

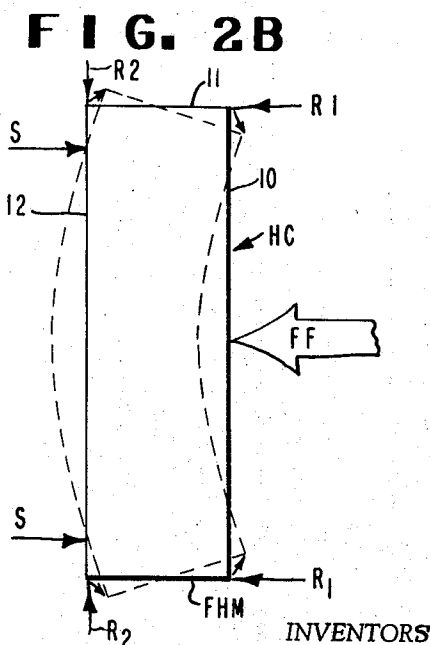
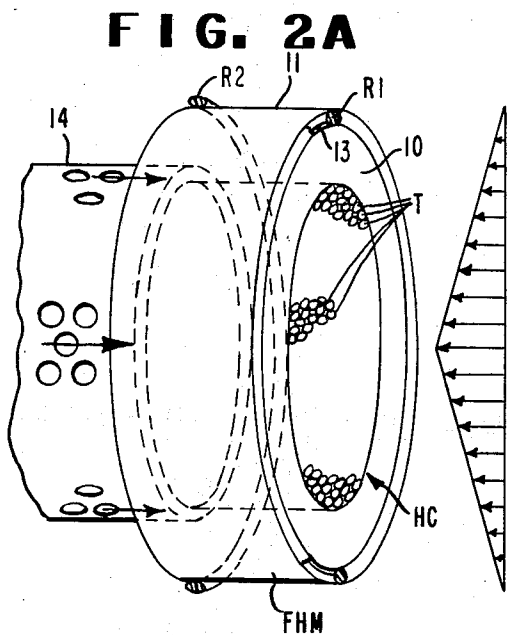
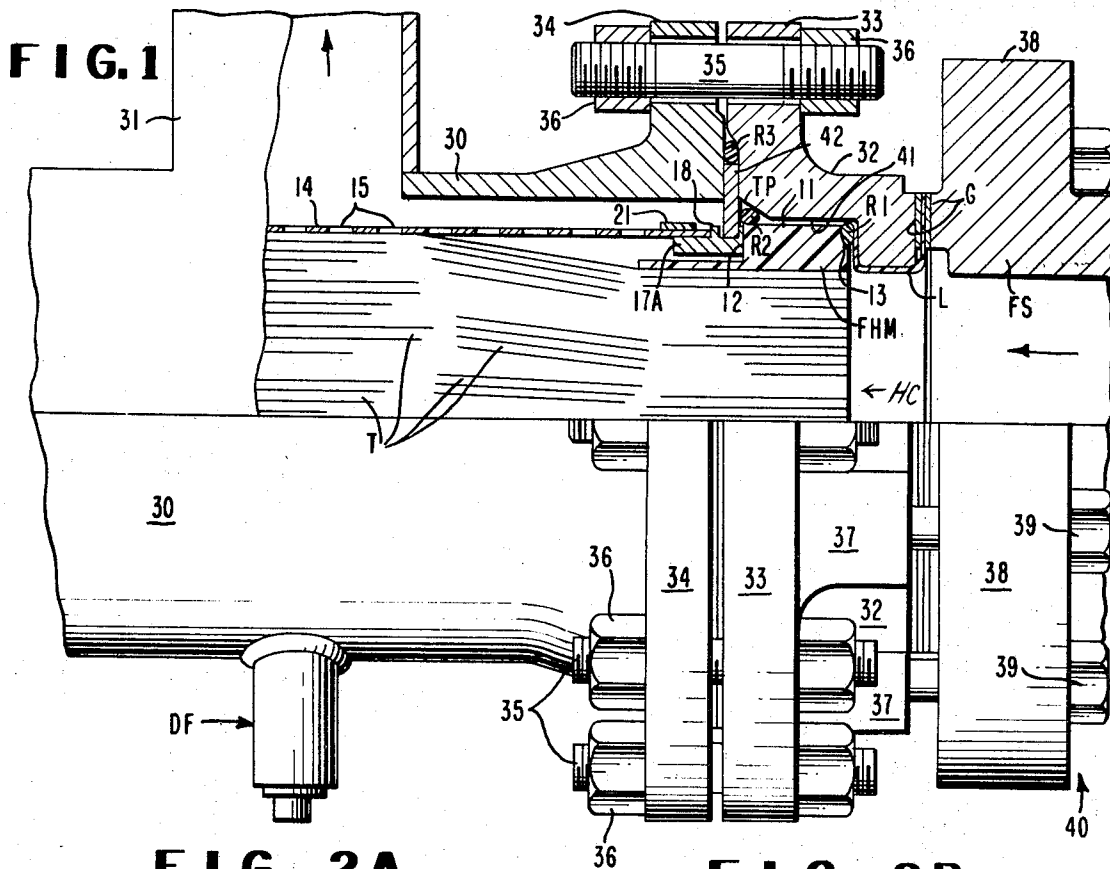
Sept. 1, 1970

