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(54) **A pipe connecting structure for a heat exchanger**

(57) A pipe connecting structure for a heat exchanger comprising:-
a header portion or manifold defined by a plurality of parallel elongate header tubes 1,2, each header tube including a plurality of spaced apertures or slots along its length for receiving the ends of a plurality of parallel heat ex-

changer tubes;
a connector block 10 having apertures formed therein for receiving an end of each of said plurality of header tubes and at least one pipe receiving aperture 15 for providing a fluid connection with at least one of said plurality of header tubes.

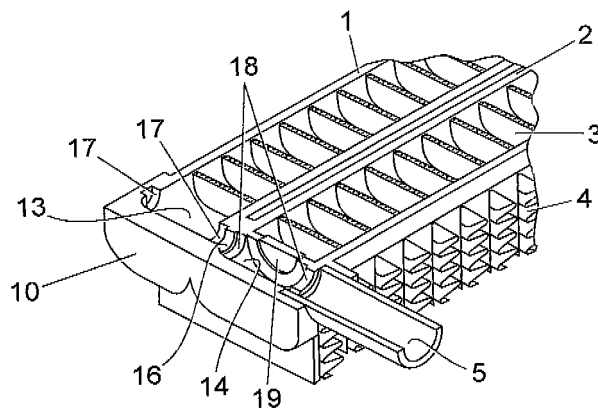


Fig. 3

Description

[0001] The present invention relates to a pipe connecting structure for a heat exchanger which is comprised of a plurality of parallel tubes for flowing a medium, the pipe connecting structure comprising header tanks or manifolds to which the ends of the tubes are connected, and connector blocks to which the ends of the header tanks are connected for connection to pipes for flowing the medium into and out of the heat exchanger.

[0002] Heat exchangers are used in vehicles to cool engine coolant, to cool charge air and to heat and/or cool refrigerant in a vehicle air conditioning system. Such heat exchangers typically comprise upper and lower header tanks or manifolds having a plurality of tubes containing fluid passages extending therebetween, air gaps, typically provided with strengthening ribs, are provided between the tubes to allow heat transfer between a flow of air passing through the air gaps and a flow of a fluid passing through the fluid passages of the tubes.

[0003] Connection means are typically provided at ends of one or both of the header tanks for connecting to delivery and discharge conduits supplying fluid to be cooled/heated to and from the heat exchanger.

[0004] Typically such connection means are formed by pressed fittings that are brazed to the ends of the header tanks. Such pipe connection means can lead to leakage problems, particularly where carbon dioxide is used as a refrigerant. When carbon dioxide is used as refrigerant, very high pressures in the range of up to more than 80 bar exist within the refrigerant circuit of the air conditioning system. The pressure loading on individual components of an air conditioning system therefore rises significantly.

[0005] What is needed is a more compact and reliable pipe connecting structure that provides more versatile pipe routing while better withstanding high refrigerant pressures while at the same time simplifying header construction.

[0006] According to the present invention there is provided a pipe connecting structure for a heat exchanger comprising:-

a header portion or manifold defined by a plurality of parallel elongate header tubes, each header tube including a plurality of spaced apertures or slots along its length for receiving the ends of a plurality of parallel heat exchanger tubes;
a connector block having apertures formed therein for receiving an end of each of said plurality of header tubes and at least one pipe receiving aperture for providing a fluid connection with at least one of said plurality of header tubes.

[0007] Preferably the connector block comprises a one piece member. Preferably the heat exchanger comprises two parallel header tubes.

[0008] Preferably said at least one pipe receiving ap-

erture extends transverse to said header tube receiving apertures.

[0009] Notches or cut outs may be formed in the ends of one or more of the header tubes received within the receiving apertures to define at least part of a fluid passageway within the connection block.

[0010] In one embodiment, the connector block is provided with a single pipe receiving aperture, preferably extending transverse to the header tube receiving apertures, said pipe receiving aperture and said header tube receiving apertures communicating with a common chamber defined within the connector block, a blanking plug being inserted within the end of at least one of said header tubes for which direct fluid communication with a pipe inserted into said pipe receiving aperture is not desired.

[0011] In a second embodiment, first and second chambers are defined within the connector block, a first receiving aperture being formed in the connector block to be in fluid communication with said first chamber and a second pipe receiving aperture being formed in the connector block for fluid communication with said second chamber, a first header tube receiving aperture communicating with said first chamber for communicating a first header tube with a pipe connected to said first pipe receiving aperture and a second header tube receiving aperture communicating with said second chamber for communicating a second header tube with a pipe connected to said first pipe receiving aperture.

[0012] In a third embodiment, said pipe connecting structure further comprises a connection pipe for conveying a fluid to and from the heat exchanger, said connection pipe having first flow passageway and one or more second flow passageways, said connection pipe being inserted into said pipe receiving aperture of said connector block, the connector block defining a first chamber, communicating with a first header tube receiving aperture and said first flow passageway of said connection pipe, and a second chamber, communicating with a second header tube receiving aperture and said one or more second flow passageways of said connection pipe.

[0013] Preferably said one or more second flow passageways are provided in an annular space surrounding said first flow passageway such that the first flow passageway is provided in an inner region of the connection pipe and said one or more second flow passageways are provided in an outer region of said connection pipe. Preferably a plurality of second flow passageways are provided in said annular space

[0014] Preferably said inner region of said connection pipe defining said first flow passageway extends through said second chamber of said connector block to be received in said first chamber, or within an aperture provided in a dividing wall between said first and second chambers, said outer region terminating within said second chamber, or within said pipe receiving aperture, to provide flow communication between said second flow

passageways and said second chamber.

[0015] Preferably an end of said connection pipe distal from said connector block is provided with a pipe coupling block defining first and second pipe connection means enabling a first pipe to be connected in communication with said first flow passageway of the connection pipe and a second pipe to be connected in communication with said one or more second flow passageways.

[0016] According to a second aspect of the present invention there is provided a method of forming a pipe connecting structure for a heat exchanger comprising the steps of forming a connector block from a single piece of material, forming apertures in the connector block therein for receiving an end of each of a plurality of parallel header tubes, forming at least one pipe receiving aperture in the connector block for providing a fluid connection with at least one of said plurality of header tubes, inserting said ends of said plurality of header tubes into said header tube receiving apertures, and inserting a connection pipe into said pipe receiving aperture.

[0017] Preferably said connector block is formed by extrusion and/or machining.

[0018] Preferred embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is a perspective view of a pipe connecting structure according to a first embodiment of the present invention;

Fig. 2 is an exploded view of the pipe connecting structure of Fig. 1;

Fig. 3 is a perspective view of the pipe connecting structure of Fig. 1;

Fig. 4 is a perspective view of a pipe connecting structure according to a second embodiment of the present invention;

Fig. 5 is a sectional view of the pipe connecting structure of Fig. 4;

Fig. 6 is a perspective view of a pipe connecting structure according to a third embodiment of the present invention;

Fig. 7 is a sectional view of the pipe connecting structure of Fig. 6;

Fig. 8 is a perspective view of a pipe connecting structure according to a fourth embodiment of the present invention;

Fig. 9 is an exploded view of the pipe connecting structure of Fig. 8;

Fig. 10 is a sectional view of the pipe connecting

structure of Fig. 8;

Fig. 11 is an exploded perspective view of a pipe end coupling of the pipe connecting structure of Fig. 8; and

Fig. 12 is a sectional view of pipe end coupling of Fig. 11.

[0019] Figs. 1 to 3 illustrate a cross flow heat exchanger 1 incorporating a pipe connecting structure according to a first embodiment of the present invention. The heat exchanger comprises first and second spaced manifolds or header tubes 1,2 with a plurality of coolant or refrigerant tubes 3 extending therefrom, said refrigerant tubes 3 being separated by fins 4 to enhance refrigerant to air heat transfer. One or more further manifolds or header tubes (not shown) are provided at the opposite end of the refrigerant tubes 3.

[0020] A first header tube 1 may comprise a refrigerant delivery conduit and the second header tube 2 may comprise a discharge conduit.

[0021] A refrigerant delivery line 5 is connected to the first header tube 1 and a refrigerant discharge line (not shown) is connected to the second header tube 2.

[0022] Such connections are made by a connector block 10 joined to each end of the header tubes 1,2 beyond the block of refrigerant tubes 3 by means of header tube receiving apertures 11,12 provided in a side face of each connector block 10 communicating with first and second fluid chambers 13,14 defined within each connector block 10.

[0023] A pipe receiving aperture 15 is formed in an end of each connection block 10 to extend into the second chamber 14 of the connection block 10 and into which is fixed, typically by brazing, the end of the respective delivery or discharge line 5, such that the discharge and delivery lines extend transverse to the header tubes 1,2.

[0024] An aperture 16 is provided in a wall portion of the connector block between the first and second chambers 13,14 to provide fluid communication therebetween and semi-circular notches 17,18 are formed in the ends of each header tube 1,2 to define a fluid passageway extending through the connector block 10.

[0025] In order to enable connection a refrigerant delivery line 5 to a selected one of the header tubes 1 (e.g. the refrigerant delivery conduit 1), a blanking plug 19 (see Fig. 3) is fixed into the end of the other header tube 2. A similar blanking plug is inserted into the other end said selected one of the header tubes such that the opposite connector block can be connected to a refrigerant discharge line.

[0026] The connector blocks 10 serve as a support and spacer means for the ends of the header tubes 1,2 as well as providing a compact and reliable connection for the discharge and delivery lines.

[0027] A second embodiment of the present invention is illustrated in Figs. 4 and 5. In the second embodiment,

the connector block 10a is adapted to enable connection of both the delivery 5 conduit and the discharge conduit 20 at the same end of the header tubes 1,2.

[0028] In the second embodiment, the header tube receiving apertures 11a,12a communicate with separate and discrete chambers 13a,14a defined within the connector block 10a whereby there is no direct fluid communication between the header tubes 1,2 via the connector block 10a.

[0029] As well as the first pipe receiving aperture 15a, formed in an end of the connection block 10a to extend into the second chamber 14a of the connection block 10a and into which is fixed, typically by brazing, the end of the discharge line 5, a second pipe receiving aperture 22 is provided in the connector block 10a, said second pipe receiving aperture communicating with the first chamber 13a, whereby the delivery line 20 can communicate with the first header tube 1.

[0030] The second pipe receiving aperture 22 extends at an angle of approximately 45° to the first pipe receiving aperture 15a to provide a compact arrangement. Alternatively, in a third embodiment, as illustrated in Figs. 6 and 7 and otherwise identical to the second embodiment, the second pipe receiving aperture 22 may extend perpendicular to the first pipe receiving aperture 5 to minimise the dimensions of the connector block 10a.

[0031] A fourth embodiment of the present invention will now be described with reference to Figs. 8 to 12.

[0032] The fourth embodiment utilises a single connection pipe 30 having multiple flow passages for carrying refrigerant both to and from the heat exchanger. As shown in the drawings, the connection pipe 30 comprises a first passageway 32 formed in a central region of the pipe for carrying fluid to or from a first header tube 1, and a plurality of second passageways 34 provided in an annular outer region of the pipe 30, surrounding said first passageway 32 for carrying fluid to or from the second header tube 2. While it is envisaged that a single second passageway may be provided arranged concentrically around the central first passageway, the provision of a plurality of small passageways 34 provided in the annular space surrounding the first passageway provides greater crush resistance and greater pressure resistance for high pressure fluids, such as CO₂ refrigerant.

[0033] As with the previous embodiments, the connector block 10c is provided with first and second header tube receiving apertures 11c,12c provided in a side face of the connector block 10c, respectively communicating with first and second fluid chambers 13c,14c defined within the connector block 10c.

[0034] As can be seen from Fig. 10, an end of connection pipe 30 is adapted such that the inner region of the connection pipe defining first passageway extends beyond the outer region of the connection pipe defining the plurality of second passageways, whereby, when the connection pipe is inserted into the connector block 10c, the first passageway 32 extends through the second chamber 14c of the connector block and into the first

chamber 13c to provide fluid communication between the first header tube 1 and the first passageway 32 of the connection pipe 30. The end of the first passageway 32 is adapted to form a fluid tight fit within an aperture defined between the first and second chambers of the connector block. At the same time, the end of the outer region of the connection pipe 30 is adapted to form a fluid tight fit in a pipe receiving aperture 15c in an end of the connector block 10c communicating with the second chamber 14c of the connector block, whereby the second passageways 34 of the connection pipe 30 open into the second chamber 14c of the connector block 10c, to provide fluid communication between the second header tube 2 and the second passageways 34 of the connection pipe 30. Notches 18c are formed in the end of the second header pipe 2 to provide a flow path between the end of the second header tube 2 and the second chamber 14c.

[0035] As shown in Figs. 11 and 12, a pipe coupling block 50 is provided for allowing the passage of refrigerant from separate discharge and delivery pipes into and out of the first 32 and second 34 passageways of the connection pipe 30.

[0036] The pipe coupling block 50 is provided with first and second pipe receiving apertures 52, 54 formed in a first face of the pipe coupling block 50 for respectively receiving discharge and delivery conduits. A larger pipe connection aperture 56 is provided in a face of the pipe coupling block 50 opposite said first pipe receiving aperture 52 for receiving a distal end of the connection pipe 30.

[0037] Similarly to the first end of the connection pipe 30 adapted to fit into the connector block 10c, a second, distal end of connection pipe 30 is adapted such that the inner region of the connection pipe 30 defining first passageway 32 extends beyond the outer region of the connection pipe defining the plurality of second passageways 34, whereby, when an end of the connection pipe 30 is inserted into the larger pipe connection aperture 56 of the pipe coupling block 50, the first passageway 32 extends into a narrowed central region 58 of the pipe coupling block 50 between the larger pipe connection aperture 56 and the first pipe receiving aperture 52 to provide fluid communication between the first passageway 32 of the connection pipe 30 and the first pipe connection aperture 52.

[0038] At the same time, an end of the outer region of the pipe 30 is a tight fit in the larger pipe connection aperture 56 such that the second passageways 34 of the pipe 30 open into a chamber 60 defined between the larger pipe connection aperture 56 and said narrowed central region. An internal passageway 62 is defined within the pipe coupling block 50 to provide fluid communication between said chamber 60 and the second pipe connection aperture 54 to provide fluid communication between said second pipe connection aperture 54 and said plurality of second passageways 34 of the connection pipe 30.

[0039] The connector block 10,10a,10b, 10c of the present invention may be formed from a single piece of

material, preferably cut from an extrusion or machined from block, the various apertures and chamber within the connector block being formed by suitable machining operations. Therefore the connector block can withstand very high internal pressures and provides reliable sealing with the header tubes and discharge and delivery pipes, rendering the connector block particularly suitable for use with high pressure fluids, such as CO₂ refrigerant.

[0040] Various modifications and variations to the described embodiments of the inventions will be apparent to those skilled in the art without departing from the scope of the invention as defined in the appended claims. Although the invention has been described in connection with specific preferred embodiments, it should be understood that the invention as claimed should not be unduly limited to such specific embodiments.

Claims

1. A pipe connecting structure for a heat exchanger comprising:-

a header portion or manifold defined by a plurality of parallel elongate header tubes, each header tube including a plurality of spaced apertures or slots along its length for receiving the ends of a plurality of parallel heat exchanger tubes;

a connector block having apertures formed therein for receiving an end of each of said plurality of header tubes and at least one pipe receiving aperture for providing a fluid connection with at least one of said plurality of header tubes.

2. A pipe connecting structure as claimed in claim 1, wherein the connector block comprises a one piece member.
3. A pipe connecting structure as claimed in claim 1 or claim 2, wherein the heat exchanger comprises two parallel header tubes.
4. A pipe connecting structure as claimed in any preceding claim, wherein the at least one pipe receiving aperture extends transverse to said header tube receiving apertures.
5. A pipe connecting structure as claimed in claim 4, wherein notches or cut outs are formed in the ends of one or more of the header tubes received within the receiving apertures to define at least part of a fluid passageway within the connection block.
6. A pipe connecting structure as claimed in any preceding claim, wherein the connector block is provided with a single pipe receiving aperture, preferably extending transverse to the header tube receiving

apertures, said pipe receiving aperture and said header tube receiving apertures communicating with a common chamber defined within the connector block, a blanking plug being inserted within the end of at least one of said header tubes for which direct fluid communication with a pipe inserted into said pipe receiving aperture is not desired.

7. A pipe connecting structure as claimed in any preceding claim, wherein first and second chambers are defined within the connector block, a first receiving aperture being formed in the connector block to be in fluid communication with said first chamber and a second pipe receiving aperture being formed in the connector block for fluid communication with said second chamber, a first header tube receiving aperture communicating with said first chamber for communicating a first header tube with a pipe connected to said first pipe receiving aperture and a second header tube receiving aperture communicating with said second chamber for communicating a second header tube with a pipe connected to said first pipe receiving aperture.
8. A pipe connecting structure as claimed in any preceding claim, further comprising a connection pipe for conveying a fluid to and from the heat exchanger, said connection pipe having first flow passageway and one or more second flow passageways, said connection pipe being inserted into said pipe receiving aperture of said connector block, the connector block defining a first chamber, communicating with a first header tube receiving aperture and said first flow passageway of said connection pipe, and a second chamber, communicating with a second header tube receiving aperture and said one or more second flow passageways of said connection pipe.
9. A pipe connecting structure as claimed in claim 8, wherein said one or more second flow passageways are provided in an annular space surrounding said first flow passageway such that the first flow passageway is provided in an inner region of the connection pipe and said one or more second flow passageways are provided in an outer region of said connection pipe.
10. A pipe connecting structure as claimed in claim 9, wherein a plurality of second flow passageways are provided in said annular space
11. A pipe connecting structure as claimed in claim 10, wherein said inner region of said connection pipe defining said first flow passageway extends through said second chamber of said connector block to be received in said first chamber, or within an aperture provided in a dividing wall between said first and second chambers, said outer region terminating within

said second chamber, or within said pipe receiving aperture, to provide flow communication between said second flow passageways and said second chamber.

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- 12.** A pipe connecting structure as claimed in any of claims 8 to 11, wherein an end of said connection pipe distal from said connector block is provided with a pipe coupling block defining first and second pipe connection means enabling a first pipe to be connected in communication with said first flow passageway of the connection pipe and a second pipe to be connected in communication with said one or more second flow passageways.

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- 13.** A method of forming a pipe connecting structure for a heat exchanger comprising the steps of forming a connector block from a single piece of material, forming apertures in the connector block therein for receiving an end of each of a plurality of parallel header tubes, forming at least one pipe receiving aperture in the connector block for providing a fluid connection with at least one of said plurality of header tubes, inserting said ends of said plurality of header tubes into said header tube receiving apertures, and inserting a connection pipe into said pipe receiving aperture.

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- 14.** A method as claimed in claim 13, wherein said connector block is formed by extrusion and/or machining.

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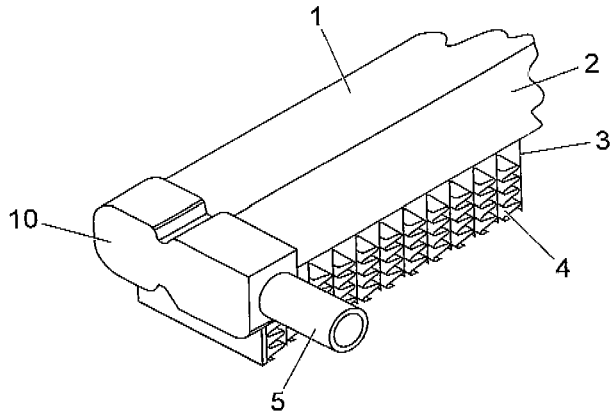


Fig. 1

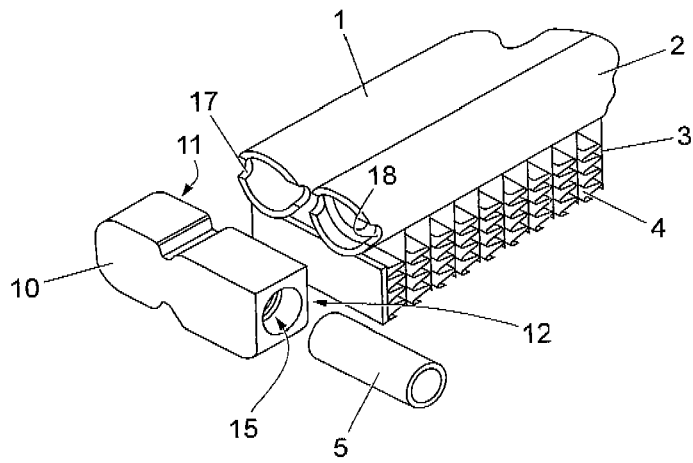


Fig. 2

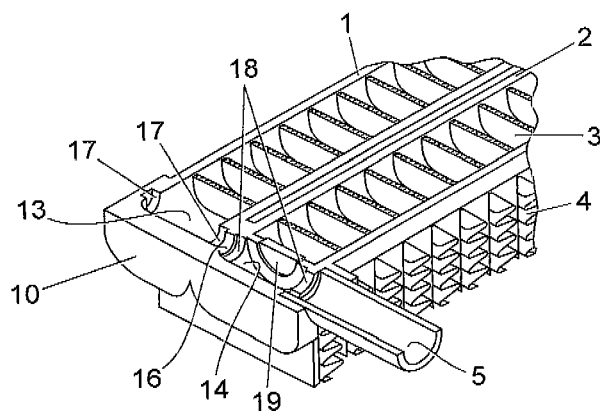


Fig. 3

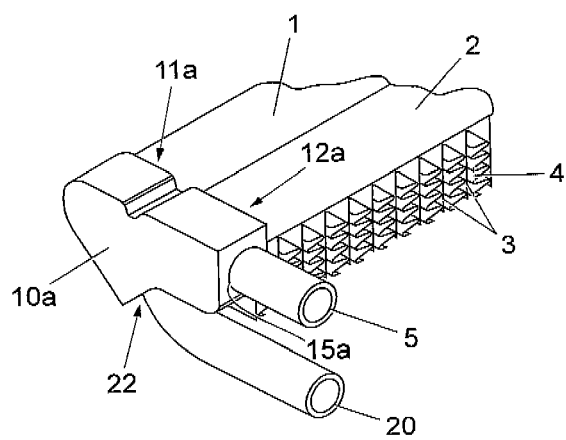


Fig. 4

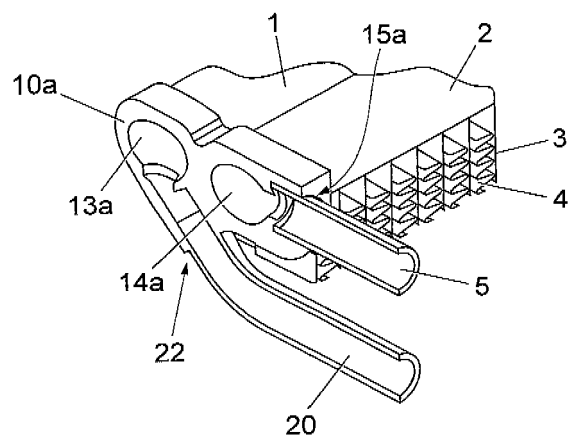


Fig. 5

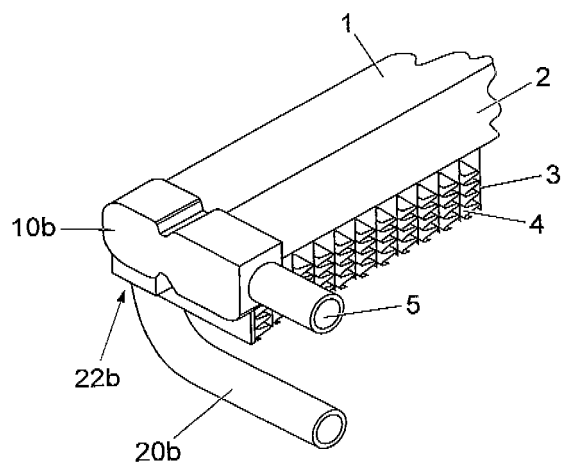


Fig. 6

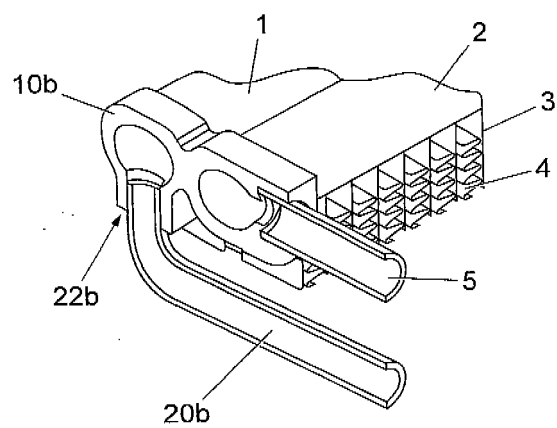


Fig. 7

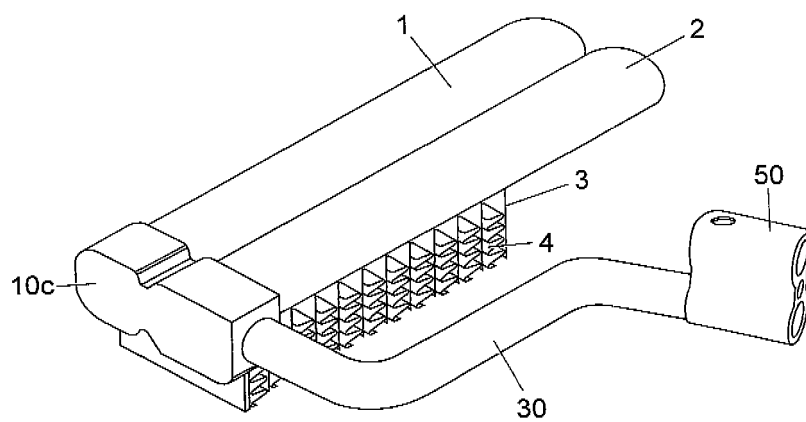


Fig. 8

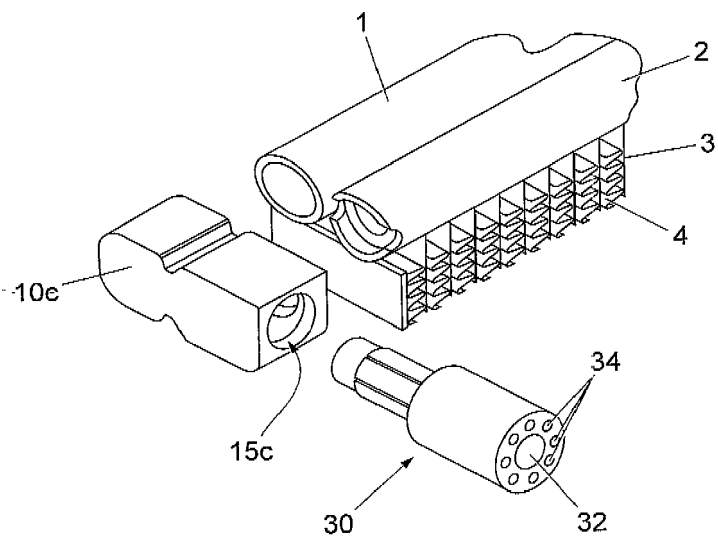


Fig. 9

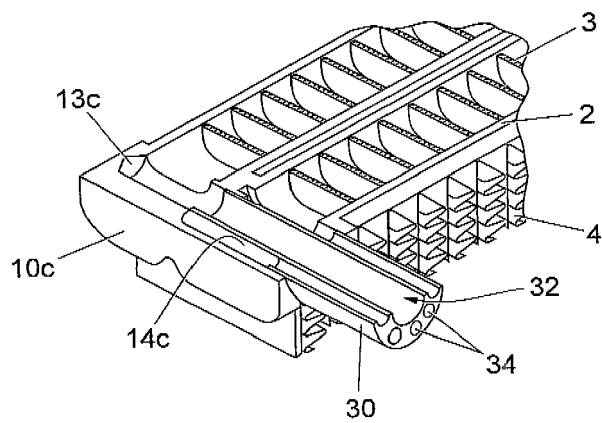


Fig. 10

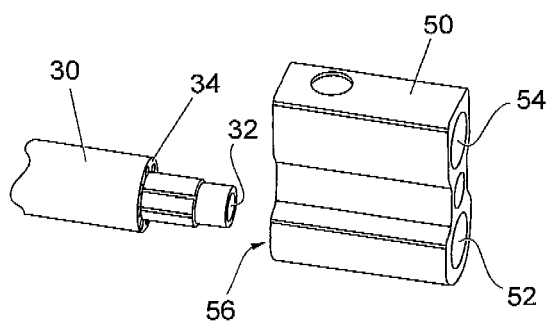


Fig. 11

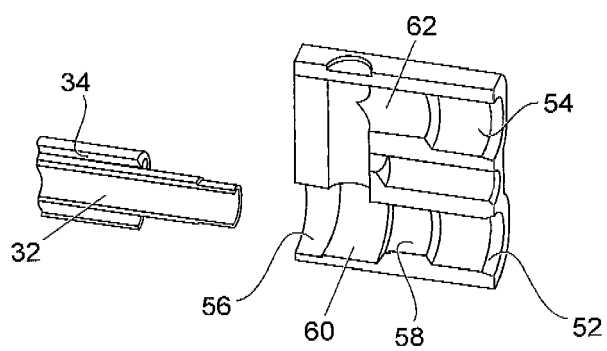


Fig. 12



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 25 1450

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 6 August 2007	Examiner Bain, David
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 25 1450

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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06-08-2007

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