

①⑫

EUROPEAN PATENT APPLICATION

②① Application number: **82305862.3**

⑤① Int. Cl.³: **F 28 D 7/10, B 21 D 53/06**

②② Date of filing: **04.11.82**

③⑩ Priority: **11.01.82 GB 8200682**
01.03.82 GB 8205946

⑦① Applicant: **Dodds, John, 17 Priors Wood, Crowthorne Berkshire (GB)**

④③ Date of publication of application: **03.08.83**
Bulletin 83/31

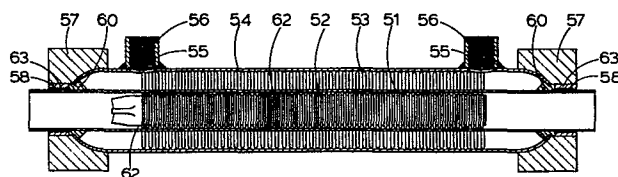
⑦② Inventor: **Dodds, John, 17 Priors Wood, Crowthorne Berkshire (GB)**

⑧④ Designated Contracting States: **DE FR GB IT NL**

⑦④ Representative: **Boon, Graham Anthony et al, Elkington and Fife High Holborn House 52/54 High Holborn, London, WC1V 6SH (GB)**

⑥④ **Heat exchange element.**

⑥⑦ A heat exchange element comprises an inner tube (51) and an outer tube (54) surrounding the inner tube and defining an annular space therewith. The end regions of the outer tube are tapered and are in sealing relationship with the exterior surface of the inner tube (51) by means of resilient grommets (60). The heat exchange element is formed from cylindrical inner and outer tubes by a method which involves positioning at each end of the assembly of inner and outer tubes a die (57) having an aperture (58) for receiving the inner tube (51) and a bearing surface for engagement with a respective end of the outer tube (54). The dies (57) are moved towards one another so as to cause the ends of the outer tube (54) to travel radially inwardly along the bearing surfaces into a position in engagement with the grommets (60).



Heat Exchange Element

This invention relates to a heat exchange element, for example a heat exchange element for use in an oil cooler, and a method of producing a heat exchange element.

Various types of oil cooler are known. One type
5 comprises a bundle of tubes mounted in a cylindrical casing. At intervals along the bundle of tubes baffles are provided with shut off the annular space between the exterior of the tube bundle and the interior of the casing over a sector of, say 75%, the remaining 25% sector being
10 open. The baffles are offset with respect to one another so that the open sector of one baffle is not aligned with the open sector of the next baffle. Oil to be cooled is directed to flow across the tubes in the casing and coolant, for example water, flows through the tubes. The oil
15 is forced to flow in a convoluted path by the baffles. Oil coolers of this type have a number of disadvantages. They have many components, are complex to assemble and have many potential leak paths. Also, they are generally expensive, partly as a consequence of the complexity in
20 manufacturing them.

Another type of known oil cooler is shown in Figure 1 of the accompanying drawings. This comprises an outer tube 1 within which the oil to be cooled flows. An inner tube 2 is mounted within the tube 1. The end portions 3 of the
25 tube 2 are flared outwardly and either soldered, brazed or welded joints 4 are formed between the end portions 3 and the inner wall of the tube 1. Metal fins or other heat transfer members 5 are in heat conductive connection with the exterior wall of the inner tube 2. An inlet 6 and an
30 outlet 7 are provided for oil to flow into and out of the annular region defined between the inner and outer tubes. This type of oil cooler also has disadvantages. The main one is that the joints 4 are difficult to form reliably, partly because of their having to be formed inside the

tube 1. Furthermore, once the joints have been formed it is difficult to be sure that they have been formed correctly, because of the difficulty in inspecting the joints.

5 According to the present invention there is provided a heat exchange element comprising a first tube for a first fluid to flow through, and a second tube surrounding the first tube in the manner of a jacket and defining therewith an annular space for a second fluid to flow
10 through, the end regions of the second tube being tapered and in sealing relationship with the exterior surface of the first tube.