H. J. VANCE ET AL
TUBE BUNDLE ASSEMBLY HAVING NOVEL BAFFLE AND HEADER SEAL
FEATURES FOR USE IN PLASTIC TUBE HEAT TRANSFER
APPARATUS COMBINATIONS

3,526,275

Filed May 27, 1968

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

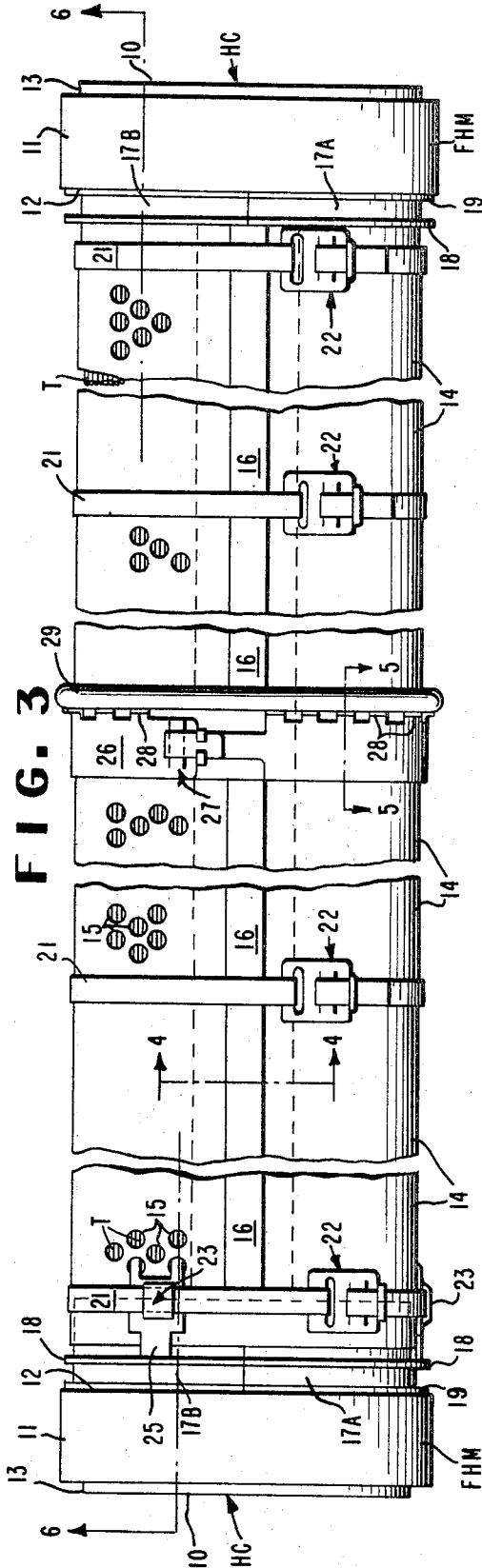


FIG. 4

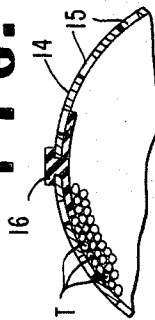


FIG. 5

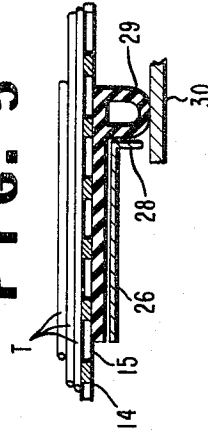
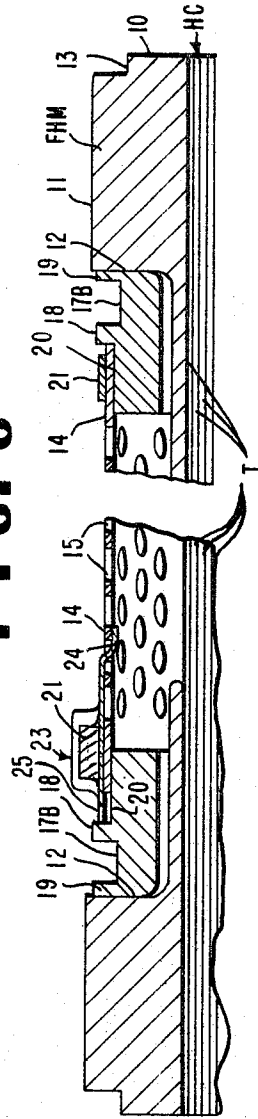


FIG. 6



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3,526,275

TUBE BUNDLE ASSEMBLY HAVING BAFFLE AND HEADER SEAL FEATURES FOR USE IN PLASTIC TUBE HEAT TRANSFER APPARATUS COMBINATIONS

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Int. Cl. F28f 9/02; F16l 41/00

U.S. Cl. 165—158

11 Claims

ABSTRACT OF THE DISCLOSURE

A heat transfer apparatus having a rigid integrated tube bundle assembly wherein flexible plastic tubes are maintained in a rigid perforated sleeve unit, said assembly further comprising an elastically deformable annular baffle structure to control shell-side flow and special sealing and supporting features for cooperation with a casing member and header members in which the tube bundle assembly and its sleeve unit are positioned.

