June 6, 1967 R. B. CANNON 3,323,585

HEADER STRUCTURE FOR HEAT TRANSFER APPARATUS

Filed Aug. 25, 1965 3 Sheets-Sheet 1

FIG. 1.

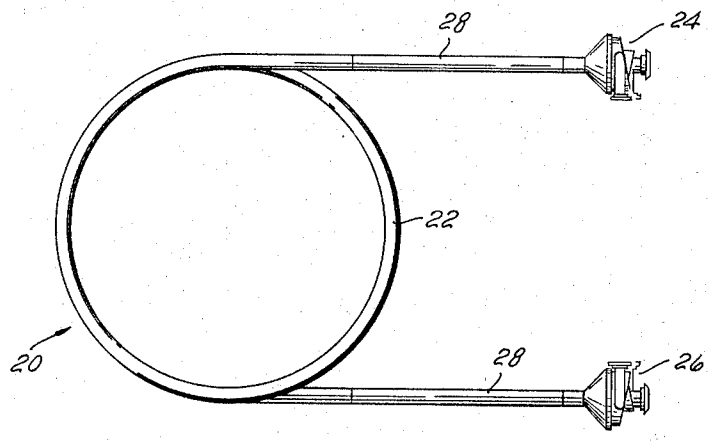


FIG. 2.

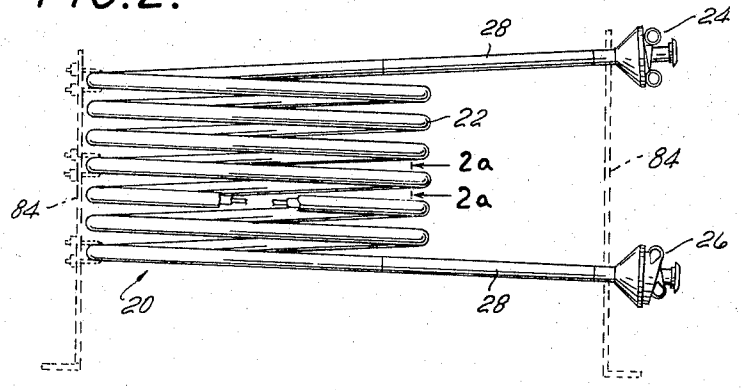


FIG. 2a.

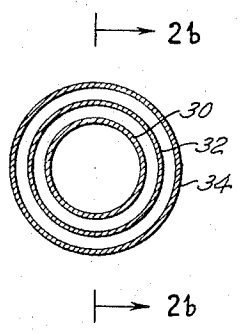
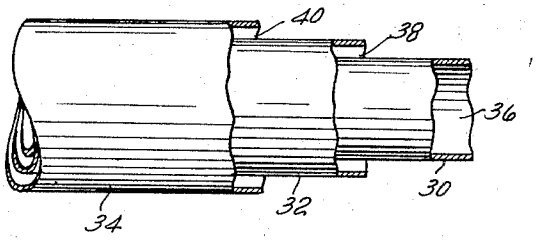


FIG. 2b.