 The invention further provides a method of producing a heat exchange element which comprises locating an inner
15 tube within an outer tube, with the ends of the inner tube extending from the ends of the outer tube, positioning at each end of the assembly of inner and outer tubes a die having means for receiving the inner tube and a bearing surface for engagement with a respective end of
20 the outer tube, and moving the dies towards one another so as to cause the ends of the outer tube to travel radially inwardly along the said bearing surfaces into a position in engagement with or adjacent to the outer surface of the inner tube.

25 In a preferred form of the method just defined grommets, preferably resilient grommets, are used to form seals between the ends of the outer tube and the exterior surface of the tube, as will be apparent from the ensuing description.

30 In the accompanying drawings:

 Figure 1, as stated above shows a known oil cooler;

 Figure 2 shows diagrammatically an embodiment of the invention;

 Figures 3 to 7 show successive steps in the manufacture of the heat exchange element shown in Figure 2;
35

 Figure 8 shows, by way of example, one form of grommet which may be used in the present invention; and

Figure 9 shows, in more detail, another embodiment of the invention in the process of being formed.

Figure 2 shows an embodiment comprising an inner tube 21 through which the coolant, water, or other fluid flows. An outer tube 22 surrounds the inner tube in the manner of a jacket. The end portions 23 of the outer tube are tapered and are joined to the inner tube by soldered, brazed or welded joints 24. The end portions 23 may be of part spherical form or frusto-conical form or some other suitable shape. The end portions 23 may, for example, be formed by a method described in more detail below, in which the ends of a tube are distorted into the desired shape by placing the tube between two opposed mould halves and exerting a longitudinal compressive force thereon.

An inlet 26 and an outlet 27 are provided for oil to flow into and out of the annular region defined between the inner and outer tubes. Advantageously, as shown, the flows of coolant and oil are in countercurrent.

The cooler shown in Figure 2 has substantial advantages over that shown in Figure 1. Firstly, in the event of a failure in service of a joint 24 there can be no contamination of one fluid by the other as would be the case with both the type shown in Figure 1 and the shell and tube type which has a multitude of joints and consequently an increased possibility of contamination. Secondly, the joints 24 are external so that they are easy to form and easy to inspect for soundness. Thirdly, the process of forming the end portions 23 results in the thickness thereof increasing towards the ends where the joints 24 are formed. The increased thickness of metal adjacent the joints means that those joints are easier to form satisfactorily than would otherwise have been the case. This is in contrast to the known cooler shown in Figure 1 where the formation of the flared portions 3 means that joints are formed where the metal is thinnest.

Metal fins or other heat transfer members 25 are in heat conductive connection with the exterior wall of the inner tube 21. The members 25 are advantageously in the form of metal coils, so the inner tube may advantageously be a wire wound metal tube of the type known as ALPHATUBE (Registered Trade Mark of Alpha Interchange Limited). If desired, heat transfer may be further improved by forming a wire winding on the interior of the inner tube 21 as well as on the exterior.

10 The method illustrated in Figures 3 to 7 begins, as shown in Figure 3, with an inner tube 31. Optionally, this tube may be provided internally with an extended surface 32, for example a winding. As shown in Figure 4, an external winding 33 is formed on the outside of the
15 tube 31. Then, as shown in Figure 5, an outer tube 34 is placed over the inner tube 31. Prior to this placement holes 35 are drilled in the outer tube and inlet and outlet tubes 36 are welded or brazed into position. It is preferred to form the holes 35 and attach the inlet and
20 outlet 36 prior to positioning the outer tube over the inner tube in order to avoid the risk of damage to the external winding of the inner tube as a result of the drilling process and the welding or brazing. Other methods besides welding and brazing could be used for attaching the inlet and outlet, but these methods are preferred
25 since they are low-temperature operations, thus lessening the risk of damage to the outer tube and reducing the danger of producing weak points.

 The next step, as shown in Figure 6, is to position
30 a die 37 at each end of the assembly of inner and outer tubes. Each die has a central aperture 38 through which passes a respective end of the inner tube 31. Each die is further provided with a part-spherical bearing surface 39 which engages with a respective end of the outer tube 34.
35 Where the aperture 38 opens into the bearing surface 39 a resilient grommet 40 is located. When the dies are in position with the inner tube passing through the apertures

38 the inner, cylindrical surfaces of the grommet 40 are in engagement with the exterior surface of the inner tube 31.

5 The dies 37 are then moved towards one another and in the process deform the end regions of the outer tube 34 so that these regions slide radially inwardly along the bearing surfaces 39 until they come into tight engagement with the exterior of the grommets 40. The heat exchange element thus formed is shown in Figure 7.

10 Figure 8 shows, purely by way of example, one form which the grommet 40 may take. It will be seen that this grommet has an external peripheral recess 41 in which the end of the outer tube 34 can engage.

15 The material of which the grommets 40 is made will depend on the temperature range at which the heat exchange element is to operate and on other operating conditions, for example the possible presence of corrosive fluids. Depending on the particular application concerned the grommet may, for example, be made of natural rubber, poly-
20 vinylchloride, neoprene rubber, nitrile rubber, a fluoro-carbon rubber, e.g. that sold under the Trade Mark VITON, or silicone.

Grommets may be used in conjunction with methods of sealing the ends of the heat exchange element other than
25 the use of the dies described above. For example, instead of deforming the ends of the outer tube that tube could be left completely cylindrical, with circular discs welded or brazed to the inner and outer tube to form the connection between them. Also, the ends of the outer tube could
30 assume some other form, for example, a frusto-conical form.

The method shown in Figures 2 to 7 involving the use of dies may be practised in a modified form in which the grommets are omitted. In this case the connection between the inner and outer tubes may be formed by welding or
35 brazing. However, one point which should be made concerning the use of resilient grommets is that they allow relative expansion between the inner and outer tubes. This

is valuable since, in use, the outer tube generally becomes hotter than the inner tube so that expansion of the outer tube is usually greater than that of the inner tube. When such expansion of the outer tube occurs the tube is caused
5 to be embedded into the material of the grommet, which thus absorbs the expansion.

Figure 9 shows a further embodiment of the invention, towards the end of its process of formation. The embodiment comprises an inner tube 51, provided internally with
10 a winding 52 and provided externally with a winding 53. An outer tube 54 is placed over the inner tube and has holes 55 formed therein over which are secured inlet and outlet tubes 56. A throttling tube 62, closed at the
15 left-hand (upstream) end is positioned inside the inner tube 51 within the internal winding 52. The presence of the tube 62 increases the efficiency of heat exchange. The winding 52 is soldered both to the inner tube 51 and the throttling tube 62, and the outer winding 53 is soldered to the inner tube 51.

20 As will be apparent, the embodiment of Figure 9 is shown at the stage where dies 57 have completed the deformation of the end portions of the outer tube 54, but have not yet been withdrawn. It will also be seen from Figure 9 that the dies 57 have bushes 63 defining central
25 apertures 58, the bushes 63 providing seats which hold grommets 60 in place during movement of the dies.

CLAIMS:

1. A heat exchange element comprising a first tube for a first fluid to flow through, and a second tube surrounding the first tube in the manner of a jacket and defining therewith an annular space for a second fluid to flow through,
5 the end regions of the second tube being tapered and in sealing relationship with the exterior surface of the first tube.
2. A heat exchange element according to claim 1, wherein
10 the end regions of the second tube are sealed to the exterior surface of the first tube by a grommet.
3. A heat exchange element according to claim 2, wherein the grommet is a resilient grommet.
15
4. A heat exchange element according to any preceding claim, comprising a heat transfer surface in the said annular space.
- 20 5. A heat exchange element according to any preceding claim, comprising a heat transfer surface inside the said first tube.
6. A heat exchange element according to any preceding
25 claim, wherein a tube closed at its upstream end is located within the said first tube and defines an annular flow path therewith.
7. A method of producing a heat exchange element which
30 comprises locating an inner tube within an outer tube, with the ends of the inner tube extending from the ends of the outer tube, positioning at each end of the assembly of inner and outer tubes a die having means for receiving the inner tube and a bearing surface for engagement with a respective
35 end of the outer tube, and moving the dies towards one another so as to cause the ends of the outer tubes to travel

radially inwardly along the said bearing surfaces into a position in engagement with or adjacent to the outer surface of the inner tube.

- 5 8. A method according to claim 7, wherein the radially
inward travel of the ends of the outer tube cause those
ends to engage respective grommets positioned on the
exterior surface of the inner tube, whereby the grommets
form fields between the ends of the outer tube and the
10 exterior surface of the inner tube.

9. A method according to claim 8, wherein the grommets
are resilient.

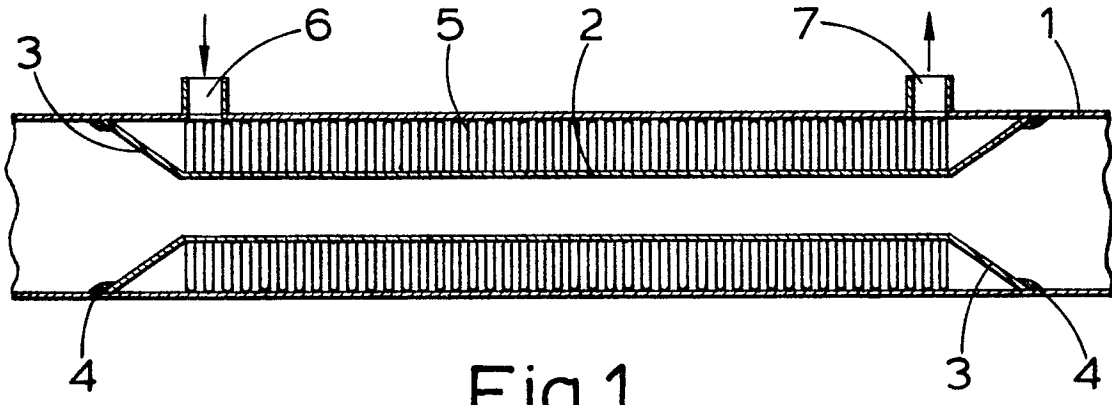


Fig.1

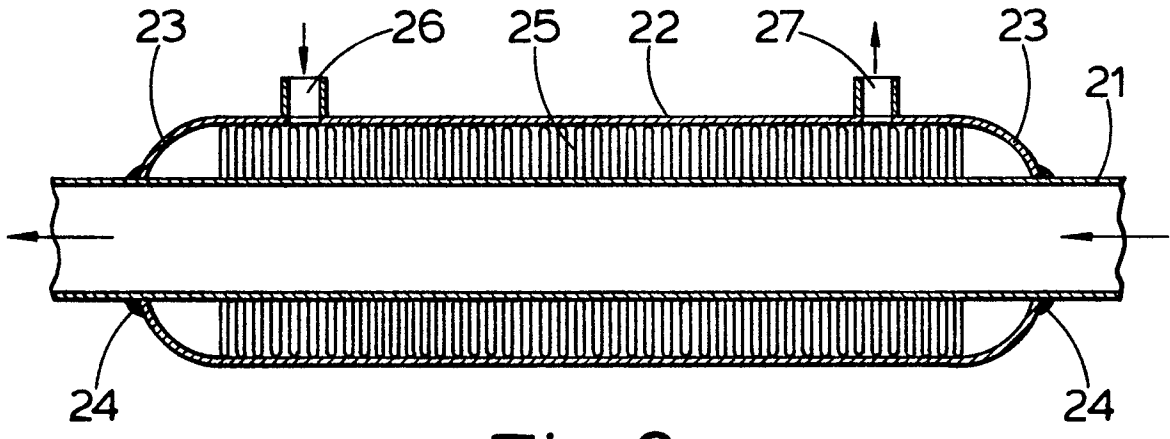


Fig.2



Fig. 3

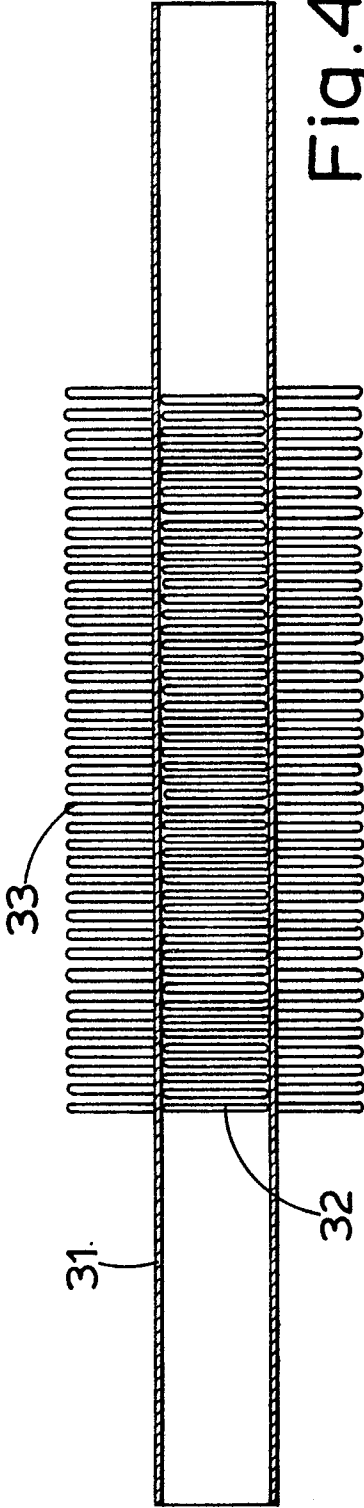


Fig. 4

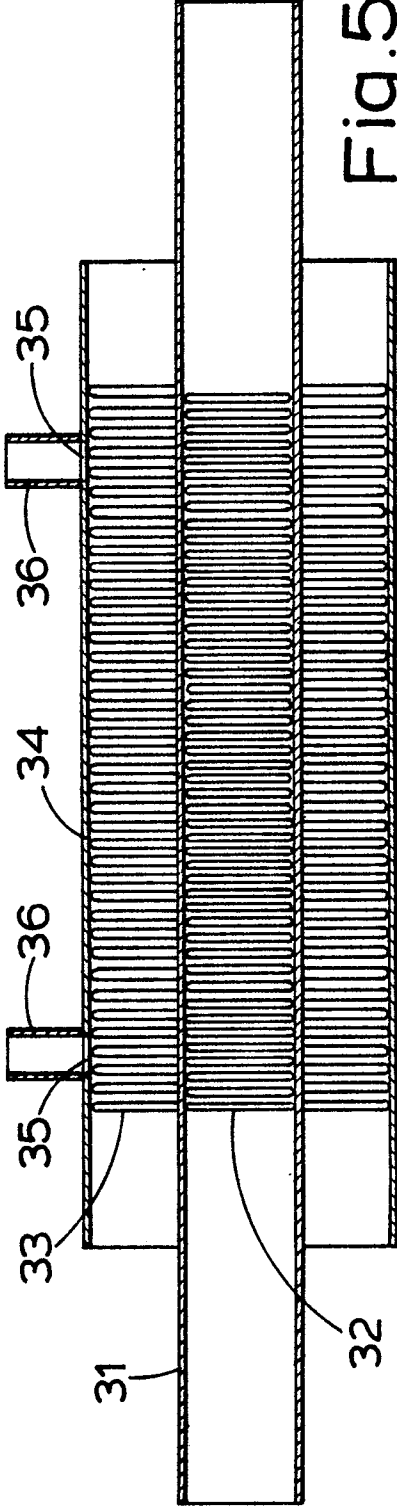


Fig. 5

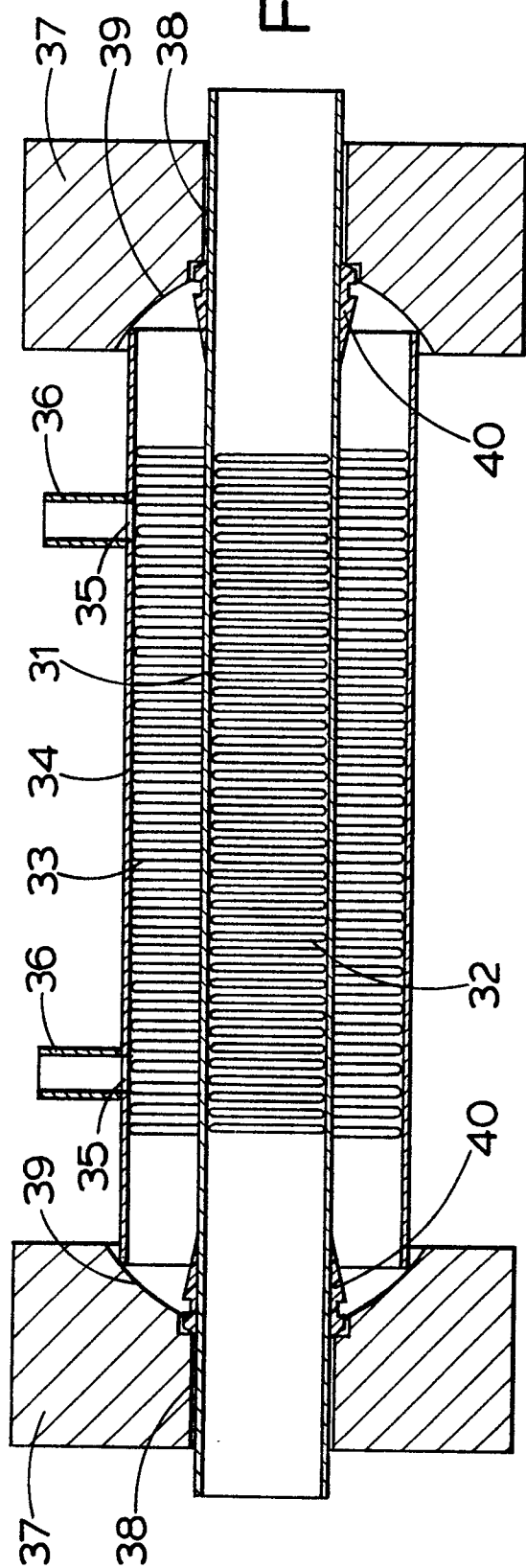


Fig. 6

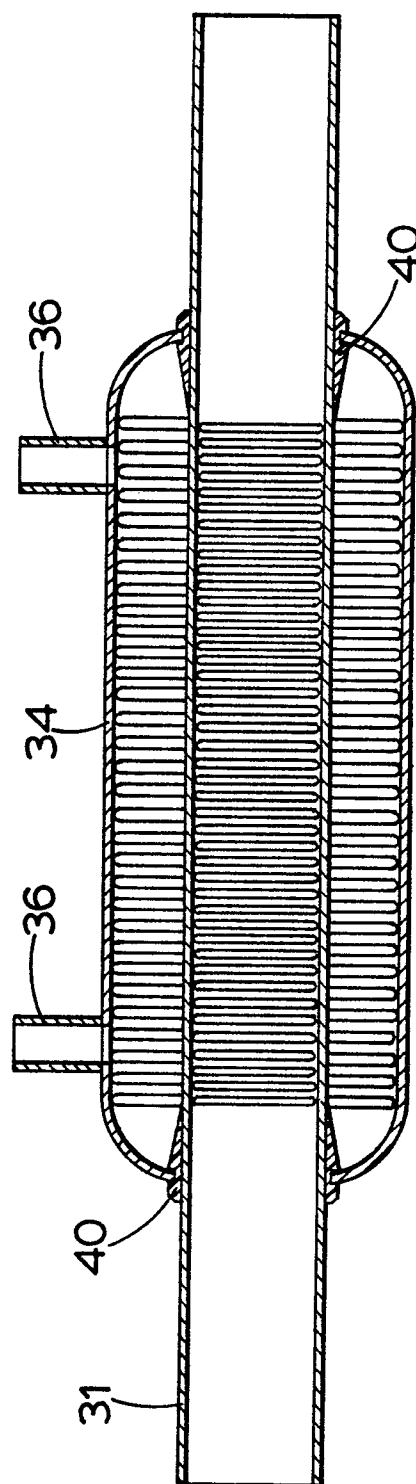


Fig. 7

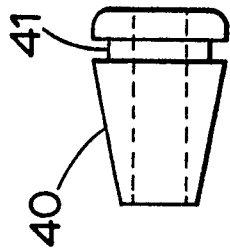


Fig. 8

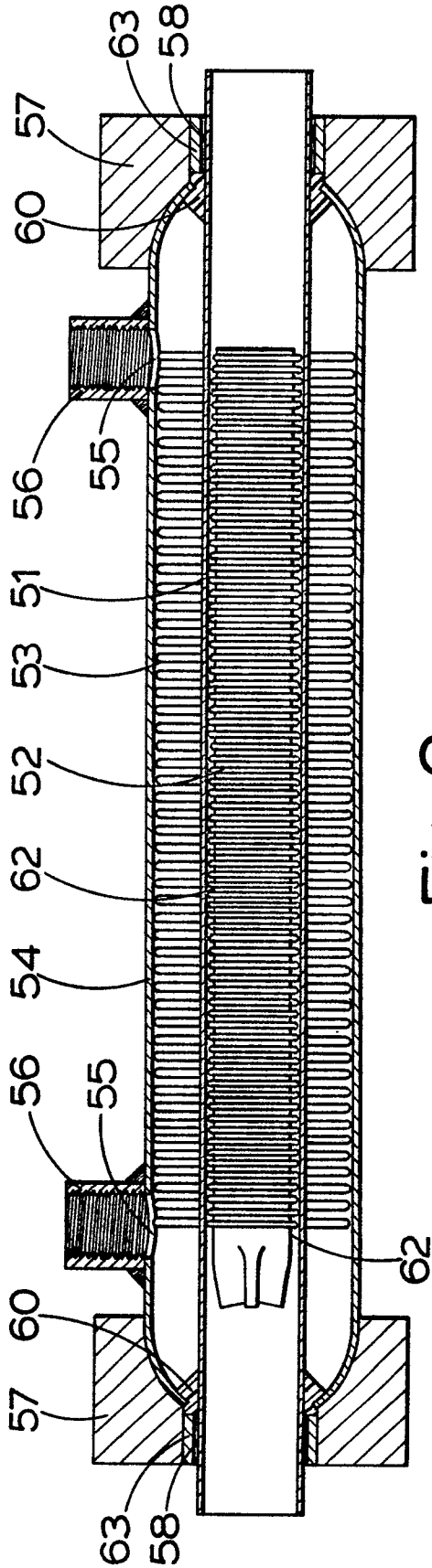


Fig. 9



European Patent
Office

EUROPEAN SEARCH REPORT

0084701 Application number

EP 82 30 5862

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
X	US-A-4 306 617 (LANCASTER) *Column 3, line 4 - column 5, line 4; figures 2-4*	1	F 28 D 7/10 B 21 D 53/06
Y		4, 5, 6	
X	FR-A-1 162 651 (MODINE) *Page 2, left-hand column, last paragraph; figure 1,2,3*	1	
Y		4, 5, 6	
Y	CH-A- 280 011 (WESTINGHOUSE) *Page 2, lines 10-48; figures 1-3*	4, 5, 6	
A	GB-A-1 384 606 (AKTIEBOLAGET CTC) *Page 2, lines 25-50; figures 5-7*	7	TECHNICAL FIELDS SEARCHED (Int. Cl. ³) F 28 D F 28 F B 21 D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 19-04-1983	Examiner PERROTTA A.
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			