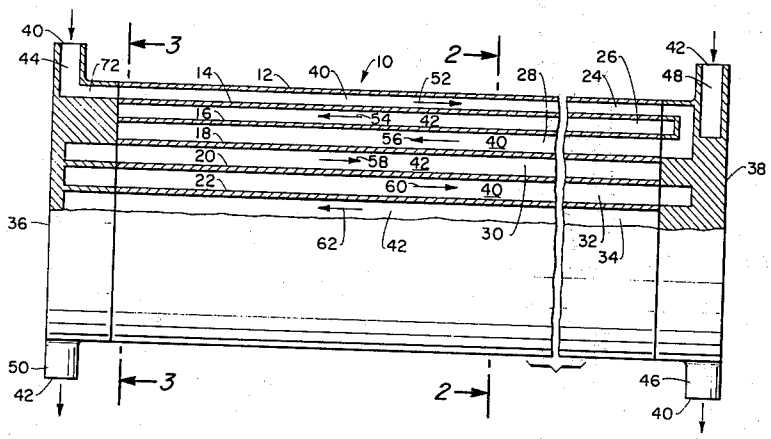
[57] **ABSTRACT**

A heat exchanger formed by a plurality of concentric tubes having annular spaces therebetween. Helical-shaped vanes having waves therein are disposed in the annular spaces. Interconnection means are provided to create fluidic paths through the annular spaces.

3 Claims, 5 Drawing Figures



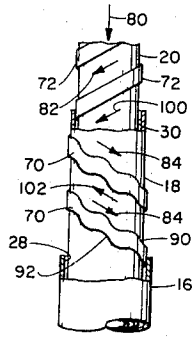


Fig. 1.

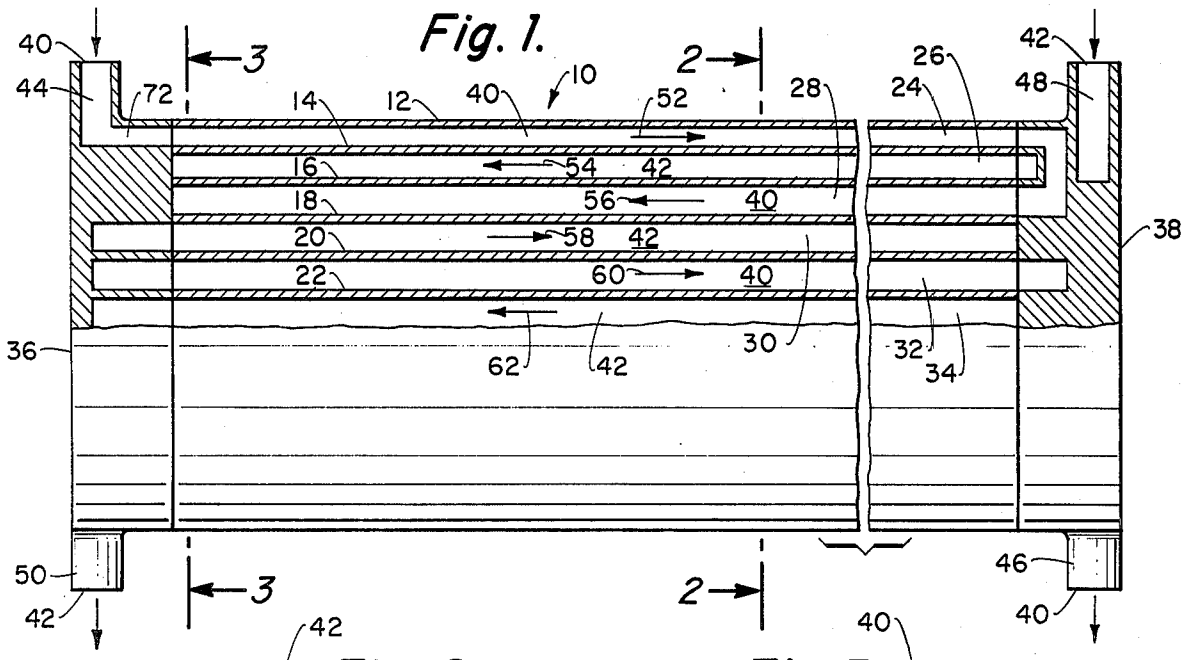


Fig. 2.

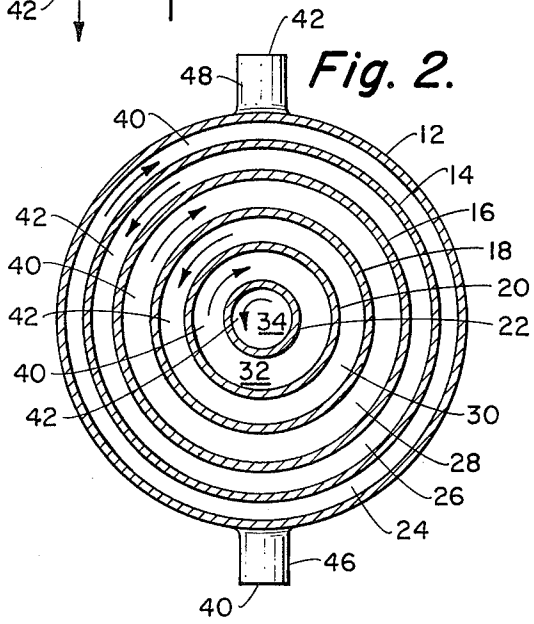


Fig. 3.

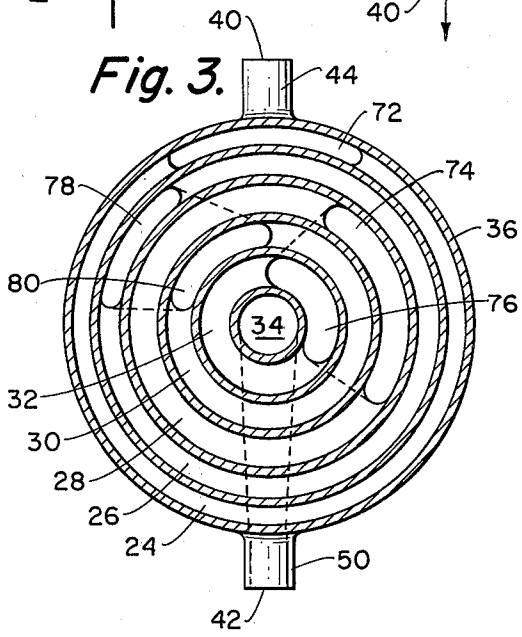


Fig. 4.

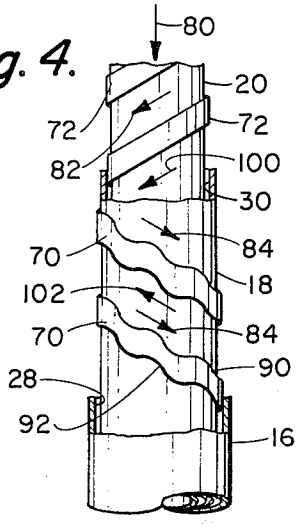
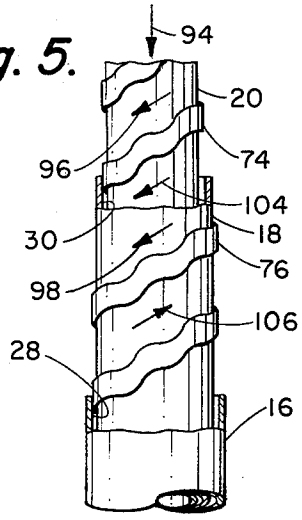


Fig. 5.



CONCENTRIC CYLINDER HEAT EXCHANGER

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to heat exchangers and more particularly to concentric tube heat exchangers having waved, helical-shaped vanes.

2. Description of the Prior Art.

A heat exchanger is a device that transfers heat from one fluid to another fluid. Large surface areas between fluids, turbulence in the fluids, and fluids flowing in opposite directions enhance heat transfer.

There are a wide variety of heat exchangers in the prior art utilizing one or more helical paths. However, such prior art heat exchangers are designed for quick disassembly or easy cleaning with heat transfer being a secondary consideration. Hence, such prior art heat exchangers do not maximize the surface areas between fluids, nor cause fluids to flow in opposite directions or create turbulence in the fluids.

SUMMARY OF THE INVENTION

The general purposes of the present invention are to provide a concentric tube heat exchanger that maximizes the surface area between fluids, causes fluids in adjacent annular spaces to flow in opposite directions, and creates turbulence in the fluids. To attain this, the present invention provides a plurality of concentric cylinders having annular spaces therebetween. Waved, helical-shaped vanes are disposed in the annular spaces. Manifolds at both ends of the concentric cylinders contain the required flow passages necessary to create opposite fluid flow in adjacent annular spaces.

Accordingly, one object of the present invention is to provide fluid flow in adjacent fluid flow paths in opposite directions.

Another object of the present invention is to induce turbulence in the field in all fluid flow paths.

Another object of the present invention is to maximize the surface area between adjacent fluid flow paths.

Another object of the present invention is to maximize heat exchange properties.

Another object of the present invention is to maximize the efficiency of heat exchange.

Another object of the present invention is to provide improved and easier maintenance.

Another object of the present invention is to provide economy of fabrication and operation.

Other objects and a more complete appreciation of the present invention and its many attendant advantages will become apparent as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein like reference numerals refer to like parts throughout the figures thereof and wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a specific embodiment of the present invention.

FIG. 2 is a sectional view indicated by the line 2 — 2 of FIG. 1 illustrating the direction of fluid flow.

FIG. 3 is a sectional view indicated by the line 3 — 3 of FIG. 1 illustrating the manifold or interconnection means.

FIG. 4 is an isometric sectional view illustrating one position of the waved helical-shaped vanes.

FIG. 5 is an isometric sectional view illustrating another position of the waved helical-shaped vanes.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a heat exchanger **10** having a cylindrical casing **12** and a series of concentric cylinders **14**, 16, 18, 20 and **22** enclosed therein. Annular space **24** is formed between cylindrical casing **12** and concentric cylinder **14**. Annular spaces **26, 28, 30** and **32** are formed between concentric cylinders **14** and **16, 16** and **18, 18** and **20**, and **20** and **22**, respectively. Annular space **34** is the innermost annular space and is formed by concentric cylinder **22**. Annular space **24** is the outermost annular space.

Manifolds **36** and **38** are connected to opposite ends of heat exchanger **10**. Manifolds **36** and **38** provide interconnections between annular spaces **24, 26, 28, 30,** 32 and **34** so that fluid paths **40** and **42** are defined. Note that fluid path **40** is adjacent to and in an opposite direction from fluid path **42**. Fluid path **40** begins at inlet **44** in manifold **36** and terminates at outlet **46** in manifold **38**. Fluid path **42** begins at inlet **48** in manifold **38** and terminates at outlet **50** in manifold **36**. Note that adjacent annular spaces have fluids flowing in opposite directions, as indicated by arrows **52, 54,** 56, 58, 60 and **62**. As will be discussed supra, manifolds **36** and **38** connect every other annular space in series to define fluidic paths **40** and **42**.

Now turning to FIG. 2, fluid paths **40** and **42** are illustrated. FIG. 2 is a sectional view along lines **2—2** of FIG. **1**.

FIG. 3 is a sectional view along lines 3 — 3 of FIG. 1 illustrating manifold **36**. Fluid in fluid path **40** enters manifold **36** at inlet **44** and passes into annular space **24** through opening **72**. The fluid then passes down annular space **24** through manifold **38** of FIG. 1 and back down annular space **28**. The fluid then passes through opening **74** and **76** in manifold **36** and into annular spaces **32**. The fluid then passes down annular space **32** through manifold **38** and outlet **46** of FIG. **1**.

The fluid in fluid path **42** enters manifold **38** at inlet **48** of FIG. **1**. The fluid flows down annular space **26,** enters manifold **36** at opening **78,** and exits manifold **36** at opening **80** into annular space **30**. The fluid then passes down annular space **30** through manifold **38** and back down annular space **34**. The fluid then exits manifold **38** through outlet **50**.

Manifold **38** is constructed with the requisite openings in like manner to manifold **36**. Also, additional concentric cylinders over the number shown in FIGS. **1, 2** and **3** may be utilized. Of course, larger manifolds with additional openings will be required in order to correctly define the proper fluid paths.

Now turning to FIG. **4**, helical-shaped vane **70,** having wave-shaped surfaces, and helical-shaped vane **72** are illustrated. Wave-surfaced, helical-shaped vane **70** is disposed in annular space **28** between concentric cylinders **16** and **18**. Helical-shaped vane **72** is disposed in

annular space **30** between concentric cylinders **18** and **20.**

Looking along the longitudinal axis of heat exchanger **10** in the direction indicated by arrow **80** in FIG. **4,** vane **72** in annular space **30** proceeds in a clockwise direction, as noted by arrow **82,** while vane **70** in adjacent annular space **28** proceeds in a counter-clockwise direction, as noted by arrow **84.** Placing the helical-shaped vanes in such manner creates a cross flow between the fluids in adjacent annular spaces. Arrow **100** indicates the direction of flow of fluid in annular space **30.** Arrow **102** indicates the direction of flow of fluid in annular space **28.**

The helical-shaped vanes create a large surface area over which fluids in adjacent annular spaces flow, thus increasing the efficiency of heat transfer between the fluids in adjacent annular spaces. In addition, the wave-surfaced, helical-shaped vanes **70** impart turbulence to the fluid in annular space **28,** thereby increasing the efficiency of heat transfer between the fluids in adjacent annular spaces to an even greater extent.

It is noted that wave-surfaced, helical-shaped vanes are disposed in annular spaces **24, 26, 28, 30** and **32** of FIGS. **1, 2** and **3** to simplify the drawings. Wave-surfaced, helical-shaped vane **70** in annular space **28** forms a fluid-tight seal at its top edge **90** with concentric cylinder **16** and its bottom edge **92** with concentric cylinder **18.** Of course, in like manner, all helical-shaped vanes in heat exchanger **10** are so sealed to their respective concentric cylinders.

Now turning to FIG. **5,** wave-surfaced, helical-shaped vanes **74** and **76** in annular spaces **30** and **28,** respectively, proceed in a clockwise direction, as noted by arrows **96** and **98,** when looking along the longitudinal axis of heat exchanger **10** in the direction indicated by arrow **94.** Placing the helical-shaped vanes in such manner creates a counter flow or opposite flow between the fluids in adjacent annular spaces. Arrow **104** indicates the direction of fluid flow in annular space **30** while arrow **106** indicates the direction of fluid flow in annular space **28.**

It is noted that the clockwise, counter-clockwise placements of helical-shaped vanes **70, 72, 74** and **76** illustrate methods of placement in annular spaces **24,** 26, 28, 30, 32 and **34** of FIGS. **1, 2** and **3** of helical-shaped vanes to achieve various directions of flow between fluids in the adjacent annular spaces. Wave-surfaced, helical-shaped vanes **74** and **76** are sealed at their edges to the concentric cylinders, forming the annular space in which they are disposed in like manner to vanes **70** and **72** of FIG. **4.**

It will be appreciated by those skilled in the art that the specific embodiment of FIG. **1** includes such suitable and necessary fluidic sealing means as to render the specific embodiment operable. Such fluidic sealing means are not illustrated in FIGS. **1, 2, 3, 4** or **5.**

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described herein.

I claim:

1. A concentric tube heat exchanger for transferring heat from one fluid to another fluid comprising:

a. a cylindrical casing having a first and a second end;

b. a plurality of concentric cylinders located inside said cylindrical casing, each pair of adjacent concentric cylinders having an annular space therebetween, each said cylinder having a first and a second end;

c. a plurality of helical-shaped vanes having continuously wave shaped surfaces contacting said fluid flowing thereby connected between adjacent concentric cylinders with one vane being disposed in each said annular space, each said vane being attached to each of its respective concentric cylinders along its entire length, said attachments providing fluid-tight seals with said concentric cylinders, said wave shaped surfaces of said helical vanes imparting turbulence to heat exchange fluids flowing through said annular spaces;

d. first inlet means;

e. first outlet means;

f. second inlet means;

g. second outlet means;

h. first and second manifold means connected to the first and second ends, respectively, of said cylindrical casing and to said plurality of concentric cylinders for creating a first and a second fluidic path through said annular spaces, said first fluidic path being between said first inlet means and said first outlet means, said second fluidic path being between said second inlet means and said second outlet means, said first fluidic path being formed by connecting every other annular space in series, starting from the annular space adjacent to the outermost annular space and proceeding to the innermost annular space, said second fluidic path being formed by connecting every other annular space in series, starting from the outermost annular space and proceeding to the annular space adjacent the innermost annular space.

2. The concentric tube heat exchanger of claim **1** wherein said plurality of helical-shaped vanes are disposed counter-clockwise in the annular spaces of both said first and second fluidic paths, thereby creating counter-flow of fluids in adjacent annular spaces.

3. The concentric tube heat exchanger of claim **1** wherein said plurality of helical-shaped vanes are disposed counterclockwise in the annular spaces defining said first fluidic path and clockwise in the annular spaces defining said second fluidic path, thereby creating cross counter-flow of fluids in adjacent annular spaces.

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