CROSS REFERENCES TO RELATED APPLICATIONS AND PATENTS

U.S. Pat. No. 3,315,740 to M. S. Withers, filed Jan. 14, 1965, issued Apr. 25, 1967; U.S. Pat. No. 3,222,456 to Brown et al., filed Mar. 1, 1965, issued Jan. 11, 1966; U.S. Pat. No. 3,277,959 to M. S. Withers, filed Aug. 12, 1964, issued Oct. 11, 1966; U.S. Pat. No. 3,363,680 to Baker, filed July 21, 1966, issued Jan. 16, 1968; U.S. Pat. No. 3,380,513 to Staats, filed Sept. 26, 1966, issued Apr. 30, 1968; application for U.S. patent Ser. No. 598,070 to R. D. Smith, filed Nov. 30, 1966, now U.S. Pat. No. 3,417,812, issued Dec. 24, 1968.

FIELD OF THE INVENTION

This invention relates to the field of heat transfer or heat exchange, more specifically to heat transfer apparatus combinations utilizing flexible plastic tube elements, and to improved tube bundle assemblies for use in such combinations.

It is a general object of the invention to provide novel and improved heat transfer apparatus combinations and tube bundle assemblies which perform more effectively and more reliably by overcoming certain problems and disadvantages associated with earlier prior art heat transfer equipment utilizing flexible plastic tube elements, as will be described in detail hereinafter.

Other objects and advantages will be apparent from the following specification, claims, and accompanying drawings.

PRIOR ART BACKGROUND OF THE INVENTION

As indicated generally in U.S. Pat. No. 3,288,456 and also in subsequent patents, such as, for example, U.S. Pat. Nos. 3,363,680, 3,277,959, and 3,380,513, heat exchange, or transfer arrangements utilizing plastic tubular elements are known and have been found to be advantageous in many commercial applications. Because of the use of small flexible plastic tubular elements a number of problems have been encountered, not only in designing and producing such arrangements, but also in their operation. Some of these problems involve the relatively low heat transfer coefficients and the relatively high coefficients of thermal expansion possessed by most plastic materials as compared with parts made of more conventional materials such as metals. Other problems relate to the different properties such as compressive strength, ten-

2

sile strength, toughness, flexibility, and melting points of these plastic materials relative to the other materials used. Production and operating techniques as well as apparatus designs have to be established such that the more conventional arts such as those still formed of the usual metallic compositions can be shaped, formed, heated, assembled, and used while in cooperative association with the plastic parts to produce and operate economical, reliable, and effective heat transfer arrangements without destroying or damaging the associated plastic parts by application of excessive forces, impacts, temperatures, or other conditions.

One problem involves damage to plastic parts such as the tubular elements and sealing rings during shipment, assembly and disassembly of heat transfer apparatus. In addition, assembly and disassembly of components to form heat transfer apparatus combinations has been difficult in certain cases because of previous designs. For example, it has been difficult, and great care was required, in assembling components as shown in U.S. Pats. 3,277,959 and 3,363,680 to form a complete heat exchanger. Positioning the flexible unsupported bundle in a close-fitting shell without damaging the small plastic tubes was difficult. Disassembly posed a similar problem. Surrounding a flexible bundle of tubular elements over only a portion of its length with helical spring elements or with perforated sleeves of limited length as shown in U.S. Pat. 3,363,680 or in assignees copending patent application Ser. No. 598,070 filed Nov. 30, 1966 in the name of Robert Dilman Smith have not proved completely satisfactory in solving this problem. Undesirable forces were still able to act upon the small plastic tubes when positioning such a partially surrounded tube bundle assembly in or removing it from the usual shell or casing member particularly when solid deposits built up on the internal surface of the shell or on the solid baffles carried by the partial sleeves. In other instances it has been difficult to assemble components as disclosed in U.S. Pat. Nos. 3,277,959 and 3,363,680 without damaging the sealing rings which must be prestressed to some considerable degree for proper functioning.

Another problem involves a tendency toward unsatisfactory sealing performance by the seal rings surrounding the annular sheath members to which the hollow tubes are bonded at each end of the tube bundle assemblies as disclosed in U.S. Pats. 3,363,680 and 3,380,513. It has been observed that at the inlet end of a tube bundle assembly, the honeycomb-like arrangement formed where the ends of the tubular elements are bonded to each other and to the surrounding annular sheath member, the portion of this honeycomb arrangement facing upstream during the flow of a hot pressurized fluid through the tubular elements may tend to bend or distort as shown in FIG. 2B of the drawings. With sealing rings arranged as shown in the U.S. Pats. 3,363,680 and 3,380,513 it is clear that, particularly the upstream sealing ring, will not function properly due to separation of the surfaces between which the sealing ring is engaged.

The novel and improved arrangement and features of the present invention overcome these problems and successfully satisfy the requirements or objects of the invention as mentioned above in providing an improved heat exchanger or transfer apparatus combination having metallic and plastic components, which combination performs effectively and reliably, and in addition, satisfactorily accommodates during its operation at elevated temperatures and pressures the different properties of the plastic and metallic components.

SUMMARY OF THE INVENTION

Generally stated, according to this invention, damage to the plastic tubular elements and sealing means is sub-

stantially reduced or eliminated, assembly and disassembly of heat transfer apparatus is facilitated, sealing action is improved and resistance to deformation at the inlet end of the tube bundle assembly is significantly increased by providing a rigid perforated or foraminous sleeve unit completely surrounding the flexible tube element bundle and secured in engagement with the annular sheath members at the ends of the bundle, the sleeve unit carrying on its outer periphery a resiliently deformable, or yieldable, circumferentially extending baffle member to control shell-side flow, and by providing a special sealing and support means cooperating in a particular way with the ends of the bundle assembly, the sleeve unit, and the header and casing members in which the assembly is positioned. The sealing and supporting means is positioned to oppose and reduce deformation of the plastic end structure of the tube bundle assembly due to hot pressurized fluid moving into the hollow tubular elements, and also to maintain proper sealing action even though some deformation of this structure occurs. The details of the improved heat transfer apparatus combination and its operation in solving the above noted problems and in achieving the desired results or objectives will be fully described in following portions of this specification.

In the drawings:

FIG. 1 is a partial side elevational view of a heat transfer apparatus combination embodying features of the invention, certain parts being broken away for a clearer showing of the tube bundle assembly and sealing and supporting means details.

FIG. 2A is a partial perspective somewhat schematic view of one end of the tube bundle assembly of a heat transfer apparatus combination of the present invention showing the support provided by the sleeve unit and the positions of the main sealing and supporting rings. Also indicated is a general representation of the profile of moments of force across a cross section of one annular member and honeycomb arrangement of a tube bundle assembly due to the pressure of an incoming fluid stream moving into the tubular elements of the bundle assembly.

FIG. 2B is a schematic view of a cross section of one annular member and honeycomb arrangement at one end of a tube element bundle assembly showing the nature of deformation under the pressure of a high temperature fluid stream moving into the tubular elements, and also showing how the sealing and supporting rings function to oppose and reduce this deformation and maintain effective sealing action.

FIG. 3 is a partial side elevational view of a tube element bundle assembly for use in a heat transfer apparatus embodying principles of this invention, certain portions of the assembly are shown broken away to conserve space.

FIG. 4 is a partial cross sectional view of the assembly of FIG. 3 taken at line 4—4 of FIG. 3.

FIG. 5 is a cross sectional view of the baffle structure mounted on the bundle assembly of FIG. 3 taken at line 5—5 of FIG. 3.

FIG. 6 is a partial longitudinal cross sectional view of the assembly of FIG. 3 taken at line 6—6, certain parts being shown broken away.

A preferred embodiment of a heat transfer apparatus combination and an improved plastic tube bundle assembly according to the present invention is shown in FIGS. 1, 3, 4, 5, and 6. In FIG. 1 only one end of the assembly is shown, the other end being substantially the same in all respects. The heat transfer apparatus combination and tube bundle assembly shown in FIGS. 1, 3, and 6 comprise a plurality of flexible tubular elements T generally extending in the same direction and laterally positioned to form a bundle. The bundle shown in these figures is cylindrical with a substantially circular transverse cross section. The tubular elements T at each end of the bundle are bonded to each other and to the interior surface of an annular first header member, or

collar member, FHM in a suitable manner so that the header members may be operatively connected one with a fluid supply conduit member FS and the other to a similar fluid exhaust conduit member (not shown) as generally shown in FIG. 1. Preferred examples of the arrangements for bonding the terminal portions of tubular elements T to each other and to the annular header members FHM are disclosed in U.S. Pat. No. 3,315,740 mentioned above. Suitable materials of which the tubular elements may be formed are disclosed in U.S. Pats. 3,228,456; 3,277,959; and 3,315,740. A preferred composition at the present time being a polyfluorinated plastic such as a copolymer of tetrafluoroethylene and hexafluoropropylene. The flexible tubular elements of the bundle assembly preferably are in a size range between about 5 and 275 mils outside diameter with a wall thickness between about 0.5 and about 30.0 mils. However, it is believed to be clear to those of ordinary skill in the art involved that other materials and dimensions could be utilized without departing from the spirit of the invention. Many other materials, such as for example, completely organic or partly organic polymeric compositions could be used, so long as they were readily fabricatable, possessed suitable compatibility with the fluids to be handled, possessed adequate properties such as strength at the desired operating conditions, and further possessed adequate thermal conductivity for the intended use.

FIG. 3 shows a tubular element bundle assembly TBA embodying features of the invention and FIG. 1 shows such a bundle assembly installed in a heat transfer apparatus combination of the invention. As indicated in FIGS. 3, 4, 5, and 6 the tube bundle assembly TBA comprises an elongated bundle of tubular elements T the terminal or end portions of which are bonded to each other and to annular header, or collar, member FHM. A honeycomb-like arrangement HC is formed where the end portions of the tubular elements T and header member FHM are thus joined together. A somewhat perspective view of this honeycomb arrangement is shown in FIG. 2A. Each annular header member FHM is provided with an outer end surface 10 and an opposing inner end surface 12 connected by a circumferentially extending peripheral surface 11. An annular shoulder or portion 13 of reduced diameter is formed at the intersection of end surface 10 with peripheral surface 11 of each first annular header member FHM. A rigid perforated or foraminous elongated sleeve unit surrounds and engages the bundle of tubular elements T and abuts the inner end surfaces 12 of the annular header or sheath members FHM. This sleeve unit comprises a main cylindrical element 14 preferably formed of suitable rigid sheet material such as metal, and provided with a pattern of distributed holes or openings 15. In the version of this sleeve unit shown in FIGS. 3, 4, 5 and 6 sheet element 14 is formed around the periphery of the tube element bundle and is opposed portions or edges cooperate with a plastic or elastomeric edge sealing member 16, as shown in FIG. 4, to completely enclose the bundle. The sheet element 14 and sealing member 16 are maintained in cylindrical form by means of suitable circumferentially extending bands 21 preferably of metal and provided with conventional band clamping and securing devices 22. The sleeve unit further comprises at each end of sheet element 14 an annular split bushing unit comprising two parts 17A and 17B as shown in FIG. 3. Each annular split bushing unit abuts an inner face 12 of annular header members FHM and is provided with an annular groove defined between two annular circumferential wall elements 18 and 19. The annular inlet bushing units also are provided with elongated longitudinally extending portions 20 of reduced diameter which portions extend into the opposed ends of the rigid cylindrical sleeve unit formed by sheet element 14 and edge sealing member 16 where they are secured by means of bands 21 as shown in FIGS. 3 and 6.

The left end of the sleeve unit as seen in FIG. 3 is provided with clip elements 23 which cooperate with the band 21 securing the sleeve sheet element 14 to portion 20 of the split bushing unit 17A, 17B. Each clip element 23 is provided with one end portion 25 (shown in FIG. 6) which abuts the circumferential wall element 18 of split bushing unit 17A, 17B and another offset end portion 24 (shown in FIG. 6) which interlocks with one of the openings 15 in sleeve sheet element 14. This adjustable cooperation between the clip element 23, wall element 18 and openings 15 established positive interengagement, and a substantially rigid support between the annular header members FHM and the sleeve unit as shown.

The sleeve unit further comprises, as seen in FIGS. 3 and 5, a circumferentially extending annular baffle device which comprises an elastomeric resilient element 29 having a P-shaped transverse cross section, and a suitable positioning band member provided with a circumferentially extending portion 26 and a clamping or securing device 27 for maintaining the resilient element 29 in desired position on said sleeve unit. Band member portion 26 is provided with circumferentially spaced radially extending portions 28 which engage and provide longitudinal support for one side of the radially projecting portion of resilient element 29 as shown in these figures.

When a tube bundle assembly TBA such as that illustrated in FIG. 3 is positioned in a heat transfer apparatus comprising a casing or shell member and end closure or header members, it is operatively engaged and supported primarily at its end portions as illustrated in detail in FIG. 1. In this figure the bundle assembly is positioned within a generally cylindrical casing member 30 of conventional design and provided with end flanges 34, inlet or outlet 31, and a drain fitting DF. An end cap or second header member 32 having flange 33 is shown secured to end flanges 34 of the casing member 30 by means of threaded stud bolt 35 and threaded nut elements 36. Header member 32 is provided with an internal recess or bore 41 and is secured to a fluid supply conduit element FS, 40, by means of machine bolts 39 extending through flange 38 on the conduit element and into threaded engagement with holes formed in enlarged portions 37 of the header member. As seen in FIG. 1 the first annular header member FHM is received in the recess 41 in second header member 32 with sufficient clearances to prevent interference due to thermal expansion at all operating temperatures. A split ring 42 is positively engaged and secured in positive between the opposed flanges 34, 33 of the casing member 30 and second header member 32 and extends inwardly into operative engagement with the annular groove of the annular split bushing unit 17A, 17B to secure the end of the tube bundle assembly in position relative to the casing member 30. A sealing and supporting means preferably comprising of an annular resilient seal and support ring R1 is positioned between the surfaces of recess 41 in the second header member 32 and the first annular header member FHM, and is specifically located as shown at shoulder or reduced portion 13 of member FHM at the general intersection of outer end surface 10 with peripheral surface 11 of header member FHM. Another sealing and supporting ring R2 is provided and located as shown in FIG. 1 in operative engagement with the peripheral surface 11 of header member FHM, a tapered portion AP of recess 41 in header member 32, and one side of split ring 42. Another sealing ring R3 is positioned in operative sealing engagement with flange 34 of the casing member 30, flange 33 of header member 32 and the outer peripheral surface of split ring 42.

If desired, a liner element L formed of a fluorinated plastic material can be provided to protect the internal surfaces of header member 32 from corrosive fluids moving through the hollow tubular elements of the bundle assembly. Suitable gaskets G can be provided to improve

the fluid-tight connection between header member 32 and a fluid conduit element FS to which it is connected.

The general operation of the heat transfer apparatus shown in FIG. 1 is believed to be clear, one fluid being passed through the casing member 30 exteriorly of the tubular elements T entering and leaving through fittings such as 31, while another fluid at a different temperature moves through supply conduit element FS as shown by the arrow into the open ends of the hollow tubular elements and then through the tubular elements to a similar header and conduit at the other end of the casing member 30.

It will be seen from the construction shown and described that the fluid within casing member 30 exteriorly of the tubular elements is prevented from leaking between the header members and the casing member by means of ring elements R2 and R1.

Ring elements R1 and split rings 42 jointly support the tube bundle assembly in position relative to the casing member 30 and header members 32. The structural interconnection between the header members FHM, at opposite ends of the apparatus, accomplished through rigid sleeve unit comprising element 14 also helps maintain the tube bundle assembly in position and to distribute forces or impacts on one header member at least partially to the other header member without overstressing or damaging the plastic tubular elements of the bundle assembly.

The resilient baffle member 29 facilitates assembly and disassembly of the tube bundle from a given casing member especially after hard solid deposits have developed on the interior of the casing member or on the baffle member. The use of such a resilient yieldable baffle member makes it possible to adapt a baffle member of given transverse dimensions to fit in operative engagement with a number of casing members having different internal transverse dimensions. This is advantageous as to interchangeability of units and reduces the number of parts needed to produce heat transfer units of various sizes. The resiliently deformable baffle member has the further advantage of being self-unloading in permitting by-passing of shell-side fluid on occurrence of pressure surges above a given level which could damage the tubular elements.

As is clear from FIGS. 2A and 2B the engagement of the split bushing unit of the rigid sleeve unit with the inner end surface 12 of header member FHM cooperates with the engagement of ring members R1 and R2 with header member FHM to resist and reduce movement and deformation of the member under forces of a pressurized heated inlet fluid, and also to cause an increase in the effectiveness of the sealing action of these ring members which are increasingly compressed as deformation occurs. However, the location of ring members R1 and R2 and the clearance between the header members FHM and 32 are such that thermal expansion of plastics member FHM at its higher rate is accommodated without interfering engagement of these members or overstressing of the ring members. This is a feature of considerable benefit and importance in overcoming the problems inherent in certain prior art heat transfer designs discussed in preceding portions of this specification.

In addition, location of ring members R1 and R2 as shown in FIG. 1 rather than in circumferential grooves in peripheral surface 11 of member FHM makes assembly much easier as to getting the ring members into their proper positions.

The features of the tube bundle assembly of this invention as discussed in the preceding portions of the specification also result in a component of a heat transfer combination which is compact, rugged, easy to handle in shipment, assembly and disassembly, simple and economical to produce, yet effective, reliable and beneficial in operation in heat transfer apparatus combinations.

It is believed to be clear that a novel beneficial improvement in heat transfer apparatus combinations has

been provided in accordance with the objects of the invention.

Although certain preferred embodiments of the invention have been described in detail in accordance with the patent statutes, many modifications and variations within the spirit of the invention will occur to those skilled in the art, and all such are considered to fall within the scope of the following claims.

What is claimed is:

1. As an article of manufacture, an assemblable component of a heat transfer apparatus combination, said component constructed and arranged for installation in a heat transfer combination of the type comprising a closed hollow shell member having a fluid inlet and a fluid outlet, and provided with two cooperating header members, one at each end, for connection to fluid supply and fluid exhaust conduits, said assemblable component comprising a rigid integrated assembly, said integrated assembly comprising an elongated bundle of highly flexible, small-diameter, thin-walled hollow tubular elements formed of a solid polymeric composition, said tubular elements having open terminal portions, said integrated assembly further comprising, at each end of said bundle, an annular member of substantially rigid solid polymeric composition surrounding the terminal portions of the tubular elements, said terminal portions at each end of said bundle being joined to each other and to the annular member at that end of said bundle in fluid tight relationship, said integrated assembly further comprising a rigid foraminous sleeve unit surrounding and engaging the periphery of said bundle and secured at each end in operative engagement with one of said annular members in a manner such as to protect said bundle by transmitting any longitudinal compressional forces exerted on one annular member to said other annular member, thereby isolating said bundle from said forces especially those that occur during assembly and disassembly of said component into the hollow shell member of a heat transfer apparatus combination and in a manner such as to resist deformation of said annular member adjacent to said fluid inlet by a fluid at an elevated temperature entering said fluid inlet from said fluid supply.

2. The improved component of claim 1 which further comprises an annular baffle member secured in fluid tight relationship around the exterior of said sleeve unit at a predetermined position between said annular members, said baffle member comprising an exterior peripheral portion formed of an elastomeric material and constructed and arranged to selectively yieldingly engage, in fluid tight relationship, the interiors of a variety of hollow shell units of differing internal transverse dimensions at a position between the fluid inlet and fluid outlet of said shell units in which the component is to be mounted.

3. The improved component of claim 2 in which said peripheral portion of said baffle member is sufficiently yieldable relative to normal fluid flow forces encountered when assembled in a hollow shell member that said portion of said baffle member collapses to permit fluid by-passing of the bundle before increasing fluid forces in such a shell member can become great enough to damage said bundle, said tubular elements or other parts.

4. The improved component of claim 1 in which said sleeve unit engages each annular member at a position or positions spaced radially inwardly from the outer periphery on one side of said annular members to assist in reinforcing said annular member against bending deformations caused by the forces of a pressurized inlet fluid at elevated temperatures acting against the other side of said annular member in passing into the open terminal portions of the tubular members joined to said annular member when said component is assembled in a hollow shell member of a heat transfer apparatus combination.

5. In a heat transfer apparatus of the type comprising an elongated bundle of highly flexible, small diameter, thin-walled, hollow, tubular elements formed of a solid

polymeric composition, the tubular elements having open terminal portions, said terminal portions being substantially parallel to each other and joined in fluid tight relationship to each other and to a surrounding substantially rigid annular collar member having a passageway there-through, an exterior peripheral surface, and two opposed transversely extending end surfaces, said terminal portions of said tubular elements where joined to each other forming a substantially rigid honeycomb-like structure extending transversely across said passageway through said collar member, said open terminal portions of said tubular elements which form said honeycomb-like structure and one adjacent end surface of said collar member adapted to be subjected to a pressurized fluid at elevated temperature conditions and further adapted to be supported from the other of said end surfaces of said collar member against forces created by said pressurized fluid such that said forces developed by such a fluid deform the central portions of said honeycomb-like structure and the said one adjacent end surface of said collar member joined thereto into a concave dished-in configuration which in turn causes an outer peripheral portion of said collar member to move in a direction generally opposed to the direction in which said deformation of said central portions occurs, said collar member being mounted in a close-fitting recess in a header unit having an inlet passageway communicating with said recess to supply inlet fluid to the open terminal portions of said tubular elements forming said honeycomb-like structure, the improvement comprising resilient support and sealing means engaging the interior surface of said recess and the outer peripheral portion of said collar member to resist and reduce said movement of said peripheral portion and deformation of said collar member due to forces of the pressurized fluid and also to increase the effectiveness of the sealing action of said support and sealing means as such movement and deformation increase to prevent leakage flow of fluid between said collar member and said header unit, said resilient support and sealing means comprises an annular elastomeric seal ring mounted in an annular groove formed at the intersection of said peripheral surface and said one adjacent end surface of said collar member, and another annular elastomeric seal ring mounted in an annular groove adjacent the intersection of the peripheral surface and said other end surface of said collar unit.

6. An improved heat transfer apparatus comprising in combination; an elongated substantially rigid hollow casing member having longitudinal and transverse dimensions, open end portions, and provided with a inlet and an outlet longitudinal spaced from said inlet, said apparatus further comprising an elongated bundle of flexible, small diameter, thin-walled tubular elements having continuously hollow interiors, said tubular elements formed of a solid polymeric composition and having open terminal portions, said bundle positioned in said casing member in a generally coextensive relationship, said open end portions at each end of said bundle lying in a substantially coplanar arrangement extending transversely of said casing member and adjacent the said end portions of said casing member, said apparatus further comprising, at each end of said casing member, a composite header assembly cooperating with the open ends of the tubular elements and the end portion of said casing member, said header assembly constructed and arranged to cooperate with a fluid conduit element to maintain free communication between such conduit element and the interiors of said tubular elements while preventing a fluid in such conduit element from flowing to and communicating with the space in said hollow casing member exteriorly of said tubular elements, each said composite header assembly comprising a first annular header member of a substantially rigid polymeric composition, said first header member having an opening therethrough and positioned to surround the open terminal portions of said hollow tubular elements at one end of said bundle, said first annular header member and the

exterior of said tubular elements at said one end of said bundle being joined to each other in a fluid-tight relationship, each first annular header member positioned adjacent one open end portion of said hollow casing member and having transverse dimensions relative to the transverse dimensions of said casing member to permit longitudinal movement of said annular header members and said bundle through the interior of said casing member, each composite header assembly further comprising a second substantially rigid header member having an annular portion closely fitted and extending around the periphery and one side of said first header member and adapted to be secured in abutting engagement with one open end portion of said casing member to prevent movement of its cooperating first header member and end of said bundle away from the adjacent open end of said casing member, said second header member provided with another portion constructed and arranged to be coupled in fluid-tight relation to a fluid conduit and having a fluid passageway there-through to provide free communication between such a fluid conduit coupled thereto through the annular portion of said second header member and the open terminal portions of said tubular elements at the end of said bundle, said apparatus further comprising releasable means securing each said second header member to said casing member, an elongated rigid forminous sleeve assembly engaging and surrounding said bundle and extending along the elongated dimension thereof between opposed other sides of said first header members at each end of said bundle, said sleeve assembly having opposed end portions engaging said other sides of said first header members in a manner such as to maintain the bundle in elongated configuration and transmit at least a portion of the forces acting on one first header member in a longitudinal direction to said other first header member through said sleeve assembly without damage to said tubular elements during assembly and disassembly and in a manner such as to resist deformation of said first annular header member due to the force exerted upon it by a fluid at an elevated temperature introduced into the fluid conduit element in said composite header assembly, said apparatus further comprising an annular baffle member secured in fluid-tight relationship around the exterior of said sleeve assembly at a position between said header assemblies and also between the inlet and outlet of said casing member, said baffle member comprising an exterior peripheral portion formed of an elastomeric material yieldingly engaging the interior of said hollow casing member in fluid-tight relationship, each composite header assembly further comprising resilient supporting and sealing means cooperating with said first and second header members to prevent fluid leakage from the interior of said casing member and from the interior of the passageway through said second header member and also to maintain the rigid unit comprising said first header members and said sleeve assembly in compression and in position between said second header members.

7. The improved apparatus of claim 6 in which said supporting and sealing means comprises an elastomeric annular ring element compressed between said each first and each second header members.

8. The improved apparatus of claim 6 which further comprises a movement limiting element cooperating with each end of said casing member and said sleeve assembly to positively maintain within predetermined limits the longitudinal and transverse position of said sleeve assembly and said first header members in said casing member, said movement limiting element also distributing a portion of forces acting on said first header member to said casing member.

9. The improved apparatus of claim 6 in which the sleeve assembly is secured in engagement with each engaged first header member and the construction, arrangement, and engagement thereof are such that the forces developed under elevated temperature conditions by an incoming pressurized fluid moving into one of said second header members and the open terminal portions of the tubular elements joined to the first header member at that end of said apparatus tends to deform the central portion of the said one side of said first header member and of the coplanar arrangement of the open terminal portions of said tubular elements joined to said first header member to form a concave dish-in configuration and deform the outer peripheral portion of said first header member in a direction generally opposed to the direction of the deformation of said central portions, said resilient supporting and sealing means cooperating with said outer peripheral portion and said second header member to resist and reduce deformation of said first header member and said coplanar arrangement of open terminal portions of said tubular elements and also increase the effectiveness of the sealing action of said supporting and sealing means as such deformation increases to prevent leakage of fluid between said first and second header members.

10. The improved apparatus of claim 9 in which said supporting and sealing means comprises an annular elastomeric ring element mounted in a groove adjacent said outer peripheral portion of said first header member and in engagement between said first and second header members.

11. The improved apparatus of claim 10 in which the transverse dimensions of the fluid passageway through each said second header member corresponds closely with the transverse dimension of the opening in the first header member in which the open terminal portions of said tubular elements at that end of said bundle are joined to each other and to said first header member.

References Cited

UNITED STATES PATENTS

3,074,480	1/1963	Brown et al.	165—158
3,363,680	1/1968	Baker	165—158
3,417,812	12/1968	Smith	165—162 X

ROBERT A. O'LEARY, Primary Examiner

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U.S. Cl. X.R.

165—159, 162; 285—132, 137

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,526,275 Dated September 1, 1970

Inventor(s) Henry Joseph Vance & Edward Bruno Eirikis

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

Column 8, line 48, change "a" to --an--.

Column 9, line 23, change "the" to --that--.

Column 9, line 26, change "forminous" to --foraminous--.

Column 10, line 22, change "dish-in" to --dished-in--.

Column 10, line 43, change "dimension" to --dimensions--.

SIGNED AND
SEALED
DEC 15 1970

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents