United States Patent [19]

Schnitzer et al.

[11] **3,921,713**

[45] **Nov. 25, 1975**

[54] **HEAT EXCHANGER**

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[22] Filed: **Dec. 26, 1973**

[21] Appl. No.: **427,794**

[52] **U.S. Cl.** **165/167**

[51] **Int. Cl.** **F28g 3/00**

[58] **Field of Search** 165/157, 166, 70, 170, 165/140.1, 167

[56] **References Cited**

UNITED STATES PATENTS

1,826,344	10/1931	Dalgliesh	165/166
1,930,879	10/1933	Linderoth et al.	165/166 X
1,945,287	1/1934	Monroe	165/166 X
2,236,976	4/1941	Rosenblad	165/166 X

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[57] **ABSTRACT**

A novel heat exchanger is formed by using alternating smooth and dimpled, thin, thermally conductive strips which are wound in a spiral to form the closed passageways for fluid between the strips and retain between an outer retaining and fluid distribution ring and an inner retaining and fluid distribution ring. The strips have means for sealing and insulating the periphery in a fluid tight manner. The dimpled strips have dimples extending from each side of the strip the size determining the fluid capacity of the passageways. The smooth and dimpled strips are used in pairs enabling two, four, etc., fluids to be passed either in concurrent or counter-current flow so as to provide an efficient heat exchanger which may be easily taken apart and cleaned for good service.

9 Claims, 4 Drawing Figures

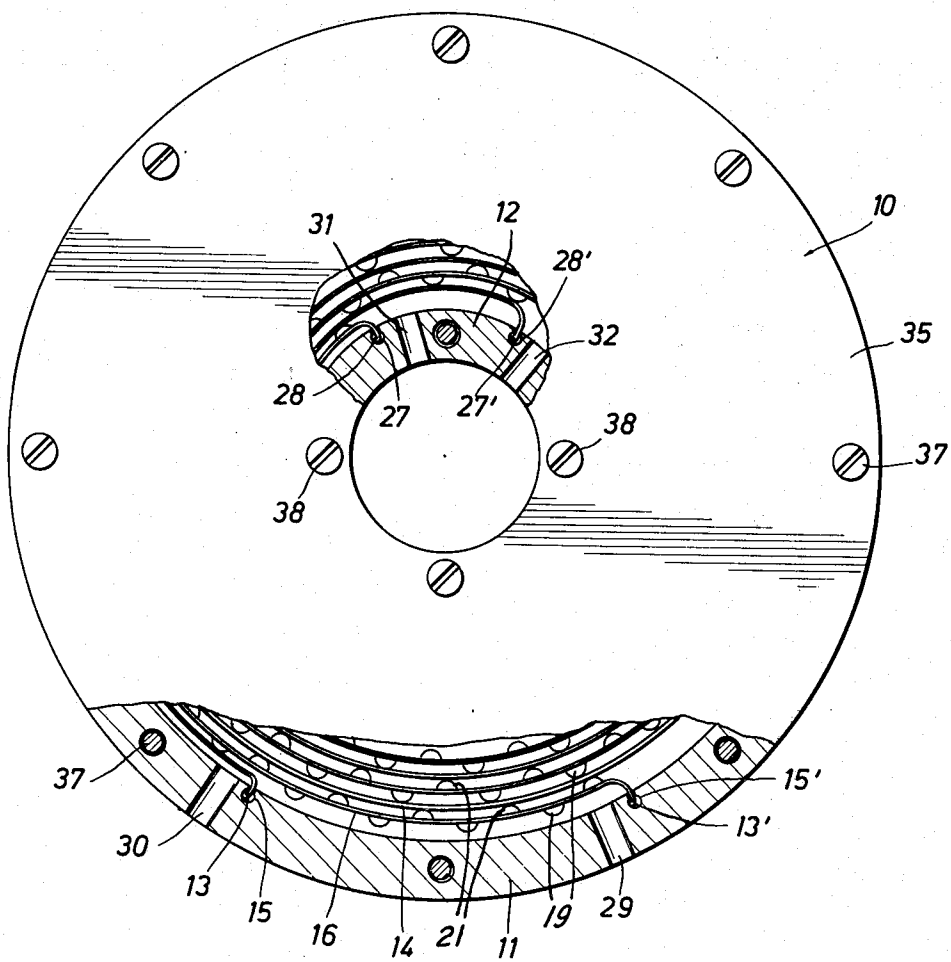


FIG. 1

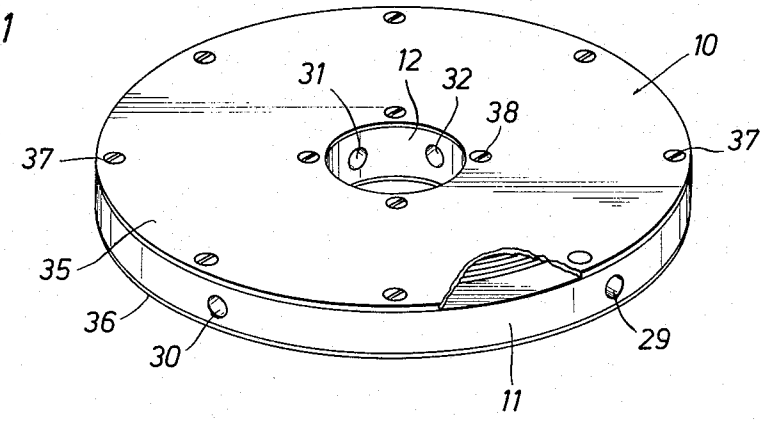
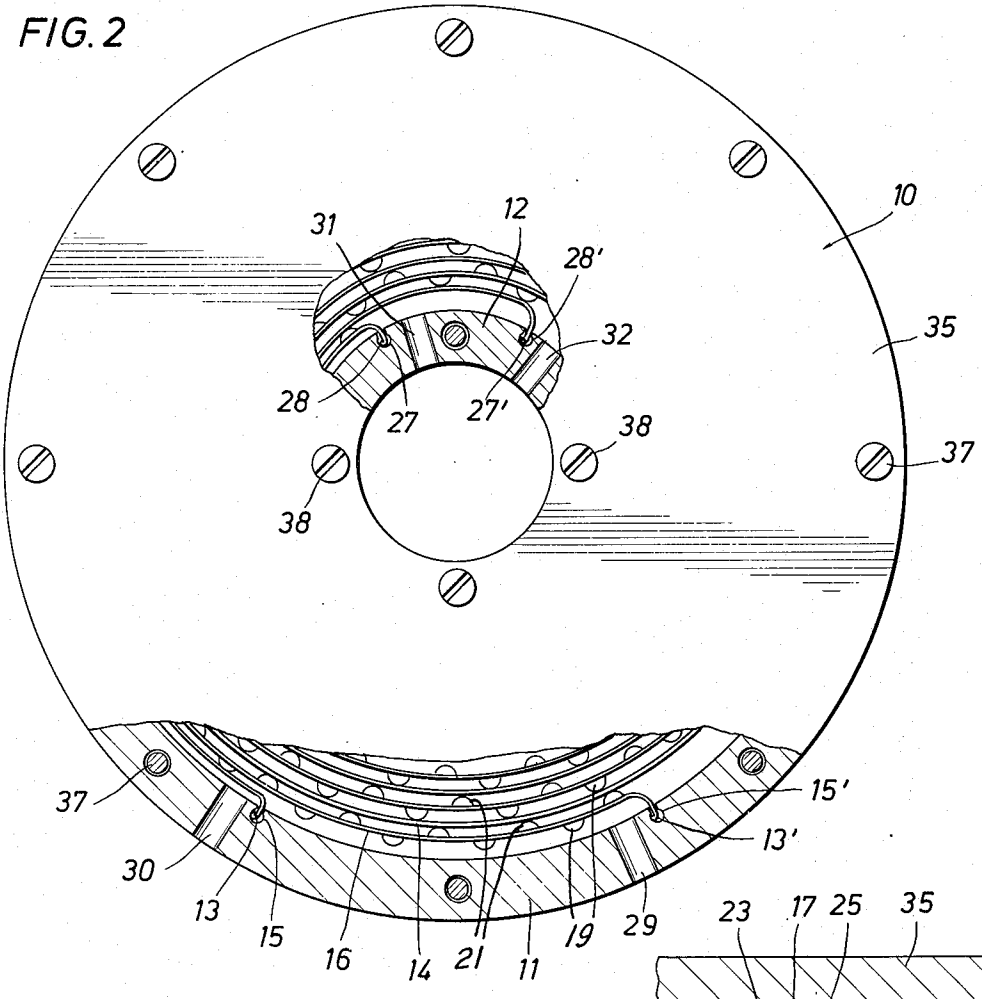


FIG. 2



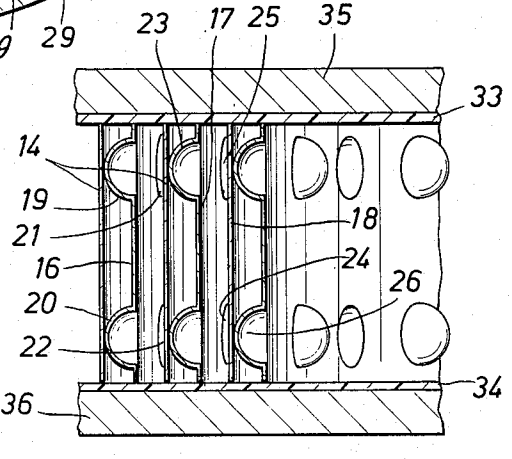


FIG. 3

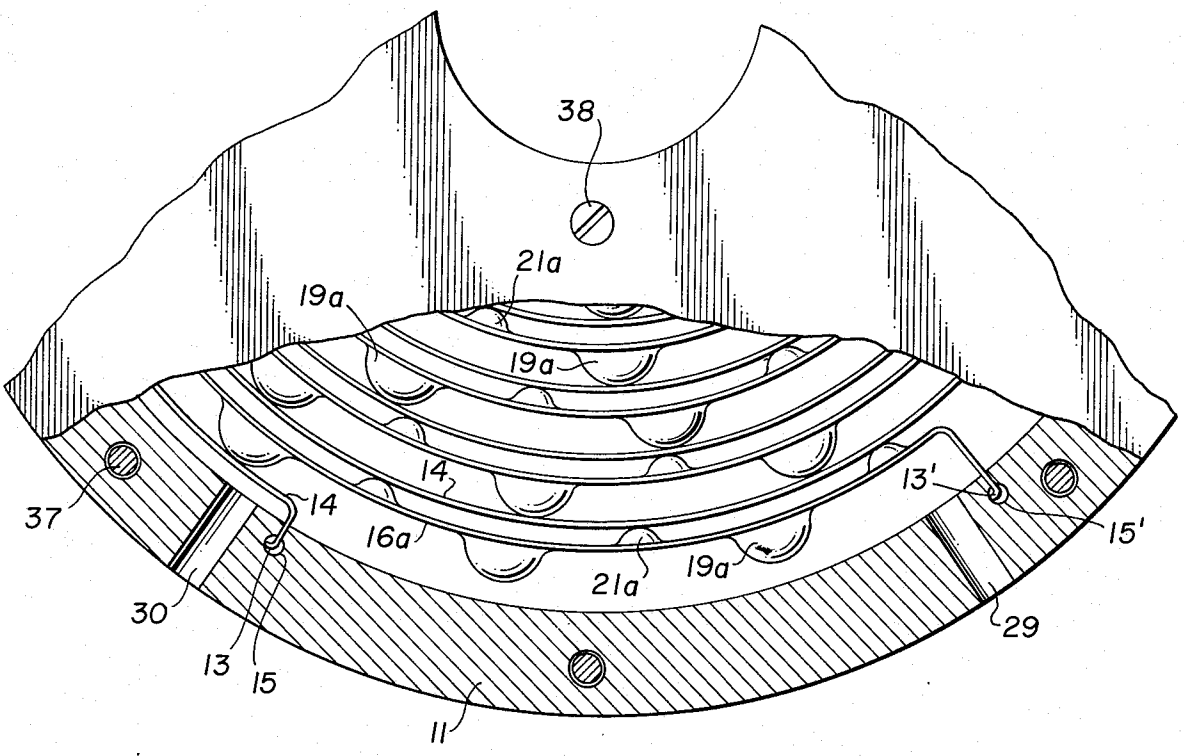


FIG. 4

HEAT EXCHANGER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to a heat exchanger. More specifically, the present invention is directed to a heat exchanger formed by alternating smooth and dimpled, thin, thermally conductive strips wrapped in a spiral.

2. Prior Art

U.S. Pat. No. 2,999,796

SUMMARY OF THE INVENTION

The present invention is directed to a heat exchanger wherein alternating smooth and dimpled, thin, thermally conductive strips are wrapped in a spiral to form the closed passageway. The dimpled strip has dimples extending from each side of the strip, the size and shape determining the fluid capacity of the passageway. The strips are utilized in pairs using either two, four or six or more alternating smooth and dimpled to form the closed passageways for the fluid. The strips are retained within an inner and outer retaining and fluid distribution ring. The strips are attached to the inner and outer retaining and fluid distribution rings at spaced points by the ends of the strips. Ports are located in the sides of the distribution rings between the spaced points for fluid to pass into or out of the passageways formed by the strips. Rubber gaskets seal the side edges of the strips and plastic or other material may be used as suitable insulating means so as to maintain the strips in a spiral between the inner and outer retaining fluid distribution ring in a fluid tight manner. In one of its more specific aspects, the present invention utilizes four strips alternating one smooth, one dimpled, another smooth, another dimpled, so as to form a tetra-fluid counterflow heat exchanger which may be easily disassembled for cleaning of any materials depositing on the strips or other operating problems.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric view of the heat exchanger of the present invention with a partial cut away of a section;

FIG. **2** is a top view of the heat exchanger of the present invention with partial cut aways showing the strips attached to the inner and outer retaining and fluid distribution rings;

FIG. **3** is a partial cross-section of a section of the heat exchanger showing the alternating strips in the spiral, and

FIG. **4** is a partial top view of the heat exchanger of the present invention with partial cutaway showing dimples of different size on the sides of the dimpled strip with fluid passageways having different capacity.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, heat exchanger **10** has an outer retaining and fluid distribution ring **11** and an inner retaining and fluid distribution ring **12.** The outer and inner retaining and fluid distribution rings **11** and **12** are made of rigid, non-porous materials, preferably with good insulation characteristics. A suitable material is a plastic such as phenolic resins. Between the rings **11** and **12** are pairs of alternating smooth and dimpled, thin, thermally conductive strips. The one end

13 of a smooth strip **14** is held in a slot **15** in the outer retaining and fluid distribution ring **11.** The slot **15** may be formed by a drilled hole of larger dimension than the slit from the inner surface of distribution ring **11** to the drilled hole. Alternatively, the slot **15** may be V-shaped with the small end at the surface of the retaining or distribution ring. The end **13** of the strip may be bent so as to form an enlarged portion with the slit or small portion of the V being essentially the size of the strips thickness. A sealant may be forced into the slot **15** after the end **13** of the strip is in the slot **15** so as to completely seal the end **13.** The end **13'** of a dimpled strip **16** is held in a similar slot **15'** within the inner circumference of outer retaining and fluid distribution ring **11.** The dimpled strip **16** is wound with the smooth strip **14** such that when it passes the slot **15,** the strips alternate as they are wound in a spiral. It is to be understood that while two strips, one smooth **14** and one dimpled **16** are described, that any number of pairs of smooth and dimpled strips may be wound in the spiral. The length of the strips are sufficient so that when wound in the spiral tightly they will fill the gap between outer retaining and fluid distribution ring **11** and inner retaining and fluid distribution ring **12.**

The dimpled strip **16** has dimples which extend from each side of the strip, as more clearly seen in the cross-section in FIG. **3.** In FIG. **3,** reference will be made to two pair of strips, the second smooth strip **18** alternating with a second dimpled strip **17.** In the embodiment of FIG. **3** the dimples **19** and **20** on one side of the dimpled strip **16** are of the same size and shape as dimples **21** and **22** on the other side although offset from one another. Likewise, the dimples **23** and **24** on one side of dimpled strip **17** are of the same size and shape as dimples **25** and **26** on the other side. This embodiment therefore is one in which four passageways of the same fluid capacity are formed. It is understood however, as shown in FIG. **4,** dimples **19*a*** on one side of dimpled strip **16*a*** may be of different size or shape from dimples **21*a*** on the other side of dimpled strip **16*a*** such that the fluid passageway between the strips may have different fluid capacity. Likewise while a spherical shape of dimple is shown in FIG. **2,** it is understood that the shape may be of any configuration provided that the strip is not punctured or weakened mechanically by the formation of the dimple.

The other end of the strips are retained in the inner retaining and fluid distribution ring **12** in the same manner as the outer retaining and fluid distribution ring **11.** An end **27** is maintained in a slot **28** in the inner retaining and fluid distribution ring **12.** Each end of the strips wrapped in the spiral will be attached to the inner retaining and fluid distribution ring **12** at a different and spaced point. A fluid port **29** in the outer retaining and fluid distribution ring **11** will pass fluid through the ring **11** such that the fluid will be between the ring and dimpled strip **16.** Another fluid port **30** in the outer retaining and fluid distribution ring **11** passes fluid so that it will be between the ring **11** and smooth strip **15.** Similarly, fluid ports **31** and **32** are shown in the inner retaining and fluid distribution ring **12.** The ports are between the fixed end of the strips in the respective rings **11** and **12.** The fluids as they are forced either from the inside to the outside or the outside to the inside of the heat exchanger **10** thus pass in a closed passageway formed by the alternating strips.

Referring to FIG. **3** a soft rubber gasket **33** at one side edge of the strips and another gasket **34** at the

other side edge is used to close the passageways in a fluid tight manner. The soft rubber gasket **33** and **34** are preferred since the sides of the strips will embed into the rubber gaskets forming a fluid tight seal. While not shown, several rubber gaskets of varying hardness may be used but it is preferred to utilize a plastic insulating cover **35** and **36** to complete the sealing and insulation of the side edge of the strips, or to use rigid metal back plates with insulation between the plate and the rubber seal.

The heat exchanger **10** is assembled by placing the alternating smooth and dimpled strips wrapped in the spiral between the outer retaining and fluid distribution ring **11** with the end of the strips held within the respective slots and the other ends held within slots in the inner retaining and fluid distribution ring **12.** The gaskets **33** and **34** are placed on either side of the strips as well as the insulating covers **35** and **36.** Bolts **37** are used which extend through the cover **35** on one side, the outer retaining and fluid distribution ring **11** to the other insulating cover **36** and can be tightened so that there is no leakage of fluid. Similarly, bolt **38** are in a ring to tighten the inner portion through inner retaining and fluid distribution ring **12.**

By the construction of the heat exchanger **10** according to the present invention it can be seen that the entire heat exchanger may be easily disassembled for cleaning. Such a heat exchanger can easily handle fluids such as salt water or chemicals of a highly corrosive or fouling nature because the heat exchanger can be easily disassembled, the strips separated and cleaned and then easily assembled for good service. Further, it has been found that heat exchangers built according to the present invention have efficiencies over 95 percent. These features are not found in heat exchangers of the prior art.

The nature and object of the present invention having been completely described and illustrated, and the best mode thereof contemplated set forth, what we wish to claim as new and useful and secure by Letters Patent is:

1. A heat exchanger which comprises:

an outer retaining and fluid distribution ring,

at least one pair of alternating smooth and dimpled thin, thermally conductive strips wound in a spiral which are attached to said outer fluid distribution ring at different points, said dimpled strip having dimples extending substantially outwardly from the plane of said dimpled strip from each side of said strip,

an inner retaining and fluid distribution ring to which said strips are attached at spaced points, and

means for sealing and insulating the side edge of said strips in a fluid tight manner thereby forming at least two closed passageways between said thermally conductive strips in spiral pathways between said outer retaining and fluid distribution ring and said inner retaining and fluid distribution ring.

2. A heat exchanger according to claim **1** wherein there are two fluid ports in said outer retaining and fluid distribution ring and said inner retaining and fluid distribution ring for each pair of spiral strips, said ports communicating with said closed passageways.

3. A heat exchanger according to claim **1** wherein four strips are alternatively spiraled.

4. A heat exchanger according to claim **1** wherein the dimpled strip has dimples on both sides of substantially the same size and shape forming closed passageways of the same fluid capacity.

5. A heat exchanger according to claim **1** wherein the dimpled strip has dimples on one side of substantially different size and shape than the dimples on the other side forming closed passageway of different fluid capacity.

6. A heat exchanger according to claim **1** wherein the ends of said strips have enlarged portions greater than the thickness of the strip and are held in slots in said inner and outer retaining and fluid distribution rings by said enlarged portions.

7. A heat exchanger according to claim **6** wherein the ends of said strips are sealed by filling said slots with a sealant.

8. A heat exchanger according to claim **6** wherein said slots are formed by drilled holes and slits in said inner and outer retaining and fluid distribution rings.

9. A heat exchanger according to claim **1** wherein the dimpled strip has dimples on one side of substantially different size than the dimples on the other side forming closed passageways of different fluid capacity.

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