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HEADER STRUCTURE FOR HEAT TRANSFER APPARATUS

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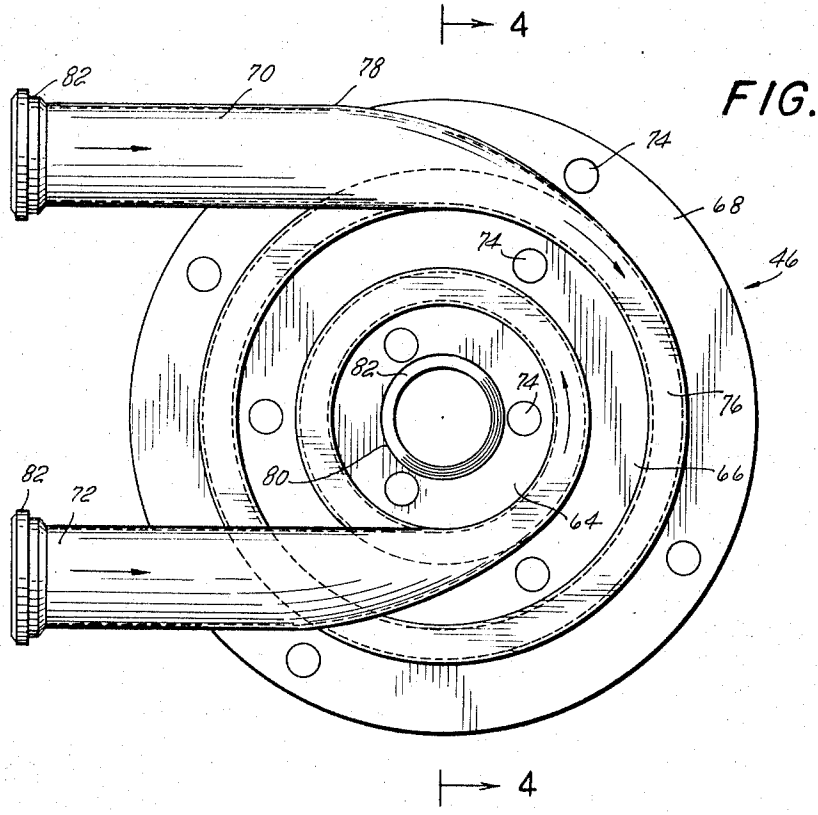


FIG. 3.

FIG. 6.

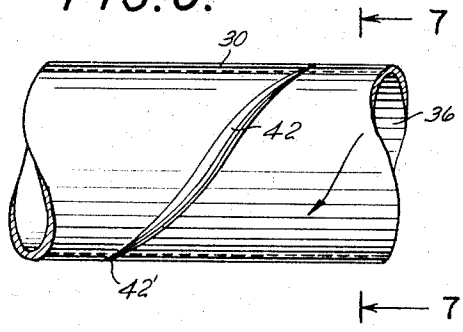
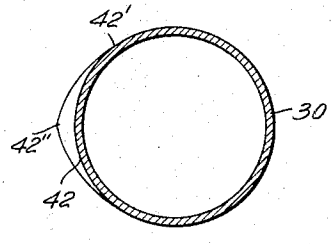


FIG. 7.



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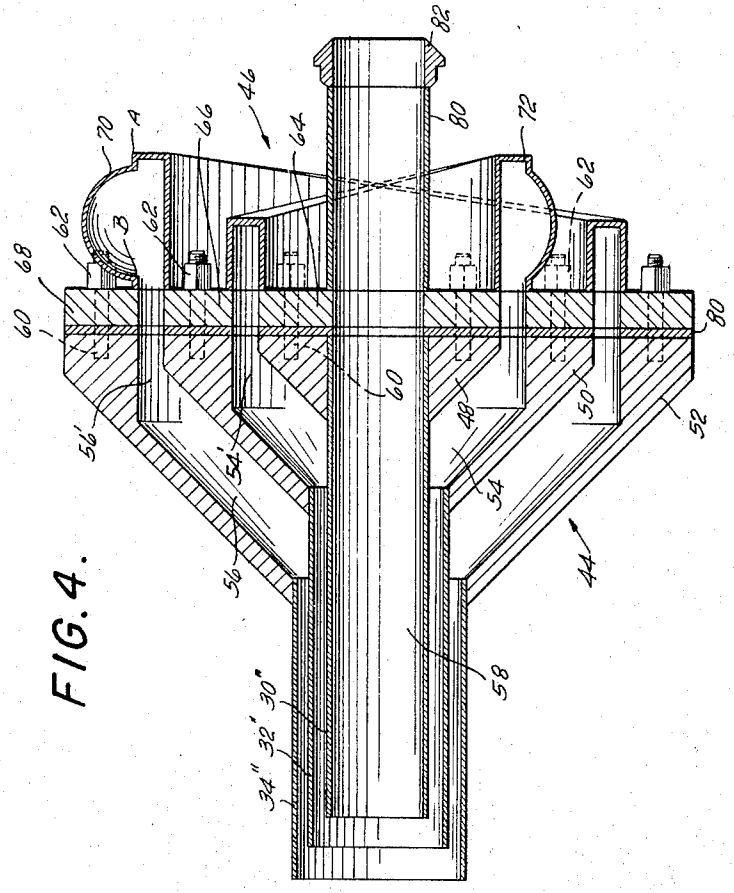

FIG. 4.

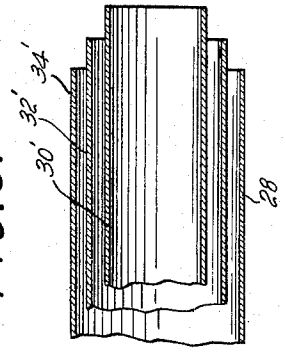

FIG. 5.

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HEADER STRUCTURE FOR HEAT TRANSFER APPARATUS

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Filed Aug. 25, 1965, Ser. No. 482,436
3 Claims. (Cl. 165—141)

The present invention relates to a fluid connector that is adapted to be connected to an apparatus used for heating or cooling fluid products during processing.

A preferred form of the invention uses a fluid connector comprising a header and distributor structure which is connected to the coils of a multiple tube heat transfer or heat exchanger apparatus. These devices are used extensively in a host of industries. As for example, such devices are used in industries concerned with the processing of liquids, such as milk and milk products, beverages, liquid foods, pharmaceuticals, chemicals, and petroleum, to name only a few.

Various types of heat transfer devices have been and are presently in use throughout these industries, among which are the so-called plate type and the tubular type, which includes the multiple tube device. In the latter a plurality of tubes are arranged in concentric relationship and the cooling or heating fluids are circulated through alternate adjacent tubes. Satisfactory results have been achieved through use of the multiple tube exchanger and specifically through the use of the spiral or helically wound type.

There is no theoretical limit on the length of the individual concentrically mounted tubes in the multiple tube spiral exchanger so that the individual tubes may be of an extended length to provide the necessary square feet of heat transfer surface. Therefore, the required surface to provide proper heat transfer is obtained without having to connect numerous sections of tubing, thus obviating the necessity for couplings and securing means which are required in other forms of exchangers of comparable length. Further, the expansion-contraction characteristic of the tubing is compensated for by the spiral shape, as may be evidenced by the implementation of an expansion loop in ordinary steam piping. Further still, and of great importance, the triple tube helically wound heat exchanger is of an improved sanitary type, lending itself to in-place-cleaning, since there are no junctures throughout its length where food or chemical products can lodge and deteriorate.

It is an object of this invention to provide a fluid connector which is particularly adapted to be used with a tubular type heat transfer apparatus, including both the straight and helically wound multi-tube devices to introduce appropriate fluids to and remove the fluids from the respective passages running the length of heat transfer tubing.

Another object is to provide a connector of the above type which introduces fluid too the transfer coil so as to have a tangential motion component, and to provide means within the helically wound coil for maintaining and generating the tangential fluid flow through the coil of the heat exchanger.

Yet an additional object is to provide a fluid connector wherein the component parts thereof are compactly oriented so as to occupy only a relatively small space and are constructed and assembled so that the connector and the assembled exchanger lends itself to in-place-cleaning.

Other objects and advantages of the invention will become apparent during the course of the following description.

The invention generally contemplates the provision of an improved fluid connector assembly which is adapted to be joined to a heat transfer apparatus for introducing

fluids to and removing fluids from a plurality of helically wound and concentrically mounted tubes. The fluid connector comprises a distributor member having a plurality of separate substantially similar hollow frusto-conical elements of graduated size which are assembled in generally concentric spaced nested relationship with their broad or base ends disposed on a common base plane and presenting a plurality of tapered annular passages separated by rings. A header assembly is attached to the broad base of the distributor to maintain the elements thereof in relative fixed relationship and to introduce fluid to the annular passages of the distributor.

In the accompanying drawings, which both illustrate a preferred embodiment of my invention and form a part of this application, and in which like numerals are employed to designate like parts throughout the same.

FIGURE 1 is a top plan view of the heat transfer apparatus, showing the coiled section and the inlet and outlet fluid connectors being joined to the coil by an extended length of straight tubing;

FIGURE 2 is a wide view of the transfer apparatus as seen in FIG. 1;

FIGURE 2*a* is a sectional view of the concentrically mounted tubes as seen along the line **2***a*—**2***a* in FIG. 2;

FIGURE 2*b* is a view partially in section and partially cut away, showing the concentrically mounted tubes as seen along the line **2***b*—**2***b* in FIG. 2*a*;

FIGURE 3 is an end view of the interchangeable inlet or outlet fluid connection;

FIGURE 4 is a sectional view of the connector assembly as seen along the line **4**—**4** in FIG. 3;

FIGURE 5 is a sectional view of an extension comprising a plurality of concentrically mounted straight tubes;

FIGURE 6 is a side view of one of the inner tubes of the exchanger showing an embossed tube spacer and turbulance generator formed thereon; and

FIGURE 7 is a sectional view of the tube and spacer as seen along the line **7**—**7** in FIG. 6.

The assembled heat transfer apparatus, generally indicated by the numeral **20**, is shown in FIGS. 1 and 2. The transfer apparatus includes a helically formed coil portion **22**, an inlet connector assembly **24** and an outlet connector assembly **26** of identical construction, and a pair of extensions **28** that connect the assemblies to the substantially straight tubular portions at opposed ends of the coil.

The coil of the heat transfer apparatus, including tubes **30**, **32** and **34** that are made of a suitable thin walled, light gauge metal, preferably a corrosion resisting metal such as stainless steel, may be formed in any manner as is well-known in the art. One of the many methods, suffice it to say, contemplates the initial fabrication of several equal lengths of tubing of different diameters. For example, the length of each tube may be in the order of 100 feet and the tubes may be 1½", 2" and 2½" in diameter. The respective tubes are individually wound on a properly dimensioned mandrel to form a spiral, with the spiral of each tube having the identical center line diameter and center line pitch distance. Thereafter, the tubes are inserted, one within the other, by a winding action. Therefore, using an outer tube having 2½" diameter and concentrically mounting a second and third tube of the type indicated above, therein, a single helical coil containing 300 feet of tubing is formed. This coil provides an adequate amount of heat transfer surface yet occupies only a relatively small space.

In the preferred embodiment, the heat exchange coil comprises three concentrically mounted tubes, but obviously the coil could contain a fewer or greater number of tubes, deypending upon industrial requirements. Using

the teaching of this invention, a connector assembly that provides necessary fluid inlets may be constructed.

Three fluid pasages **36**, **38** and **40**, bounded by the inner wall of tube **30** and the inner and outer walls of adjacent tubes, respectively, are formed by the concentrically mounted tubes. The relative spacing between these tubes is maintained by a plurality of spacers that are embossed on the tubes **30** and **32** in predetermined locations.

A single spacer element **42**, which is formed on tube **30** and representative of every spacer, is shown in FIG. 6 but, as brought out above, spacers are carried on both tubes **30** and **32** and these spacers are appropriately located along the length of each tube. The spacer element is of an elongated substantially helical configuration and generally directed at an angle of approximately 45° to the axis of the tube. The opposed ends of the spacer at **42'** are flush with the peripheral surface of the tube and each spacer gradually rises to a height, at a center point **42''**, that is slightly less than the radial distance between concentric tubes. Thus, in one aspect, the spacers maintain the relative spacing between the assembled tubes to provide a uniform cross-section and therefore maintain a constant fluid flow through the coil, yet the spacers are not of such dimension so as to make the assembly operation an impossibility.

In practice, I employ a plurality of spacers with adjacent spacers positioned both longitudinally and rotationally from one another. Satisfactory results are obtained when the spacers are located with adjacent center points (points of maximum height) being longitudinally spaced at two feet intervals and rotationally spaced by 120°. Further, the spacers on one tube (FIG. 6) are generally directed from left to right. Therefore, as will be brought out below, since fluid entering the coil **22**, and in particular the fluid passages **38** and **40**, has a tangential motion component whereby fluid flow is in a substantially helical path, one flow being clockwise and the other counter-clockwise, the positioning of the spacers acts to maintain and generate this rotational directivity along the length of the aforementioned passages.

The fluid connector assembly, as best shown in FIGS. 3 and 4, comprises a distributor member **44** and a header **46**. Since both the inlet and outlet connectors **24** and **26** (FIG. 1) are of identical construction only a single connector and its component parts will now be described.

The distributor member is formed by and includes a plurality of hollow frusto-conical distributor elements **48**, **50** and **52**. The elements are generally similar in shape and graduated in size so that they may be loosely nested one within the other. The elements carry an annular base portion that, when each element is properly aligned, lies on a common base plane to provide a pair of concentric, annular openings **54'** and **56'** leading to a pair of fluid passages **54** and **56** between the inner and outer walls of adjacent conical elements. A third fluid passage **58** is bounded by the inside wall surface of the inner frusto-conical element **48**.

It is to be noted that the tapered wall of each element when the elements are aligned, is spaced from the tapered wall of an adjacent element. This spacing, while not of any critical dimension, should be approximately ⅜"–½" and is required so that the elements are longitudinally movable relative to one another when joining the connector to the coil. This will be discussed below.

Carried by the base portion of each element and at angularly spaced locations are a plurality of studs **60**. The studs are positively seated in the bases and extend for a substantial distance in a direction normal to the base plane with the extended length being threaded and thereby capable of receiving the nuts **62**.

A header **46**, that is adapted to be received on the distributor member, comprises a plurality of flat annular rings **64**, **66** and **68** together with a pair of similar control conduits **70** and **72** that are suitably welded thereto so as to define a rigid structure.

The rings are also of graduated size, each having an inner and outer diameter that is equal to the inner and outer diameters of the associated and complementary base portions of the distributor elements. Therefore, when their faces are in juxtaposed relation, the annular and concentric openings between adjacent rings will be in alignment with and form a continuation of the annular and concentric openings **54'**, **56'** and **58** formed by the base portions of the distributor elements.

The individual rings are provided with a plurality of holes **74** that are formed through their faces. The holes are angularly located in each ring and in alignment with the studs **60** on the distributor elements so that the header may be mounted on the distributor member and secured thereto.

As brought out hereinbefore and apparent from the figures, flow control conduits **70** and **72** are similar in construction differing only in size. Therefore, the following description is considered adequately descriptive of both conduits.

Conduit **70** includes an annular portion **76** and an interconnected substantially tubular portion **78**. The parts may be welded, otherwise suitably connected together or else, the conduit may be cast and therefore be of unitary construction. In either case the interconnected walls, at the point of juncture, are streamlined and provide a tangential connection between portions.

The annular portion has inner and outer walls that are generally cylindrical and a top surface that is inclined to the plane of the base of the annular portion so that each vertical section therethrough, is rectangular in shape. As noted in FIG. 4, the rectangles uniformly decrease in height from a maximum A at 0° to a minimum B at 360°. Further, the annular portion has a rectangular fluid channel disposed therein and because of the sloping nature of the top wall the fluid flow will generally be in a converging helical direction toward the concentric openings between rings **64**, **66** and **68**. By reference to the arrows in FIG. 3, it is noted that one conduit converges the flow in counter-clockwise direction.

The flow control conduits **70** and **72** are sequentially received on the rings to form the rigid header with the annular base of conduit **70** being welded or suitably fastened to the periphery of rings **66** and **68** whereby the fluid channel communicates with the concentric opening **56'**. Similarly, the conduit **72** is received on rings **64** and **66** so that its fluid channel communicates with the concentric opening **54'**. Thereafter, a straight conduit **80** is welded to the inner peripheral surface of ring **64**.

As seen in FIG. 3, all the aforementioned conduits are provided with sanitary tube fittings **82** for connection to proper plant process piping.

In assembling the appartus, the connector may be directly joined to the coil or else connected by means of an extension piece **28**. The extension shown in FIG. 5, includes tubes **30'**, **32'** and **34**. Suitably the aforementioned tubes are of the same gauge and dimension as the tubes **30**, **32** and **34** forming the coil **22**.

Whether the coil be directly joined to the connector or joined to the extension, the individual tubes at the opposed ends of the coil are cut so that the tubes terminate in steps. The longitudinal spacing between adjacent tube ends may be on the order of ⅜". Preferably the extensions **28**, comprising tubes **30'**, **32'** and **34'**, are welded to the opposed ends of the coil and because the latter tubes are initially of equal length, the welded tubes retain the stepped relationship of the tube ends in coil **22**.

The reduced ends of the distributor elements are welded to the outer surface of tubes **30''**, **32''** and **34''**. These tubes are of selected lengths so that when the base portions of the elements lie on the common base plane, the ends of tubes **30''**, **32''** and **34''** will be stepped in the opposite direction and complementary to the tubes in extensions **28**. Because the individual conical elements are longitudinally movable relative to one another, the conical

elements may be joined to the extension by sequentially welding the complementary tubes, the inner tube first. Thereafter, a stainless clad asbestos gasket and the header is received on the studs **60** and secured by the nuts **62**. The assembled apparatus may now be supported by frame **84**, shown in FIG. 2.

While the invention has been particularly shown and described with reference to the preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

Having described by invention, I claim:

1. A heat transfer apparatus for the heating or cooling of a liquid product comprising a plurality of concentrically mounted and extended tubular members, a plurality of generally nested, spaced, hollow frusto-conical elements secured to the outer wall of each of said tubular members and terminating in a base lying on a common base plane, the space between the inner and outer walls of adjacent concentric elements providing a fluid passage in communication with the space between tubular members, the terminated bases providing a first plurality of concentrically arranged annular rings adjacent to the first plurality for directing fluid within the boundaries of each separate passage, means connected to the header rings for supplying different fluids into the different passages and simultaneously introducing a fluid motion having a component substantially tangent to the annular openings, and means on at least some said tubular members for relatively positioning said members along said extended length to provide a uniform cross-section and further to maintain the substantial tangential directivity of the fluid flow.

2. The apparatus of claim **1** wherein said means on at least some of said members is a plurality of protuberances each having a pair of intersection inclined surfaces and elongated substantially in the longitudinal direction.

3. A heat transfer apparatus for the heating or cooling of a liquid product comprising a first plurality of concentrically mounted and extended tubular heat transfer members, a plurality of generally nested, spaced, hollow frustro-conical elements, said elements having one end secured to the outer wall of a second plurality of concentrically mounted tubular members and the other end terminating in a base lying on a common base plane whereby the inner tubes of said second plurality do not project beyond an adjacent outer tube, the space between the inner and outer walls of adjacent concentric conical elements providing a fluid passage, the terminated bases providing a first plurality of concentrically arranged annular rings, a header including a second plurality of concentrically arranged annular rings adjacent to the first plurality for directing fluid within the boundaries of each passage, means connected to the header rings for supplying different fluids into the different passages and simultaneously introducing a fluid motion having a component substantially tangent to the annular openings, and means connecting said first and second pluralities of concentrically mounted tubular members to provide fluid communication therethrough.

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A. W. DAVIS, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,323,585 June 6, 1967

Robert B. Cannon

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 57, "too" should read -- to --. Column 2, line 21, "wide" should read -- side --; line 71, "deypending" should read -- depending --. Column 5, line 24, after "rings" insert -- , a header including a second plurality of concentrically arranged annular rings --.

Signed and sealed this 13th day of January 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents