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(54) **HEAT EXCHANGER WITH AN IMPROVED CONNECTOR FOR AN AIR CONDITIONING CIRCUIT OF A MOTOR VEHICLE**

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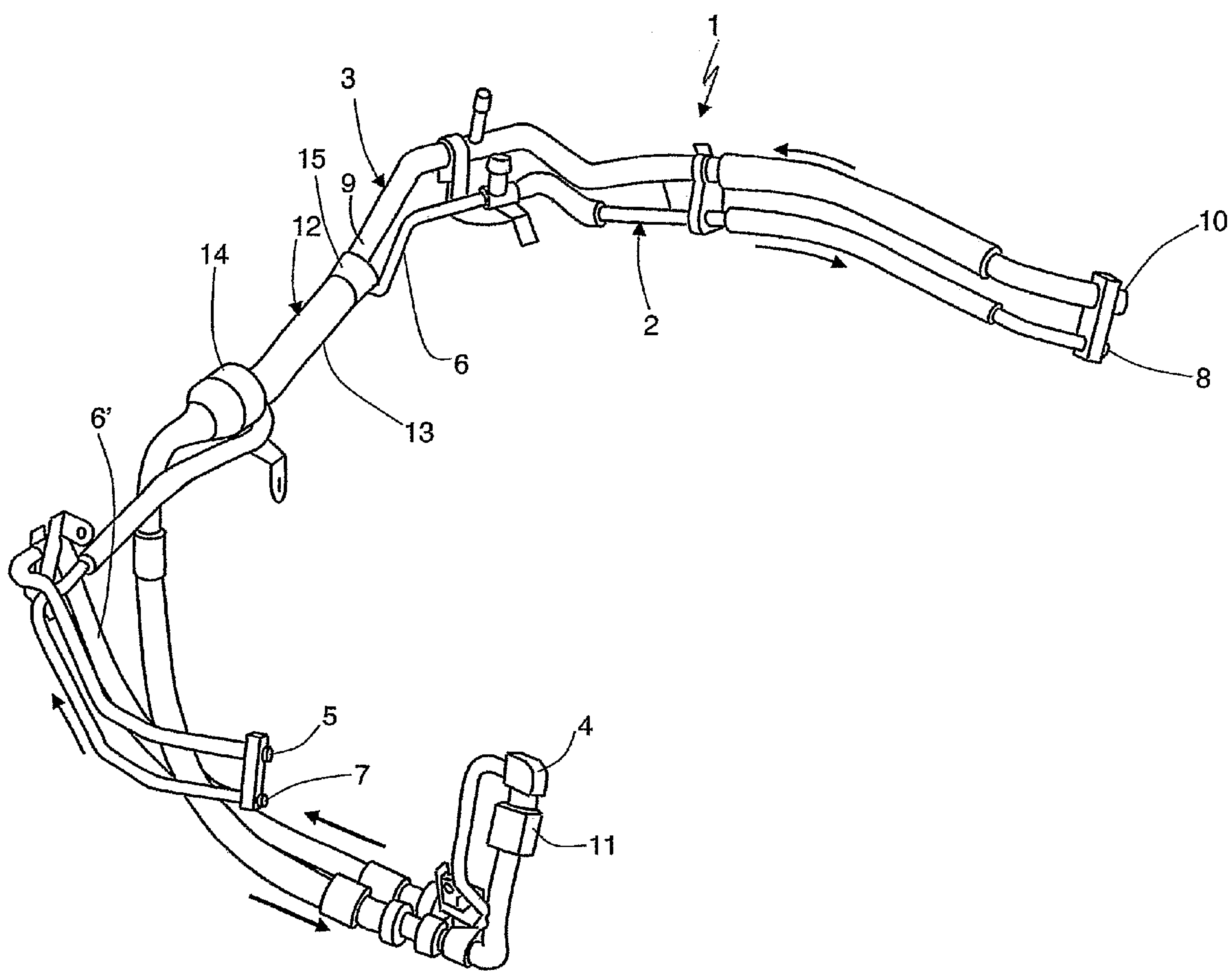
(57) **ABSTRACT**

A heat exchanger for an air conditioning circuit of a motor vehicle, comprises a body defining a central duct having an axis and a plurality of peripheral ducts surrounding the central duct and at least one connector defining a first port fluidically connected to the central duct and a second port fluidically connected to the peripheral ducts, so that the central duct and the peripheral ducts are fluidically insulated. In particular, the connector comprises a tubular portion fluid-sealingly housed within the central duct and fluidically connected to the first port and defines a chamber surrounding the tubular portion and fluidically connected between the peripheral ducts and the second port.



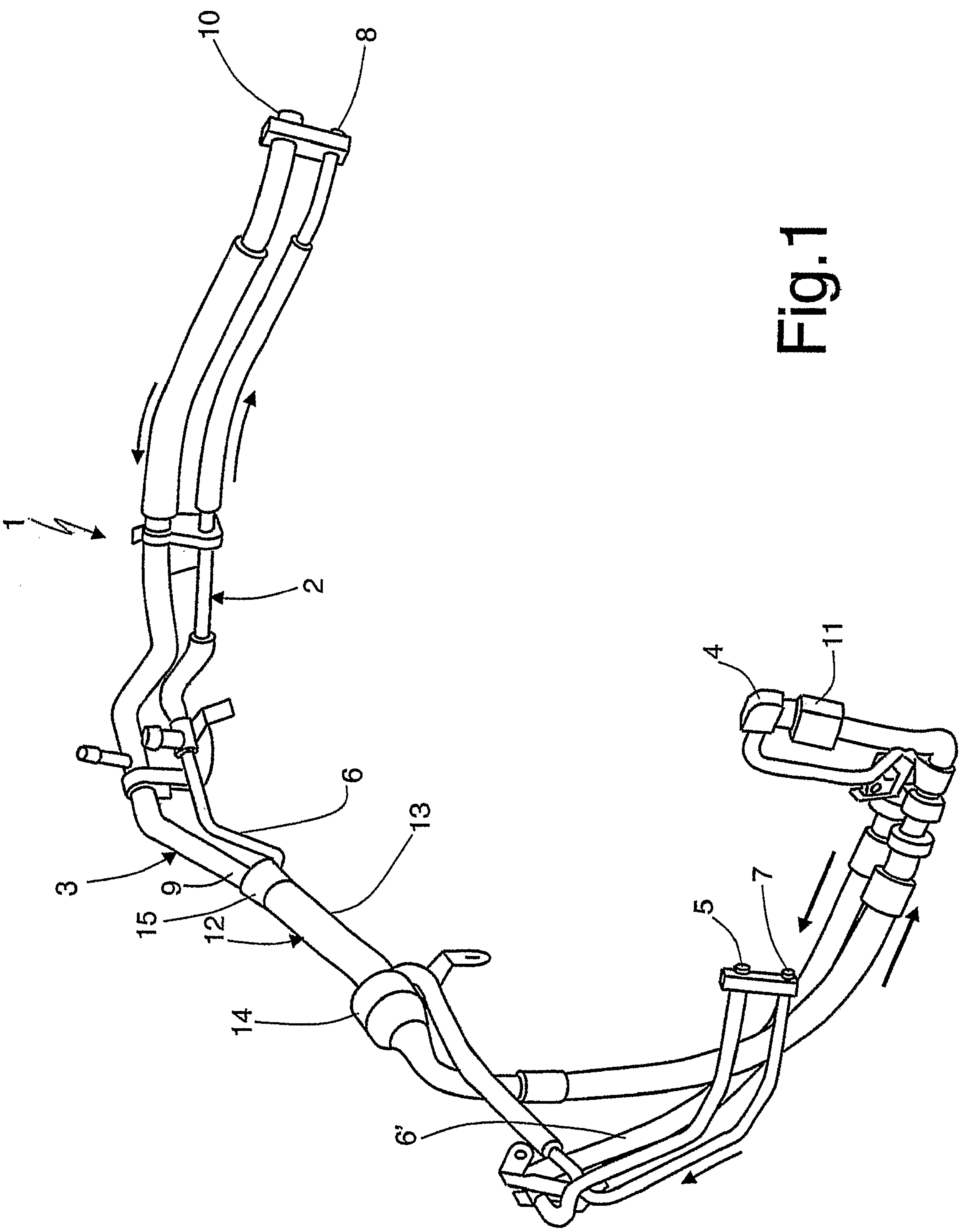


Fig.1

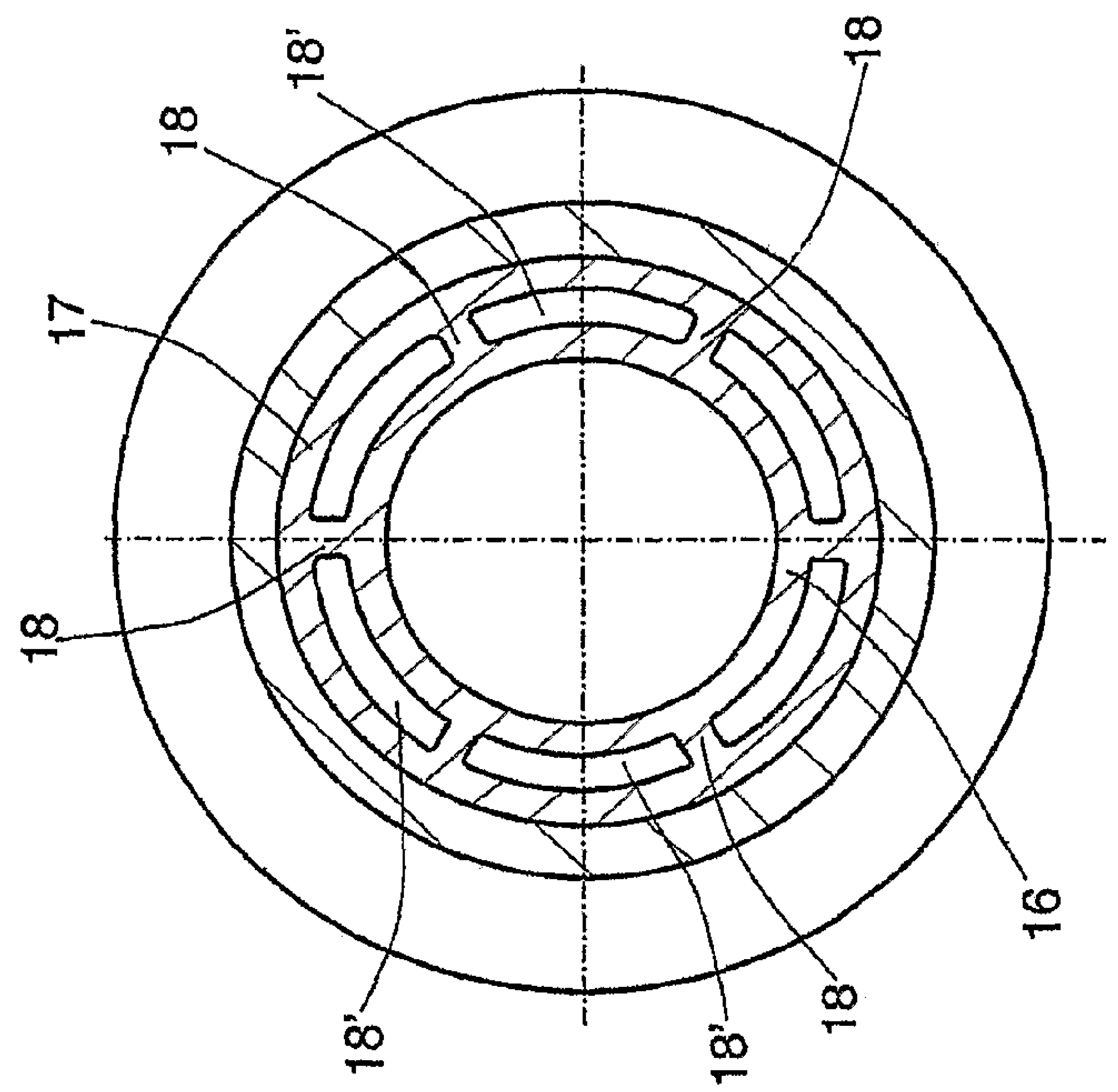

18'
18
18
17
18
16
18'
18'
18

Fig.3

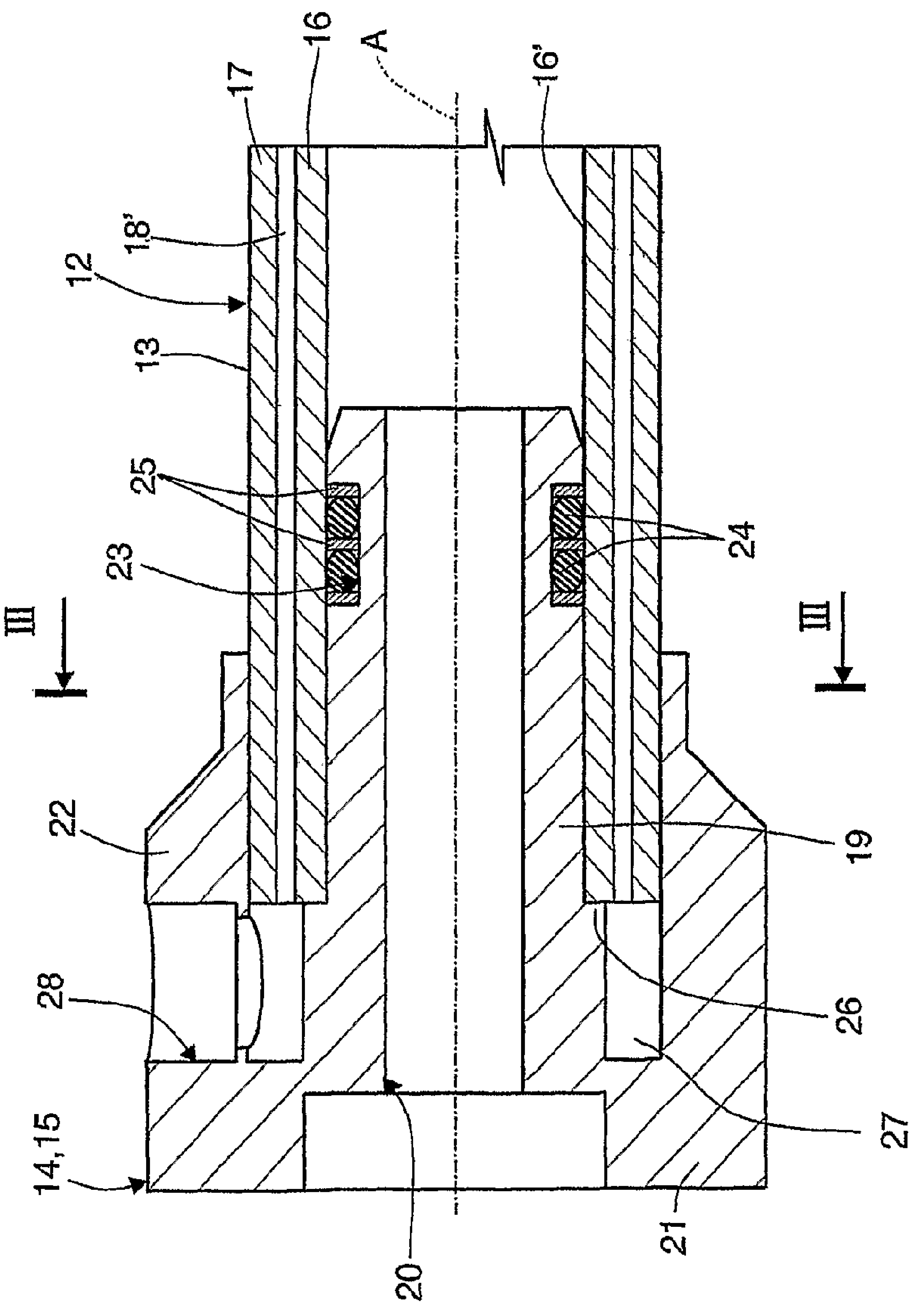

17
16
A
16'
18'
12
13
25
23
24
III
III
22
19
28
26
27
14,15
20
21

Fig.2

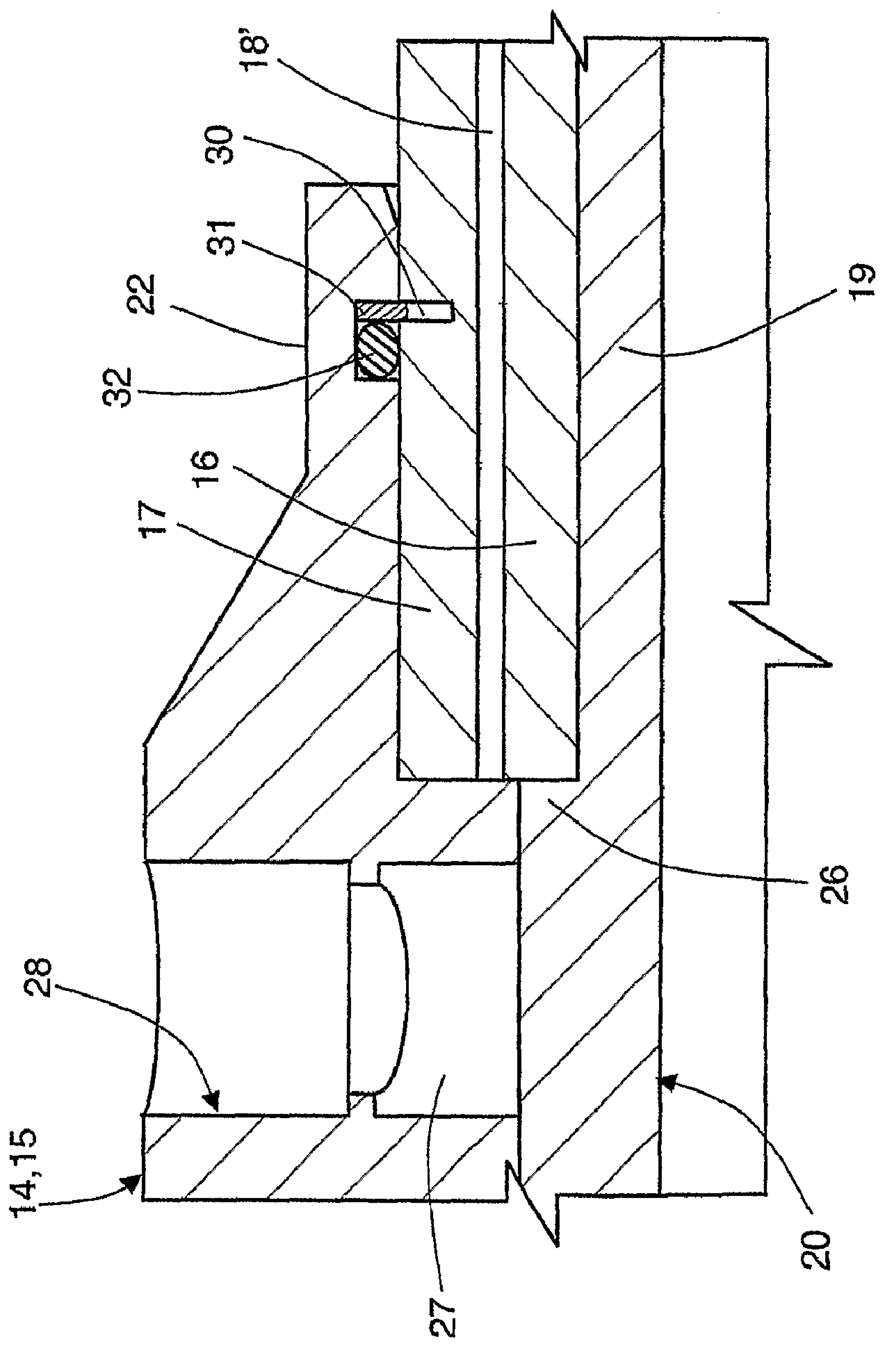


Fig.4

HEAT EXCHANGER WITH AN IMPROVED CONNECTOR FOR AN AIR CONDITIONING CIRCUIT OF A MOTOR VEHICLE

TECHNICAL FIELD

[0001] The present invention relates to a heat exchanger for an air conditioning circuit of a motor vehicle, in particular to a connecting system between a radiating body of the heat exchanger and the inlet and outlet ducts of the air conditioning circuit.

BACKGROUND ART

[0002] An air conditioning circuit of a vehicle comprises a compressor, a condenser, an expansion system, an evaporator and fluidic assembly for connecting the previously mentioned components to one another.

[0003] In particular, the evaporator is crossed by an air current which is fed by means of specific ducts into the passenger compartment and the compressor may be arranged either in the front or in the back of the engine compartment.

[0004] The compressor supplies work to take a fluid from a relatively low temperature and pressure, e.g. 2° C. and 2 bars respectively, to a higher pressure and temperature, e.g. 80° C. and 15 bars.

[0005] The fluid gives heat to the outer environment in the condenser and is directed towards the evaporator, an expansion valve causing a pressure drop being interposed, until the fluid evaporates in the evaporator thus subtracting heat from the air flow which crosses it and which is conveyed into the passenger compartment.

[0006] Downstream of the evaporator, the compressor should supply work to the fluid equal to the enthalpy difference between suction and delivery. In order to make the refrigerating cycle more efficient and reduce polluting emissions, it is known to implement a heat exchanger in which the fluid exiting from the evaporator is heated by the fluid exiting from the condenser. Thereby, the fluid aspirated by the compressor has a higher pressure and temperature, and the enthalpy difference and thus the work of the compressor decrease.

[0007] In the case of a circuit having the compressor arranged in a front position within the engine compartment, the fluidic assembly ducts are arranged side by side along most of the path within the engine compartment and the exchanger has an elongated shape which follows the path of the ducts themselves.

[0008] Heat exchangers are known, comprising a main body for feeding both the refrigerating fluid to be heated and the heating fluid, and a pair of connectors mounted at respective ends of the main body for connecting the heat exchanger to the appropriate ducts of the air conditioning circuit.

[0009] The main body defines a central duct and a plurality of peripheral ducts surrounding the central duct. The central duct is defined by a tubular wall. The peripheral ducts are defined in the radial direction by the tubular wall of the central duct and by an outer tubular wall which is concentrical to the tubular wall of the central duct and, in the circumferential direction, by a plurality of angularly equidistant rectilinear partitions (see FIG. **3**).

[0010] The central duct feeds the refrigerating fluid from the evaporator directed towards the compressor suction, and the peripheral ducts back-flow feed the refrigerating fluid exiting from the condenser.

[0011] In particular, the main body is made by extrusion and may then be folded to adapt to the space available inside the engine compartment.

[0012] A connector for a main body made by extrusion currently comprises a metal block defining a connecting port for one end from the main body, a port for the low-temperature refrigerating fluid and a port for the high-temperature refrigerating fluid.

[0013] For assembling the known connector, the main body should be machined by stock removing. Both the tubular wall and the partitions are removed along an axial end length. The tubular wall of the central duct is thus uncovered and inserted into the connector. The connecting port of the connector is shaped so as to fluidically connect the central duct to the low-temperature fluid port, and the peripheral ducts to the high-temperature, refrigerating fluid port.

[0014] The removal of a portion of outer tubular wall and partitions is a complex operation to be performed and requires carefully cleaning the main body from scraps so as to avoid the main body itself from being contaminated by solid particles having dimensions which could obstruct the expansion assembly and the peripheral ducts, thus compromising the operation of the air conditioning circuit.

DISCLOSURE OF INVENTION

[0015] It is the object of the present invention to provide a heat exchanger for an air conditioning circuit of a motor vehicle which is free from the above-specified drawbacks.

[0016] The object of the present invention is achieved by a heat exchanger according to claim **1**.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] For a better understanding of the present invention, it will be further described with reference to the accompanying drawings, in which:

[0018] FIG. **1** is a perspective view of a fluidic assembly which connects the main components of an air conditioning circuit to one another, and comprises an exchanger according to the present invention;

[0019] FIG. **2** is a partial axial section of a fitting of a tubular, concentrical heat exchanger according to the present invention;

[0020] FIG. **3** is a section taken along line in FIG. **2**; and

[0021] FIG. **4** is a partial axial section of a second embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0022] In FIG. **1**, numeral **1** shows as a whole a fluidic assembly for an air conditioning system of a motor vehicle, comprising a high-pressure line **2** for feeding a refrigerating fluid between the delivery of a compressor and an expansion valve (not shown), and a low-pressure line **3** to feed a refrigerating fluid from the expansion valve to the compression suction (not shown).

[0023] In particular, the high-pressure line **2** comprises metal and rubber ducts mounted in series, a fitting **4** adapted to be connected to the delivery of a compressor, a fitting **5** connected to the inlet of a condenser, and a tube **6'** between the fittings **4** and **5**. Furthermore, the high-pressure line **2** comprises a line **6** for connecting the condenser to an expansion valve (not shown). Line **6** comprises a fitting **7** adapted to be connected to the outlet of the condenser and a fitting **8** adapted to be connected to the expansion valve.

[0024] The low-pressure line **3** comprises a line **9** having a fitting **10** adapted to be connected to the outlet of an evaporator (not shown) and a fitting **11** adapted to be connected to an inlet of the compressor.

[0025] The ducts of lines **2**, **3** comprise at least one layer of a barrier material for preventing the normally very volatile refrigerating fluid from being permeated. For example, the material may be aluminium or polyamide 6.10. In the case of a carbon dioxide system, the pipes are made of steel.

[0026] The refrigerating fluid flowing in line **9** is at a low temperature and is heated by the refrigerating fluid flowing along line **6** to the condenser outlet. For this purpose, the fluidic assembly **1** comprises a heat exchanger **12** comprising a main body **13** and a pair of connectors **14**, **15** for fluidically and mechanically connecting the main body to the lines **6** and **9**.

[0027] For conciseness purposes, FIG. **2** shows a single end portion of the exchanger **12**, it being understood that the other end portion is identical to the one shown.

[0028] The main body of the exchanger **12** comprises a tubular wall **16** having an axis A, an outer tubular wall **17** which is concentrical to the tubular wall **16** and a plurality of radial partitions **18**, all in a single body.

[0029] The tubular wall **16** defines a duct **16'** belonging to the line **9** to feeding refrigerating fluid from the evaporator outlet to the compressor suction. The tubular wall **16**, the outer tubular wall **17** and the partitions **18** radially and circumferentially define, respectively, a plurality of ducts **18'** arranged parallel to one another and belonging to line **6** for feeding refrigerating fluid between the condenser outlet and the expansion valve. According to a preferred embodiment of the present invention, the main body **13** is made by extrusion.

[0030] The connector **14** preferably comprises a tubular portion **19** defining a through duct **20**, a head **21** radially exiting from the tubular portion **19** and a sleeve **22** connected to a peripheral edge of the head **21** and surrounding the tubular portion **19**, all in a single body.

[0031] In particular, portion **19** defines both an annular seat **23** for housing a pair of sealing rings **24** and corresponding spacer rings **25** and a shoulder **26** for defining the relative axial position of the connector **14** with respect to the main body **13**.

[0032] The sealing rings **24** and the spacers **25** define a fluid-tight seal with an inner surface of the tubular wall **16** to avoid the refrigerating fluid from leaking from the high-pressure line **6** towards the low-pressure line **9**.

[0033] The shoulder **26** is spaced apart from an inner surface of the head **21** and, when the connector **14** is mounted on the main body **13**, head **21**, a portion of sleeve **22**, a portion of the tubular wall axially comprised between the head **21** and a shoulder **26** and the main body **13** delimit an annular chamber **27**.

[0034] The ducts **18'** lead into the annular chamber **27** which is connected to line **6** by means of a radial port **28** defined by the sleeve **22**.

[0035] When the shoulder **26** axially comes in contact with the main body **13**, the sealing rings **24** define the fluidic seal on the inner surface of the tubular wall **16** and the sleeve **22** comes in contact with an outer surface of the outer tubular wall **17**.

[0036] Sleeve **22** is rigidly fixed to the outer tubular wall **17** by means of an either low-temperature or cold connection, so as not to damage the sealing rings **24** which are already in a contact position with the inner surface of the tubular wall **16** when the fixing operation is to be performed, and may not be mounted at a later time.

[0037] In particular, the fixing operation is performed by acting only on the outer tubular wall **17** and without acting on the tubular wall **16**, which substantially has the same length as the outer tubular wall **17**.

[0038] For example, the fixing operation is performed either by magnetically welding or crimping the lip of sleeve **22** or by means of a snapping connection with an elastic retaining ring and a seal, as shown in FIG. **4**.

[0039] The aforesaid fixing methods may also be combined in series to improve the fitting tightness, e.g. by using a sealing adhesive and crimping the lip of sleeve **22**.

[0040] In particular, according to the embodiment shown in FIG. **4**, the outer tubular wall **17** defines a seat **30** in which an elastic retaining ring **31** is housed.

[0041] Sleeve **22** also has an annular seat facing the outer tubular wall **17**, within which both the elastic retaining ring **31** and a sealing ring **32** are housed to avoid the refrigerating fluid from leaking to the external environment.

[0042] The advantages of the heat exchanger implemented according to the present invention are apparent from the description provided with reference to the accompanying drawings.

[0043] The connector **14**, **15** may be mounted on the main body **13**, **14** without stock removing operations on tubular wall **17** and partitions **18**. In particular, this result is achieved by the shape of the connector which fluid-sealingly surrounds the outer tubular wall **17** by means of sleeve **22** and internally comes in contact with the inner tubular wall **16** by means of the tubular portion **19**. In particular, no stock removing operations which completely remove the outer tubular wall **17** are carried out. Seats for elastic rings or sealing rings may be made instead.

[0044] The main body **13** may be further connected to the lines **6**, **9** by minimum or null interventions on the main body **13**.

[0045] The assembling operation is rapid and the fixing operation may be easily automated. Furthermore, if the main body **13** is made by extrusion, the excessively broad machining tolerances require a step of calibrating the outer tubular wall **17** before the connector **15** is mounted. This calibration may be carried out without cutting the tubular walls themselves and is generally performed by plastic deformation.

[0046] The connector **14**, **15** may be entirely made by plastic deformation with great advantages in terms of times and costs.

[0047] It is finally apparent that changes and variations may be made to the present invention without departing from the scope of protection defined by the appended claims.

[0048] The connector **14**, **15** may be obtained in a single body by impact extrusion or by die-casting.

[0049] The connector **14**, **15** may be adapted to many types of connection with line **9**. For example, the connection may be of frontal seal washer type, as shown in the figures. Alternatively, the connector **14**, **15** may comprise, preferably in only one body, the male element of either a quick coupling or a threaded connection. Such a male element is coaxial to the axis A and protrudes with respect to the head **21** from the axial side opposite to the tubular portion **19**.

1. A heat exchanger for an air conditioning circuit of a motor vehicle, comprising a body defining a central duct having an axis and a plurality of peripheral ducts surrounding said central duct and at least one connector defining a first port fluidically connected to said central duct and a second port fluidically connected to said peripheral ducts so that said central duct and said peripheral ducts are fluidically insulated, characterized in that said connector comprises a tubular portion which is fluid-sealingly housed within said central duct and fluidically connected with said first port and defines a chamber fluidically connected between said peripheral ducts and said second port.

2. The heat exchanger according to claim **1**, characterized in that said first port is concentrical to said tubular portion and in that said second port is arranged radially.

3. The exchanger according to claim **1**, characterized in that it comprises a sleeve concentrical to said tubular portion and surrounding an outer wall of said body, said sleeve being rigidly connected and fluid sealed to said outer wall.

4. The exchanger according to claim **3**, characterized in that said chamber is defined in a radial direction at least by said tubular portion and by said sleeve.

5. The exchanger according to claim **3**, characterized in that it is snap-fitted to said outer wall and in that it comprises sealing means interposed between said outer wall and said sleeve.

6. The exchanger according to claim **3**, characterized in that said tubular portion and said sleeve are integral.

7. The heat exchanger according to claim **1**, characterized in that said connector is made by plastic deformation.

8. The heat exchanger according to claim **1**, characterized in that said connector is rigidly connected to said body by means of a process selected among crimping and a magnetic welding.

9. A fluidic assembly for connecting at least two among a compressor, an evaporator, an expander assembly and a condenser of an air-conditioning circuit of a motor vehicle, characterized in that it comprises an exchanger according to claim **1**.

10. An air conditioning circuit for a motor vehicle comprising an exchanger according to any of claim **1**.

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