

FLOW DISTRIBUTOR

Related Applications

This application claims the benefit of U.S. Provisional Application No.
5 62/118,714 filed February 20, 2015, which is hereby incorporated herein by
reference.

Field of Invention

The present invention relates generally to flow distributors, and more
10 particularly to flow distributors for thermal expansion valves for refrigeration
circuits.

Background

Air conditioning and refrigeration systems are able to utilize the phase
15 changes of refrigerant fluids in order to extract heat from circulated air, and thus
cool the air. A typical air conditioning or refrigeration system includes a
compressor, a condenser, a thermal expansion valve and an evaporator. The
compressor compresses a cool vapor-phase refrigerant (e.g., R410a, or R404a) to
increase the temperature of the refrigerant, resulting in a high-pressure vapor-
20 phase refrigerant that is hot. The hot vapor-phase refrigerant runs through the
condenser, which condenses the hot vapor-phase refrigerant into liquid
refrigerant.

The liquid refrigerant is typically regulated through the thermal expansion
valve, which typically evaporates the refrigerant to a cold and low-pressure
25 saturated liquid-vapor-phase refrigerant. The cold and low-pressure saturated
liquid-vapor-phase refrigerant runs through the evaporator to absorb heat from the
circulated air. Absorbing the heat causes the cold saturated liquid-vapor-phase
refrigerant to become the cool vapor-phase refrigerant.

Previous thermal expansion valves have an outlet connected to a
30 refrigerant distributor with a distribution portion that is machined to accept tubing
to connect the refrigerant distributor to multiple evaporator coil circuits within the
evaporator. Typically, refrigerant distributors are expensive to manufacture,
require multiple connection operations (e.g., multiple brazing operations at various

locations) to connect the refrigerant distributor to the previously-known thermal expansion valves, and require a large quantity of expensive materials (e.g., brass).

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Summary of Invention

The present invention provides a flow distributor assembly for an expansion valve, and the flow distributor assembly may include a tube receiving body telescopically fitted in an end of a tubular fitting body of the flow distributor assembly. The flow distributor may be less expensive to manufacture than
10 previously-known refrigerant distributors. For example, a tube receiving body according to the present invention may require less material (e.g., expensive materials such as brass) compared to previously-known flow distributor bodies.

A tube receiving body according to the present application may reduce assembly costs compared to previously-known refrigerant distributors. The tube
15 receiving body may require less assembly time, such as the number of brazing or soldering operations, and/or less assembly materials, such as brass to form the tube receiving body, to assemble the tube receiving body into a tubular fitting body of a flow distributor assembly compared to assembly of previously-known refrigerant distributors. For example, the tube receiving body may be recessed
20 from the axial end of the tubular fitting body to form a cavity that may receive a brazing or soldering filler material. A single-heating operation at the end of the tubular fitting body may melt the filler material to braze or solder the tube receiving body and the tubes to the tubular fitting body.

In an embodiment, the single-heating operation may melt the filler material
25 to braze or solder a nozzle body to the tubular fitting body and/or to the tube receiving member.

The tube receiving body may be less expensive to manufacture compared to previously-known brass flow distributor bodies. For example, the tube receiving body may include a plurality of parallel through holes, which may be machined
30 without taking time to adjust an angle of the tube receiving body to machine non-parallel holes that are common in previously-known flow distributor bodies.

The tubular fitting body may be thin-walled, which may reduce material costs compared to a thick-walled tubular fitting body. For example, the thickness

of the wall of the tubular fitting body may be less than 20% a width of the tubular fitting body. In an embodiment, the tubular fitting body is cylindrical and the wall thickness may be less than 20% the diameter of the tubular fitting body.

The flow distributor assembly may be integral with the expansion valve to
5 reduce installation time and cost when installing the expansion valve as part of a refrigeration system. For example, the tube receiving body may be telescopically fitted within an outlet housing of the thermal expansion valve assembly to reduce the number of components required for the thermal expansion valve assembly.

According to one aspect of the invention, a flow distributor assembly for an
10 expansion valve includes a tubular fitting body having a first end and a second end and a tube receiving body telescopically fitted in the second end of the tubular fitting body and including a plurality of through holes for receiving an end portion of a tube, wherein the tube receiving body defines a downstream end of a distribution chamber that is downstream of an orifice.

According to another aspect of the invention, a method of manufacturing a
15 flow distributor assembly for an expansion valve includes telescopically fitting a tube receiving body into a tubular fitting body, wherein the tube receiving body includes a plurality of through holes for receiving an end portion of a tube, wherein the tube receiving body defines a downstream end of a distribution chamber that
20 is downstream of an orifice.

The foregoing and other features of the invention are hereinafter described in greater detail with reference to the accompanying drawings.

Brief Description of the Drawings

25 Fig. 1 is a partial cross-sectional view of a side of an exemplary thermal expansion valve assembly with an exemplary flow distributor assembly, included in a schematically illustrated refrigeration system.

Fig. 2 is an oblique view of the flow distributor assembly of Fig. 1.

Fig. 3 is an exploded cross-sectional view of a side of the flow distributor
30 assembly of Fig. 2.

Fig. 4 is a cross-sectional view of a side of the flow distributor assembly of Fig. 2.

Fig. 5 is an enlarged portion of the cross-sectional view of the side of the flow distributor assembly of Fig. 4 including an exemplary joining material.

Fig. 6 is an exploded cross-sectional view of a side of another exemplary flow distributor assembly, which may include a replaceable orifice.

5 Fig. 7 is a cross-sectional view of a side of the flow distributor assembly of Fig. 6.

Fig. 8 is an exploded cross-sectional view of a side of another exemplary flow distributor assembly, which may include a fluid filter, may include a nozzle body with a paraboloid-shaped portion, and may include a tube receiving body with
10 a conical-shaped portion of an upstream facing surface.

Fig. 9 is a cross-sectional view of a side of the flow distributor assembly of Fig. 8.

Fig. 10 is an exploded cross-sectional view of a side of another exemplary flow distributor assembly, which may include an orifice that is venturi-shaped.

15 Fig. 11 is a cross-sectional view of a side of the flow distributor assembly of Fig. 10.

Fig. 12 is an exploded cross-sectional view of a side of another exemplary flow distributor assembly, which may include a tube receiving body with an indented portion of an upstream facing surface of an exemplary tube receiving
20 body.

Fig. 13 is a cross-sectional view of a side of the flow distributor assembly of Fig. 12.

Detailed Description

25 The principles of this present application have particular application to refrigerant distributors for distributing fluid mixtures (e.g., a saturated liquid-vapor-phase refrigerant), and thus will be described below chiefly in this context. It will of course be appreciated, and also understood, that principles of this invention may be applicable to other systems where it is desirable to distribute fluid from
30 one component to another component, such as any electric or thermostatic expansion valve that has a two-phase fluid that expands across a pressure drop.

Referring initially to Fig. 1, a refrigeration system 20 may include a refrigeration circuit 22, which may include an evaporator 24, a compressor 26, a

condenser 28, and thermal expansion valve assembly 30 for providing a cooling operation of an external fluid moving adjacent to the evaporator 24 (e.g., for cooling air moved by an external fluid motive device 32, such as a fan). For example, the evaporator 24 may have an inlet that is fluidly connected to an outlet of the thermal expansion valve assembly 30 through a flow distributor assembly 34 of the thermal expansion valve assembly 30 via a fluid line 40 (e.g., tubing). The compressor 26 may have an inlet that is fluidly connected to an outlet of the evaporator 24 via a fluid line 42 (e.g., tubing). The condenser 28 may have an inlet that is fluidly connected to an outlet of the compressor 26 via a fluid line 44 (e.g., tubing). The condenser 28 may have an outlet that is fluidly connected to an inlet of the thermal expansion valve assembly 30 via a fluid line 46 (e.g., tubing).

The refrigeration system 20 may include the external fluid motive device 32 (e.g., a fan) to move the external fluid (e.g., air) across evaporator coils 48 (shown schematically) of the evaporator 24. As illustrated, the external fluid may flow by or through the evaporator 24 and absorb heat from an internal fluid (e.g., a refrigerant, such as R-410a (a nearly azeotropic mixture of difluoromethane (also known as R-32) and pentafluoroethane (also known as R-125)) or chlorodifluoromethane (also known as R-22)) that may flow through the refrigeration circuit 22 to the evaporator 24.

The thermal expansion valve assembly 30 (e.g., a refrigerant valve assembly) may include a thermal expansion valve 50 (e.g., a mechanical or an electronic expansion valve) that is fluidly connected to the flow distributor assembly 34 to distribute the internal fluid flow from the thermal expansion valve 50 to the evaporator 24. For example, the flow distributor assembly 34 may be fluidly connected to an outlet 52 of the thermal expansion valve 50 to provide the internal fluid to the evaporator 24.

The evaporator 24 may include multiple coils 48 (shown schematically) and each coil 48 may be fluidly connected via multiple fluid lines, which are partially shown as tubes 54, 56 fluidly connected to schematically shown distribution lines 58, 60. The distribution lines 58, 60 are schematically shown as merging together to connect to the fluid line 40. The fluid line 40 may maintain the distribution lines 58, 60 fluidly separated. For example, the fluid line 40 may include multiple tubes that each correspond to only one of the distribution lines 58, 60. In an

embodiment, more than four distribution lines may fluidly connect to more than four tubes of the flow distributor assembly.

The flow distributor assembly 34 may include a tubular fitting body 70 and a tube receiving body 72 telescopically fitted in an outlet end 74 of the tubular fitting body 70 that may receive the tubes 54, 56 (shown best in Fig. 2). The tubular fitting body 70 may have an inlet end 76 that is fluidly connected to the outlet 52 of the thermal expansion valve 50. For example, the inlet end 76 may be a portion of a tube (e.g., a copper tube stub), which may be cylindrical. In an embodiment, the inlet end may be connected to another valve or to a tubular member for another system.

The flow distributor assembly 34 may include a distribution chamber 78 that is upstream of the tube receiving body 72, and the flow distributor assembly 34 may include an orifice 80 that is upstream of the distribution chamber 78 to throttle fluid flowing from upstream of a nozzle body 82.

The flow distributor assembly 34 may be integral with the thermal expansion valve 50. For example, the tubular fitting body 70 may be integral with an outlet housing 84 of the thermal expansion valve assembly 30. In an embodiment, the outlet housing of the thermal expansion valve forms the tubular fitting body in one-piece that is fixedly connected to a main body of the thermal expansion valve assembly. Forming the tubular fitting body with the outlet housing in one-piece allows the tube receiving body to be telescopically fitted within the outlet housing to reduce the number of components required for the thermal expansion valve assembly. Combining the outlet housing and tubular fitting body into one-piece may eliminate assembly time and manufacturing costs associated with assembling and fixedly connecting the tube fitting body to the outlet housing. For example, only a single connection may be required to fixedly connect the outlet housing and the tubular fitting body to the main body of the thermal expansion valve assembly.

In another embodiment, the thermal expansion valve assembly includes only a single enlarged outlet portion to both telescopically receive the tube receiving body and to reduce pressure of an internally flowing fluid.

During operation, the flow distributor assembly 34 may mix and/or separate the internal fluid, which may be in a cold and low-pressure saturated liquid-vapor-

phase. The internal fluid may flow from the distribution chamber 78 to separate tubes 54, 56 to corresponding evaporator coils 48 in the evaporator 24. The internal fluid may release heat to the external fluid when flowing through the evaporator 24, which may cause the internal fluid to be in a cool-vapor phase.

5 The internal fluid, while in the cool vapor-phase, may flow to the compressor 26, which may increase a temperature of the internal fluid. Increasing the temperature of the internal fluid may cause the internal fluid to be in a hot high-pressure vapor-phase.

10 The internal fluid, while in the hot high-pressure vapor-phase, may flow to condenser coils 86 (shown schematically) of the condenser 28, which may condense the internal fluid to release heat to ambient external fluid (e.g., air) via the condenser coils 86. Releasing heat from the internal fluid may cause the internal fluid to be in a liquid phase.

15 While in the liquid phase, the internal fluid may flow to the thermal expansion valve 50, which may cause the internal fluid to again be in the cold and low-pressure saturated liquid-vapor-phase for distribution by the flow distribution assembly 34. The cycle may continue repeatedly as described to continue cooling the external fluid passing by the evaporator 24.

20 Referring now to Fig. 3, the tubular fitting body 70 may define a central through passage 88 that may extend at least partially along a central axis A from the inlet end 76 to the outlet end 74 of the tubular fitting body 70. For example, the central through passage 88 may extend entirely along the central axis A and may be coaxial with the central axis A.

25 The tubular fitting body 70 may have thin walls that define the central through passage 88. For example, the thin walls may have a wall thickness T that is 5-15% a cross-sectional width W of the outlet end 74 of the tubular fitting body 70, preferably 7-12%, more preferably 10%.

30 The outlet end 74 may be able to receive the tube receiving body 72 and/or the nozzle body 82 opposite the inlet end 76. The outlet end 74 may be cylindrical and may be coaxial with the central axis A. In an embodiment, the outlet end may form any other suitable shape, such as a rectangular prism. In another embodiment, the outlet end may not be coaxial with the central axis.

The outlet end 74 may have a larger cross-sectional area compared to a cross-sectional area of the inlet 76 to receive the tube receiving body 72. For example, the tubular fitting body 70 may include a transition portion 90 that transitions from a cross-sectional area X of the inlet end 76 to the cross-sectional area W of the second end 74. For example, the transition portion 90 may be a tubular-frustoconical body. In an embodiment, the transition portion may form any other suitable shape, such as a rectangular prism to fluidly connect the inlet end to the outlet end. In another embodiment, the transition portion may not be coaxial with the central axis.

The transition portion 90 may form a radially inward protrusion 100 to limit upstream axial movement of the nozzle body 82 relative to the tubular fitting body 72. For example, the radially inward protrusion 100 may be formed by a step that is formed at a downstream end of the transition portion 90. In an embodiment, the radially inward protrusion may be formed by one or more radially inwardly extending portions extending from a radially inwardly facing surface of the tubular fitting body to limit upstream axial movement of the nozzle body and/or the tube receiving body. In another embodiment, another portion of the tubular fitting body (e.g., the outlet end) may include a radially inward protrusion to limit upstream movement of the nozzle body or the tube receiving body.

The flow distributor assembly 34 may include the nozzle body 82, which may form the orifice 80. The nozzle body 82 may have a frustoconically-shaped portion 102 facing the transition portion 90, which may be upstream of a cylindrical portion 104, for being telescopically received in the transition portion 90 and the outlet end 74, respectively.

The orifice 80 may be defined by a radially inwardly facing surface 106 of the nozzle body 82. For example, the orifice 80 may be a through hole (e.g., a cylindrical through hole) to fluidly open to the distribution chamber 78 (shown best in Figs. 4 and 5) at a downstream end of the orifice 80. The orifice may be coaxial with the central axis A to provide internal fluid flow to a radially central portion of the tube receiving body 72 through a radially central portion of the distribution chamber 78.

The nozzle body 82 may define an upstream portion of the distribution chamber 78. For example, the nozzle body 82 may include a downstream facing

surface 108 that faces downstream toward the tube receiving body 72. The downstream facing surface 108 may span radially from the outlet of the orifice 80 to form a circular surface that is coaxial with the central axis A. In an embodiment, the downstream facing surface is another suitable shape for forming the distribution chamber 78.

A downstream end of the distribution chamber 78 may be defined by an upstream facing surface 110 of the tube receiving body 72. The upstream facing surface 110 may be a circular surface that is coaxial with the central axis A. The upstream facing surface 110 of the tube receiving body 72 may include a flat portion that is extend radially outward from the central axis A for receiving internal fluid from the distribution chamber 78. In an embodiment, the upstream facing surface is another suitable shape for forming the distribution chamber and/or for receiving fluid flow from the orifice.

When assembled, as discussed further below, the upstream facing surface 110 may be axially offset from the downstream facing surface 108 to define an axial length of the distribution chamber 78.

The axial offset may be formed by an axially extending tubular portion 112 that may form part of the cylindrical portion 104 and may circumscribe the central axis A. The nozzle body 82 may include the axially extending tubular portion 112, which may extend downstream of the downstream facing surface 108. For example, the downstream facing surface 108 and the axially extending tubular portion 112 may be formed by a counter bore that is coaxial with the central axis A. In an embodiment, the axially extending tubular portion may be formed by a radially inwardly extending projection of the tubular fitting body to define a portion of the distribution chamber and/or to limit upstream movement of the tube receiving body.

The tube receiving body 72 may have a radially outwardly facing surface 114 with a profile that matches or is slightly smaller than a profile of a radially inwardly facing surface 116 of the tubular fitting body 70 to allow the tube receiving body 72 to telescopically fit into the outlet end 74. For example, the tube receiving body 72 may be cylindrical with a diameter that is less than or equal to a diameter of the outlet end 74 of the tubular fitting body 70 to allow the outlet end 74 to receive the tube receiving body 72.

The tube receiving body 72 may be press fit into the tubular fitting body 70 or otherwise tightly fit to allow the radially outwardly facing surface 114 to abut the radially inwardly facing surface of the tubular fitting body 116. For example, the entire radially outwardly facing surface 114 may abut the radially inwardly facing surface 116 about the central axis A. In an embodiment, only a portion of the
5 radially outwardly facing surface abuts the radially inwardly facing surface.

It will be appreciated that enough space may be available between the radially outwardly facing surface 114 and the radially inwardly facing surface 116 to allow each surface 114, 116 to be brazed or soldered together, as discussed
10 further below.

The tube receiving body 72 may include four through holes 118, 120 (two through holes are not shown in the cross-section) that are able to receive an end portion 122, 124 of each corresponding tube 54, 56. Each through hole 118, 120 may be radially offset from the central axis A and spaced apart from each other.
15 For example, each through hole 118, 120 may be equally radially spaced from the central axis A and equally circumferentially spaced from each adjacent through hole 118, 120. In an embodiment, the through holes may not be equally radially spaced from the central axis and/or may not be equally circumferentially spaced. In another embodiment, the tube receiving body includes more than four through
20 holes for receiving corresponding tubes.

Each of the through holes 118, 120 may be cylindrical and parallel with the central axis A. Machining the through holes 118, 120 parallel to one another allows each through hole 118, 120 to be machined without adjusting an angle of the tube receiving body 72. For example, the through holes may be counter bored
25 to provide a shoulder 126, 128 to limit upstream axial movement of each tube within each through hole 118, 120 during assembly.

The tubes 54, 56 may be any suitable shape and spaced apart to be received in each corresponding through hole 118, 120. For example, the tubes 54, 56 may each have a circular cross-section. Alternatively, the tubes may have
30 another cross-sectional shape, such as a rectangular cross-sectional shape.

The end portion 122, 124 of each tube may be coaxial with each corresponding through hole 118, 120 to be telescopically receiving in each through hole 118, 120 to be fluidly connected to the orifice 80 via the distribution

chamber 78. After assembly, each of the end portions 122, 124 may be fixedly connected within each corresponding through hole 118, 120. The end portions may be fixedly connected in any suitable manner, including brazing or soldering processes described further below.

5 In an embodiment, the end portions may be non-parallel with the other. For example, each end portion may be non-parallel with the central axis A and may be coaxial with the corresponding through hole.

 In an embodiment, the tubes may be any other suitable fluid line for allowing fluid flow from the tube receiving portion to the evaporator coils.

10 Referring now to Fig. 4, the end portions 122, 124 may be disposed within each through hole 118, 120 (e.g., abutting each radially inwardly extending shoulder 126, 128). Disposing the end portions 122, 124 in each through hole 118, 120 allows each end portion 122, 124 to be fluidly connected to the distribution chamber 78, which may be partially formed by the upstream facing
15 surface 110, as described above.

 The upstream facing surface 110 of the tube receiving body 72 may abut an axially facing surface 130 of the axially extending tubular portion 112 within the outlet end 74. Abutting the upstream facing surface 110 against the axially facing surface 130 may limit upstream axial movement of the upstream facing surface
20 110 relative to the downstream facing surface 108 of the nozzle body 82. Limiting the axial movement of the upstream facing surface 110 may define an axial distance of the distribution chamber formed between the downstream facing surface 108 and the upstream facing surface 110.

 An upstream facing surface of the frustoconically-shaped portion 102 of the
25 nozzle body 82 may abut the radially inward protrusion 100 to prevent upstream axial movement of the nozzle body 82 relative to the tubular fitting body 70. Preventing upstream axial movement of the nozzle body 82 may prevent upstream axial movement of the tube receiving body 72 and the tubes 54, 56 relative to the tubular fitting body 70.

30 Manufacturing and/or assembly of the flow distributor assembly 34 may include enlarging the outlet end 74 of the tubular fitting body 70 (e.g., a diameter of the outlet end 74 of the tubular fitting body may be enlarged). For example, a mandrel (not shown) may be inserted into the outlet end 74 and tapped with a

mallet (not shown) to enlarge the outlet end 74 and to form the transition portion 90. The enlarged outlet end 74 may provide a space for receiving the nozzle body 82 and tube receiving body 72.

5 The nozzle body 82 may be telescopically received in the outlet end 74 of the tubular fitting body 70. For example, the nozzle body 82 may be inserted against an upstream facing surface of the radially inward protrusion 100 of the tubular fitting body 70 to prevent upstream movement of the nozzle body 82.

10 The nozzle body 82 may be telescopically fitted into an end of the fitting body prior to the tube receiving body. For example, the tube receiving body 72 and the radially inward protrusion 100 may sandwich the nozzle body 82 to prevent axial movement of the nozzle body 82 within the tubular fitting body 70.

Sandwiching the nozzle body 82 with the tube receiving body 72 may form the distribution chamber 78. The size and geometry of the distribution chamber 78 may facilitate mixing of the internal fluid that may flow through the orifice 80.
15 For example, the distribution chamber 78 may be cylindrical.

Any suitable size and geometry of the downstream facing surface 108 and tubular portion 112 of the nozzle body 82, and/or any suitable size and geometry of the upstream facing surface 110 of the tube receiving body 72 may be utilized. For example, the geometry of the upstream facing surface 110 and/or the size and
20 shape of the distribution chamber 78 can be varied to achieve different flows and mixing of the internal fluid flowing through the orifice 80 to the upstream facing surface 110 of the tube receiving body 72.

The tube receiving body 72 may be telescopically fitted into the tubular fitting body 70 downstream of the radially inward protrusion 100. For example, the
25 entire tube receiving body 72 may be telescopically fitted in the outlet end 74 such that the radially inwardly facing surface 116 of the tubular fitting body 70 entirely circumscribes the tube receiving body 72 about the central axis A.

The tube receiving body may be telescopically fitted into the outlet end 74 such that a downstream facing surface 140 of the tube receiving body 72 may be
30 axially recessed from an end of the outlet end 74. For example, the tube receiving body 72 may have an axial length L (as shown best in Fig. 5) and the downstream facing surface 140 may be recessed an axial length R, from a downstream facing surface 142 of the outlet end 74, less than the axial length L. For example, the

axial length R may be .005-.015", preferably .007-.012", and more preferably .01". The axial length L may be .350"-.400", preferably .360-.390, and more preferably .375".

Recessing the downstream facing surface 140 may form a cavity 144 at least partially bounded by the downstream facing surface 140 and a portion of the radially inwardly facing surface 116 at the outlet end 74. The cavity 144 may receive a joining material (shown schematically in Fig. 5), as discussed further below.

Each of the tubes 54, 56 may be telescopically fitted into the corresponding through hole 118, 120. Each through hole 118, 120 may be disposed within the tubular fitting body 70 when each of the tubes 54, 56 are inserted, such that each end portion 122, 124 of each tube 54, 56 is inserted at least partially within the outlet end 74 of the tubular fitting body 70.

Each end portion 122, 124 may be inserted until each end portion 122, 124 abuts the corresponding radially inwardly extending shoulder 126, 128, which may prevent upstream movement of each abutting tube 54, 56.

Referring now to Fig. 5, a joining material 146 may be disposed in the cavity 144, which may fixedly connect the tube receiving body 72 to the radially inwardly facing surface 116 of the tubular fitting body 70. The joining material may entirely cover the radially outwardly facing surface 114 of the tube receiving body 72 to fixedly connect the tube receiving body 72 to the tubular fitting body 70. In an embodiment, any other suitable connection may be used to fixedly connect the tube receiving body to the tubular fitting body.

The joining material 146 may be a contiguous joining material, such as a single-brazed connection or a single-soldered connection that may be formed by brazing or soldering a filler material (e.g., aluminum, copper, brass, silver, or any other suitable filler material). The filler material may be wetted to the radially outwardly facing surface 114 of the tube receiving body 72 and to the radially inwardly facing surface 116 of the tubular fitting body 70.

The filler material may be a metal that has a melting point less than a melting point of a material of the tube receiving body 72 and a material of the tubular fitting body 70. The low melting point of the filler material allows the filler material to wet to the tube receiving body 72 and the tubular fitting body 70

without melting and/or deforming the tube receiving body 72 or the tubular fitting body 70.

The joining material 146 may be contiguous and may fixedly connect one or more of the tubes 54, 56 to the tube receiving body 72. For example, the
5 contiguous joining material 146 may contact each surface that defines the cavity 144, such as the radially inwardly facing surface 116 of the outlet end 74, the downstream facing surface 140 of the tube receiving body 72, and a portion of a radially outwardly facing surface 148, 150 of each tube 54, 56. The contiguous joining material 146 may entirely cover the radially outwardly facing surface 148,
10 150 of each end portion 122, 124 of each tube 54, 56 to fixedly connect each tube 54, 56 to the tube receiving body 72.

The contiguous joining material 146 may fixedly connect the cylindrical portion 104 of the nozzle body 82 to the radially inwardly facing surface 116 of the tubular fitting body 70. For example, the contiguous joining material 146 may
15 extend axially from the downstream facing surface 140 to the radially inwardly facing protrusion 100 of the tubular fitting body 70 to fixedly connect the nozzle body 82 to the tubular fitting body 70. The contiguous joining material 146 may entirely cover the cylindrical portion 104 of the nozzle body 82 to fixedly connect each tube 54, 56 to the tube receiving body 72.

20 The contiguous joining material 146 may fixedly connect the tubular portion 112 to the tube receiving body 72. For example, the contiguous joining material 146 may extend radially inward to join a downstream facing surface of the tubular portion 112 to a radially outward portion of the upstream facing surface 110.

In an embodiment the tubular portion may be a separate component from
25 the nozzle body and the contiguous joining material may fixedly connect the tubular portion to the nozzle body, the tube receiving body, and/or the tubular fitting body.

A single manufacturing step, such as a brazing or soldering step, may form the contiguous joining material 146. For example, a filler material may be
30 disposed in the cavity 144 and a single-heating step, such as a single-brazing or a single-soldering heating step (e.g., heating the filler material, the outlet end 74, the tube receiving body 72, and the end portions 122, 124 with a torch), may melt the filler material to wet the filler material to the tube receiving body 72 and to the

radially inwardly facing surface 116. A capillary action may pull the melted filler material axially upstream to cover the radially outward facing surface 114 of the tube receiving body 72 and the radially inwardly facing surface 116 of the tubular fitting body 70.

5 During the single-heating step, the filler material may wet to the radially outwardly facing surface 148, 150 of each tube 54, 56. A capillary action may pull the filler material axially upstream to cover the radially outwardly facing surface 148, 150 of the end portion 122, 124 of each tube 54, 56. In an embodiment, a separate heating step may be used to fixedly connect the tubes to the tube
10 receiving body.

 The filler material may wet to the downstream facing surface, of the tubular protrusion 112, and to the radially outward portion of the upstream facing surface 110 of the tube receiving body 72 during the single-heating step. For example, a capillary action may pull the filler material axially upstream to the tubular
15 protrusion 112 and radially inwardly to cover the downstream facing surface of the tubular protrusion 112 to fixedly connect the tubular protrusion 112 to the upstream facing surface 110 of the tube receiving body 72.

 The filler material may wet to the radially outwardly facing surface, of the tubular protrusion 112, and to the radially inwardly facing surface 116 of the
20 tubular fitting body 70 during the single-heating step. For example, a capillary action may pull the filler material axially upstream to cover the radially outwardly facing surface of the tubular protrusion 112 to fixedly connect the tubular protrusion 112 to the radially inwardly facing surface 116 of the tubular fitting body 70.

25 The filler material may wet to the cylindrical portion 104 of the nozzle body 82 and to the radially inwardly facing surface 116 of the tubular fitting body 70 during the single-heating step. For example, a capillary action may pull the filler material axially upstream to cover the cylindrical portion 104 of the nozzle body 82. In an embodiment, a separate heating step may be used to fixedly connect
30 the nozzle body to the tubular fitting body.

 During use of the flow distributor assembly 34, the tubular fitting body 70 may direct the internal fluid downstream from to inlet end 76 (shown in Figs. 1 and 3) to the outlet end 74. For example, the internal fluid may flow within the tubular

fitting body 70 from the inlet end 76 to the transition portion 90 to the orifice 80. The internal fluid may flow through the orifice 80 to the distribution chamber 78 and to the upstream facing surface 110 formed by the tube receiving body 72. The upstream facing surface 110 may receive the internal fluid from the orifice 80 to distribute the internal fluid to each of the through holes 118, 120 through the distribution chamber 78. For example, the flat portion of the upstream facing surface 110 may receiving the internal fluid from the orifice 80.

An entire portion, of the internal fluid that flows through a portion of the tube receiving body 72 may simultaneously flow through the tubular fitting body 70. For example, all internal fluid that flows through the end portion 122, 124 of each tube 54, 56 may be disposed within the tube receiving body 72 and the tubular fitting body 70, simultaneously.

Turning now to Fig. 6, an exemplary embodiment of the flow distributor assembly is shown at 34. The flow distributor assembly 34 is substantially the same as the above-referenced flow distributor assembly 34, and consequently the same reference numerals are used to denote structures corresponding to similar structures in the flow distributor assemblies. In addition, the foregoing description of the flow distributor assembly 34 is equally applicable to the flow distributor assembly 34 except as noted below. Moreover, it will be appreciated upon reading and understanding the specification that aspects of the flow distributor assemblies 34 may be substituted for one another or used in conjunction with one another where applicable.

The nozzle body 82 may include a separate replaceable orifice 160, which may be formed in a replaceable orifice body 162. The replaceable orifice body 162 may include a radially outwardly threaded surface 164 for engaging a radially inwardly threaded surface 166 of the nozzle body 82. The replaceable orifice body may include a radially outwardly extending shoulder 168 for abutting an axially facing surface 170 of the nozzle body to limit downstream movement of the replaceable orifice body 162. In an embodiment, the nozzle body may include an axially extending tab, which may extend downstream from a downstream face of the nozzle body, to engage an upstream facing recess in the tube receiving body to prevent relative rotation between the nozzle body and the tube receiving body. For example, when the threaded surfaces of the nozzle body and the replaceable

orifice body are engaged and rotated relative to one another, the axially extending tab and the upstream facing recess may prevent the nozzle body from rotating relative to the tube receiving body.

The replaceable orifice body 162 may include a keyed portion 172 (e.g., a
5 hex portion) to rotate the replaceable orifice body 162 relative to the radially inwardly threaded surface 166 of the nozzle body 82. For example, a user may insert a keyed tool (e.g., a hex tool (not shown)) into the keyed portion 172 to install the replaceable orifice body 162 to achieve the desired flow characteristics (e.g., flow rate or mixing rate) of the internal fluid through the replaceable orifice
10 160.

In an embodiment, the replaceable orifice body may be replaced with another replaceable orifice body (not shown) that defines an orifice with a different shape or size, which allows for easier assembly of different orifices.

Referring now to Fig. 7, the radially outwardly threaded surface 164 of the
15 replaceable orifice body 162 may engage the radially inwardly threaded surface 166 of the nozzle body 82. For example, each surface threaded surface 164, 166 may engage one another to axially fix the replaceable orifice body 162 relative to the tubular fitting body 70 when each threaded surface 164, 166 is engaged. As mentioned above, a user may install the replaceable orifice body 162 by engaging
20 the threaded surfaces 164, 166 and rotating the keyed portion 172. In an embodiment, the threaded surfaces are engaged prior to inserting the nozzle body into the tubular fitting body and fixedly connecting the tube receiving body and the tubular fitting body (as discussed above regarding Fig. 5).

When the threaded surfaces 164, 166 are engaged, a downstream facing
25 surface 174 of the replaceable orifice body 162 may form a portion of the upstream end of the distribution chamber 78. When the threaded surfaces 164, 166 are fully engaged, the radially outwardly extending shoulder 168 may abut the axially facing surface 170 of the nozzle body to prevent further downstream movement of the replaceable orifice body 162.

30 Turning now to Fig. 8, an exemplary embodiment of the flow distributor assembly is shown at 34. The flow distributor assembly 34 is substantially the same as the above-referenced flow distributor assemblies 34, and consequently the same reference numerals are used to denote structures corresponding to

similar structures in the flow distributor assemblies. In addition, the foregoing descriptions of the flow distributor assemblies 34 are equally applicable to the flow distributor assembly 34 except as noted below. Moreover, it will be appreciated upon reading and understanding the specification that aspects of the flow distributor assemblies 34 may be substituted for one another or used in conjunction with one another where applicable.

The flow distributor assembly 34 may include a fluid filter 176 disposed upstream of the orifice 80. The fluid filter may be a screen that includes a radially outwardly extending flange 178 for engaging the radially inwardly facing surface 116 of transition portion 90 to prevent upstream movement of the fluid filter 176 when the fluid filter 176 engages the radially inwardly facing surface 116.

The fluid filter 176 may circumscribe the central axis A and have an end 180 for abutting the frustoconically-shaped portion 102 of the nozzle body 82 to prevent unfiltered fluid from flowing to the orifice 80.

The upstream facing surface 110, of the tube receiving body 72, may include a conical-shaped portion 182 for receiving internal fluid from the distribution chamber 78. For example, the conical-shaped portion 182 may face upstream to receive the internal fluid and to distribute the internal fluid to each tube 54, 56. The conical-shaped portion 182 may alter flow of the internal fluid compared to other shapes for receiving the internal fluid from the orifice 80 of the nozzle body 82.

The nozzle body 82 may include a downstream facing surface 108 with a paraboloid-shaped portion 184 that defines at least a portion of an upstream end of the distribution chamber 78. The paraboloid-shaped portion 184 may circumscribe the central axis A and may face downstream toward the upstream facing surface 110 of the tube receiving body 72.

Referring now to Fig. 9, when assembled the fluid filter 176 may be disposed axially upstream of the orifice 80 with the end 180 abutting the frustoconically-shaped portion 102 of the nozzle body 82 to filter all of the internal fluid that flows downstream to the orifice 80. For example, the end 180 may be engaged with the frustoconically-shaped portion 102 to prevent internal fluid flow between the fluid filter 176 and the frustoconically-shaped portion 102 to require all of the downstream flowing internal fluid to flow through the fluid filter 176. The

end 180 may expand radially outwardly when engaged with the frustoconically-shaped portion 102 to prevent upstream axial movement of the end 180 by engaging the radially inwardly facing surface 116 of the tubular fitting body 70 with the outwardly extending flange 178.

5 The conical-shaped portion 182 may be disposed downstream of the orifice and within the paraboloid-shaped portion 184 of the nozzle body 82. When the internal fluid flows from the orifice 80, the conical-shaped portion 182 may receive the internal fluid to distribute the internal fluid to the through holes 118, 120.

10 Turning now to Fig. 10, an exemplary embodiment of the flow distributor assembly is shown at 34. The flow distributor assembly 34 is substantially the same as the above-referenced flow distributor assemblies 34, and consequently the same reference numerals are used to denote structures corresponding to similar structures in the flow distributor assemblies. In addition, the foregoing descriptions of the flow distributor assemblies 34 are equally applicable to the flow
15 distributor assembly 34 except as noted below. Moreover, it will be appreciated upon reading and understanding the specification that aspects of the flow distributor assemblies 34 may be substituted for one another or used in conjunction with one another where applicable.

 The nozzle body 80 may include an orifice 80 that may be venturi-shaped.
20 For example, an upstream end 186 of the venturi-shaped orifice 80 may be larger than a downstream end 188 of the orifice 80. The downstream narrowing of the venturi-shaped orifice 80 may provide an increase in fluid flow velocity through the venturi-shaped orifice 80.

 Referring now to Fig. 11, when assembled the internal fluid may flow from
25 the upstream end 186 of the venturi-shaped orifice 80 to the downstream end 188. The velocity of the fluid at the downstream end 188 may be higher than the velocity at the upstream end 186 to impinge the upstream facing surface 110 of the tube receiving body 72.

 Turning now to Fig. 12, an exemplary embodiment of the flow distributor
30 assembly is shown at 34. The flow distributor assembly 34 is substantially the same as the above-referenced flow distributor assemblies 34, and consequently the same reference numerals are used to denote structures corresponding to similar structures in the flow distributor assemblies. In addition, the foregoing

descriptions of the flow distributor assemblies 34 are equally applicable to the flow distributor assembly 34 except as noted below. Moreover, it will be appreciated upon reading and understanding the specification that aspects of the flow distributor assemblies 34 may be substituted for one another or used in
5 conjunction with one another where applicable.

The upstream facing surface 110 of the tube receiving body 72 may include an indented portion 200 facing upstream for receiving fluid from the distribution chamber to improve mixing of fluid in the distribution chamber 78. The indented portion 200 may be a half sphere that is symmetrical about the central axis A. In
10 an embodiment, the indented portion is another suitable indented shape.

Referring now to Fig. 13, when assembled the internal fluid may flow from the orifice 80, of the flow distributor assembly 34, downstream to impinge the indented portion 200 of the upstream facing surface 110 of the tube receiving body 72. For example, the internal fluid may flow through the orifice 80 to the
15 indented portion 200 to distribute the internal fluid to the tubes 54, 56 through holes 118, 120.

Although the invention has been shown and described with respect to a certain embodiment or embodiments, it is obvious that equivalent alterations and modifications will occur to others skilled in the art upon the reading and
20 understanding of this specification and the annexed drawings. In particular regard to the various functions performed by the above described elements (components, assemblies, devices, compositions, etc.), the terms (including a reference to a "means") used to describe such elements are intended to correspond, unless otherwise indicated, to any element which performs the specified function of the
25 described element (i.e., that is functionally equivalent), even though not structurally equivalent to the disclosed structure which performs the function in the herein illustrated exemplary embodiment or embodiments of the invention. In addition, while a particular feature of the invention may have been described above with respect to only one or more of several illustrated embodiments, such
30 feature may be combined with one or more other features of the other embodiments, as may be desired and advantageous for any given or particular application.

Claims

What is claimed is:

1. A flow distributor assembly (34) for an expansion valve (50),
5 including:
a tubular fitting body (70) having a first end (76) and a second end (74);
and
a tube receiving body (72) telescopically fitted in the second end (74) of the
tubular fitting body (70) and including a plurality of through holes (118/120) for
10 receiving an end portion (122/124) of a tube (54/56), wherein the tube receiving
body (72) defines a downstream end of a distribution chamber (78) that is
downstream of an orifice (80/160).
2. The flow distributor assembly (34) of claim 1, wherein the tubular
15 fitting body (70) entirely circumscribes the tube receiving body (72) about a central
axis (A) of the tubular fitting body (70).
3. The flow distributor assembly (34) of any one of claims 1-2, wherein
the tube receiving body (72) is recessed from the second end (76) of the tubular
20 fitting body (70) to form a cavity (144) at least partially bounded by an axially
facing surface (140), of the tube receiving body (72), that faces away from the
distribution chamber (78), and at least partially bounded by a radially inwardly
facing surface (116) at the second end (76) of the tubular fitting body (70).
- 25 4. The flow distributor assembly (34) of any one of claims 1-3, wherein
the tubular fitting body (70) includes a radially inward protrusion (100) upstream of
the tube receiving body (72).
5. The flow distributor assembly (34) of claim 4, wherein the radially
30 inward protrusion (100) is formed by a step formed in a transition portion (90), of
the tubular fitting body (70), that transitions from a first cross-sectional area
upstream of the second end to a second cross-sectional area that is downstream
of the first cross-sectional area and is larger than the first cross-sectional area.

6. The flow distributor assembly (34) of any one of claims 4-5, wherein the tube receiving body (72) is telescopically fitted in the tubular fitting body (70) downstream of the radially inward protrusion (100).

5

7. The flow distributor assembly (34) of any one of claims 4-6, further including a nozzle body (82), which forms the orifice (80/160), and which is telescopically fitted in the tubular fitting body (70) against an upstream facing surface of the radially inward protrusion (100) to prevent upstream movement of the nozzle body (82).

10

8. The flow distributor assembly (34) of any one of claims 1-7, wherein the tubular fitting body (70) defines a central through passage that extends at least partially along a central axis (A) from the first end of the tubular fitting body (70) to the second end of the tubular fitting body (70).

15

9. The flow distributor assembly (34) of any one of claims 1-8, wherein the tubular fitting body (70) has a wall thickness that is less than 20% cross-sectional width of an axially corresponding portion of the tubular fitting body (70), preferably less 5-15%, more preferably 7-12, even more preferably 10%.

20

10. The flow distributor assembly (34) of any one of claims 1-9, wherein a contiguous joining material (146) fixedly connects the tube receiving body (72) to a radially inwardly facing surface (116) of the tubular fitting body (70).

25

11. The flow distributor assembly (34) of claim 10, wherein the contiguous filler material (146) is a metal that has a melting point less than a melting point of both a material of the tube receiving body (72) and a material of the tubular fitting body (70).

30

12. The flow distributor assembly (34) of any one of claims 10-11, wherein the contiguous joining material (146) is a brazed connection or a soldered connection at the second end, and wherein the brazed connection or the soldered

connection fixedly connects the tube receiving body (72) to the tubular fitting body (70).

13. The flow distributor assembly (34) of claim 12, wherein the
5 contiguous joining material (146) is a single-brazed connection or a single-soldered connection.

14. The flow distributor assembly (34) of any one of claims 10-13,
wherein the contiguous joining material (146) fixedly connects a nozzle body (82),
10 which forms the orifice (80/160), to a radially inwardly facing surface (116) of the tubular fitting body (70).

15. The flow distributor assembly (34) of any one of claims 10-14,
wherein the contiguous joining material (146) fixedly connects one or more tubes
15 (54, 56) to the tube receiving body (72).

16. The flow distributor assembly (34) of any one of claims 1-15, further
including a nozzle body (82) that is telescopically fitted in the tubular fitting body
(70) upstream of the distribution chamber (78), wherein the nozzle body (82)
20 forms the orifice (80/160).

17. The flow distributor assembly (34) of claim 16, wherein a contiguous
joining material (146) fixedly connects the tube receiving body (72) to the nozzle
body (82), and fixedly connects the tube receiving body (72) to a radially inwardly
25 facing surface (116) of the tubular fitting body (70).

18. The flow distributor assembly (34) of any one of claims 16-17,
wherein the distribution chamber (78) is partially formed by a counter bore in the
nozzle body (82) and an upstream facing surface of the tube receiving body (72)
30 forms a downstream end of the distribution chamber (78).

19. The flow distributor assembly (34) of any one of claims 16-18,
wherein the nozzle body (82) includes downstream facing surface with a

paraboloid-shaped portion (184) that defines at least a portion of an upstream end of the distribution chamber (78).

20. The flow distributor assembly (34) of any one of claims 16-19,
5 wherein the nozzle body (82) includes a replaceable orifice (160).

21. The flow distributor assembly (34) of any one of claims 1-20,
wherein the orifice (80/160) is configured to throttle fluid flowing from upstream of
the orifice (80/160).
10

22. The flow distributor assembly (34) of any one of claims 1-21,
wherein the orifice is venturi-shaped.

23. The flow distributor assembly (34) of any one of claims 1-22, further
15 including a fluid filter (176) disposed upstream of the orifice.

24. The flow distributor assembly (34) of claim 23, wherein the fluid filter
(176) is a screen that includes a radially outwardly extending flange (178) for
engaging a radially inwardly facing surface (116) of the tubular fitting body (70) to
20 prevent upstream movement of the fluid filter (176) when the fluid filter (176)
engages the radially inwardly facing surface (116).

25. The flow distributor assembly (34) of any one of claims 1-24, further
including the distribution chamber (78) disposed downstream of the orifice
25 (80/160) through which fluid can flow into the distribution chamber (78).

26. The flow distributor assembly (34) of any one of claims 1-25,
wherein the tube receiving body (72) includes an upstream facing surface (110)
with a flat portion for receiving fluid from the distribution chamber (78).
30

27. The flow distributor assembly (34) of any one of claims 1-26,
wherein the tube receiving body (72) includes a conical-shaped portion (182) or

an indented portion (200), of an upstream facing surface (110), for receiving fluid from the distribution chamber (78).

28. The flow distributor assembly (34) of any one of claims 1-27,
5 wherein each through hole of the plurality of through holes (118/120) of the tube receiving body (72) is parallel with a central axis (A) of the tubular fitting body (70).

29. The flow distributor assembly (34) of any one of claims 1-28,
wherein at least one of the plurality of through holes (118/120) is a counter bored
10 through hole with a radially inwardly extending shoulder (126/128) for receiving the tube (54/56).

30. The flow distributor assembly (34) of any one of claims 1-29,
wherein the plurality of axially extending through holes (118/120) includes four or
15 more axially extending through holes (118/120).

31. The flow distributor assembly (34) of any one of claims 1-30,
wherein a plurality of tubes (54/56) are each secured within a corresponding
through hole (118/120) and fluidly connected to the orifice (80/160) via the
20 distribution chamber (78).

32. An expansion valve assembly (30) including the flow distributor
assembly (34) of any one of claims 1-31, wherein the flow distributor assembly
(34) is fluidly connected to an outlet (52) of an expansion valve (50) of the
25 expansion valve assembly (30).

33. The expansion valve assembly (30) of claim 32, wherein the tubular
fitting body (70) is integral with an outlet housing (84) of the expansion valve
assembly (30), optionally the tubular fitting body (70) is formed in one-piece with
30 an outlet housing (84).

34. The expansion valve assembly (30) of any one of claims 32-33,
wherein the expansion valve assembly (30) is a refrigerant valve assembly.

35. A refrigeration circuit (22), including:
the expansion valve assembly (30) of any one of claims 32-34;
an evaporator (24) fluidly connected to an outlet of the expansion
5 valve (50) through the flow distributor assembly (34);
a compressor (26) fluidly connected to an outlet of the evaporator
(24);
a condenser (28) fluidly connected to an outlet of the compressor
(26);
10 wherein an outlet of the condenser (28) is fluidly connected to an
inlet of the expansion valve (50).
36. A method of operating the flow distributor assembly (34) of any one
of claims 1-35, including:
15 directing fluid downstream within the tubular fitting body (70), wherein an
entire portion, of the fluid that flows through a portion of the tube receiving body
(72), simultaneously flows through the tubular fitting body (70).
37. The method of operating of claim 36, wherein the fluid flows through
20 an orifice (80/160) to an upstream facing surface (110) formed by the tube
receiving body (72) so that the upstream facing surface receives (110) the fluid
from the orifice (80/160) to distribute the fluid to each of the plurality of through
holes (118/120).
- 25 38. The method of operating of any one of claims 36-37, wherein the
fluid flows through the orifice (80/160) to an upstream facing surface of the tube
receiving body (72) so that the upstream facing surface (110) receives flow from
the orifice (80/160) to distribute fluid to each of the plurality of through holes
(118/120).
- 30 39. The method of operating of claim 38, wherein a flat portion, a
conical-shaped portion (182), or an indented portion (200) of the upstream facing

surface (110) receives the fluid from the orifice (80/160) to distribute the fluid to the plurality of through holes (118/120).

40. A method of manufacturing a flow distributor assembly (34) for an expansion valve (50), including:

providing a tubular fitting body (70) having a first end (76) and a second end (76); and

telescopically fitting a tube receiving body (72) into the second end (74) of the tubular fitting body (70), wherein the tube receiving body (72) includes a plurality of through holes (118/120) for receiving an end portion (122/124) of a tube (54/56), wherein the tube receiving body (72) defines a downstream end of a distribution chamber (78) that is downstream of an orifice (80/160).

41. The method of manufacturing of claim 40, further including fixedly connecting the tube receiving body (72) to a radially inwardly facing surface of the tubular fitting body (70), preferably fixedly connecting the tube receiving body (72) with a contiguous joining material (146), optionally fixedly connecting includes brazing a single-brazed connection or by soldering a single-soldered connection.

42. The method of manufacturing of any one of claims 40-41, further including fixedly connecting each of a plurality of tubes within a corresponding through hole of the plurality of through holes (118/120), optionally fixedly connecting each of a plurality of tubes with a contiguous joining material (146) and fixedly connecting the tube receiving body (72) to a radially inwardly facing surface of the tubular fitting body (70) with the contiguous joining material (146), further optionally the contiguous joining material (146) is made by brazing a single-brazed connection or by soldering a single-soldered connection.

43. The method of manufacturing of any one of claims 40-42, further including enlarging the second end (74) of the tubular fitting body (70) to receive the tube receiving body (72), optionally forming a transition portion (90) in the tubular fitting body (70).

44. The method of manufacturing of claim 43, further including enlarging the second end (74) of the tubular fitting body (70) to form a transition portion (90), of the tubular fitting body (70), that transitions from a first cross-sectional area upstream of the second end (74) to a second cross-sectional area that is
5 downstream of the first cross-sectional area and is larger than the first cross-sectional area to receive the tube receiving body (72).

45. The method of manufacturing of any one of claims 40-44, further including inserting each of a plurality of tubes (54/56) into a corresponding through
10 hole of the plurality of through holes (118/120) of the tube receiving body (72), and inserting each of the plurality of tubes (54/56) partially within the second end (74) of the tubular fitting body (70).

46. The method of manufacturing of any one of claims 40-45, further
15 including telescopically fitting a nozzle body (82), which forms the orifice (80/160), into the tubular fitting body (70), optionally the nozzle body is the nozzle body (82) of any one of claims 16-20.

47. The method of manufacturing of any one of claims 40-46, further
20 including fixedly connecting a nozzle body (82), which forms the orifice (80/160), to a radially inwardly facing surface (116) of the tubular fitting body (70), preferably fixedly connecting with a contiguous joining material (146), optionally the contiguous joining material (146) is made by brazing a single-brazed connection or by soldering a single-soldered connection.

25

48. The method of manufacturing of any one of claims 41-47, wherein fixedly connecting includes connecting the tube receiving body (72) with a contiguous joining material (146) at the second end (74) of the tubular fitting body (70), optionally the contiguous joining material (146) is made by brazing a single-
30 brazed connection or by soldering a single-soldered connection.

49. The method of manufacturing of any one of claims 41-48, wherein the fixedly connecting includes:

fixedly connecting the tube receiving body (72) to a radially inwardly facing surface (116) of the tubular fitting body (70) with a contiguous joining material (146);

5 fixedly connecting each of a plurality of tubes (54/56) within a corresponding through hole of the plurality of through holes (118/120) with the contiguous joining material (146); and

fixedly connecting a nozzle body (82), which forms the orifice (80/160), to a radially inwardly facing surface (116) of the tubular fitting body (70), with the contiguous joining material (146).

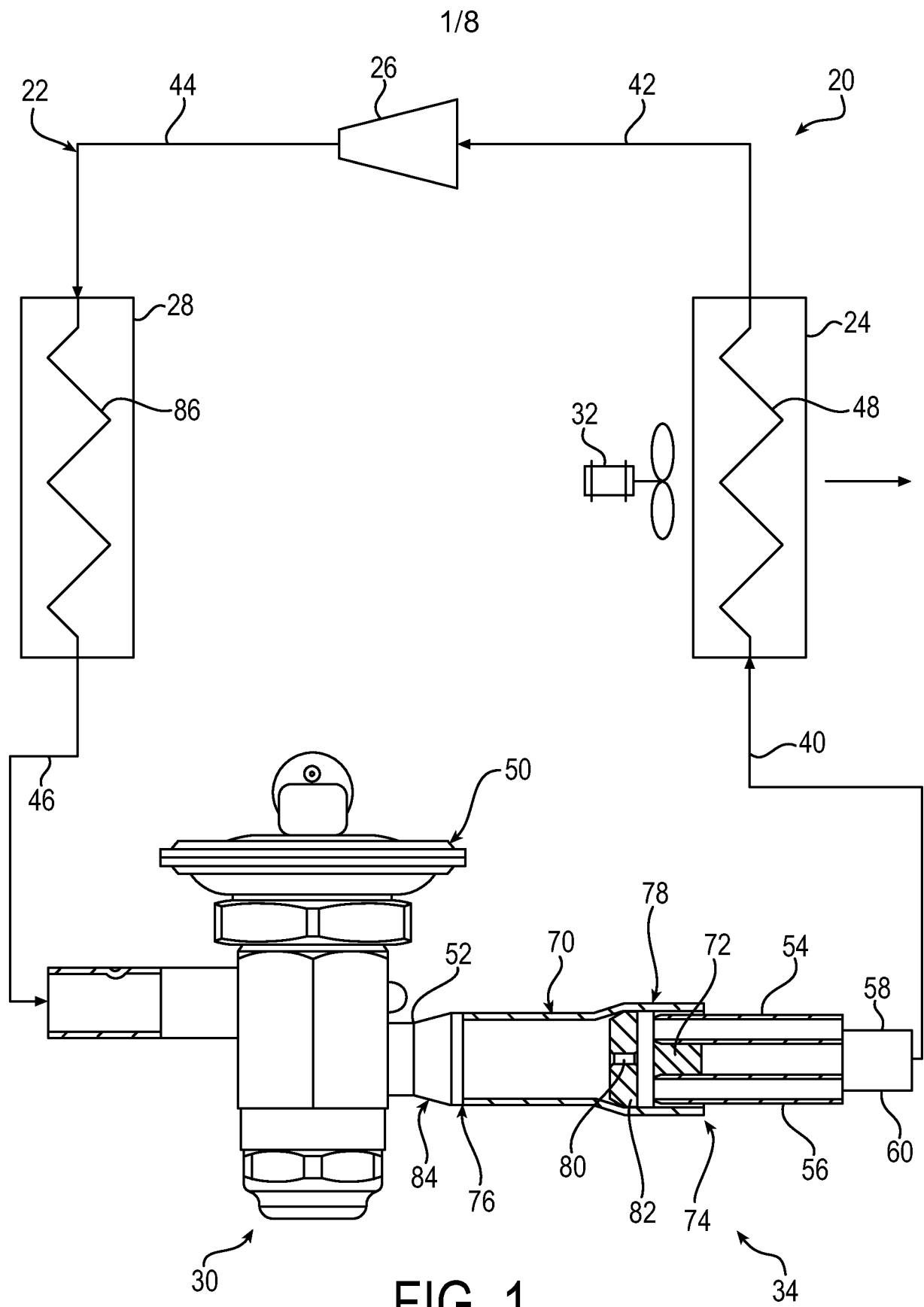
10

50. The method of manufacturing of claim 49, wherein the contiguous joining material (146) is made by brazing a single-brazed connection or by soldering a single-soldered connection.

15 51. The method of manufacturing of any one of claims 40-50, wherein the flow distributor assembly (34) is the flow distributor assembly (34) of any one of claims 1-34.

20 52. A method of manufacturing an expansion valve assembly (30), including the method manufacturing of any one of claims 40-51, wherein the flow distributor assembly (34) is connected to an outlet (52) of an expansion valve (50), optionally the tubular fitting body (70) is integral with a housing (84) of the expansion valve assembly (30).

25 53. The method of manufacturing an expansion valve assembly (30) of claim 52, wherein the expansion valve assembly (30) is a refrigerant valve assembly.



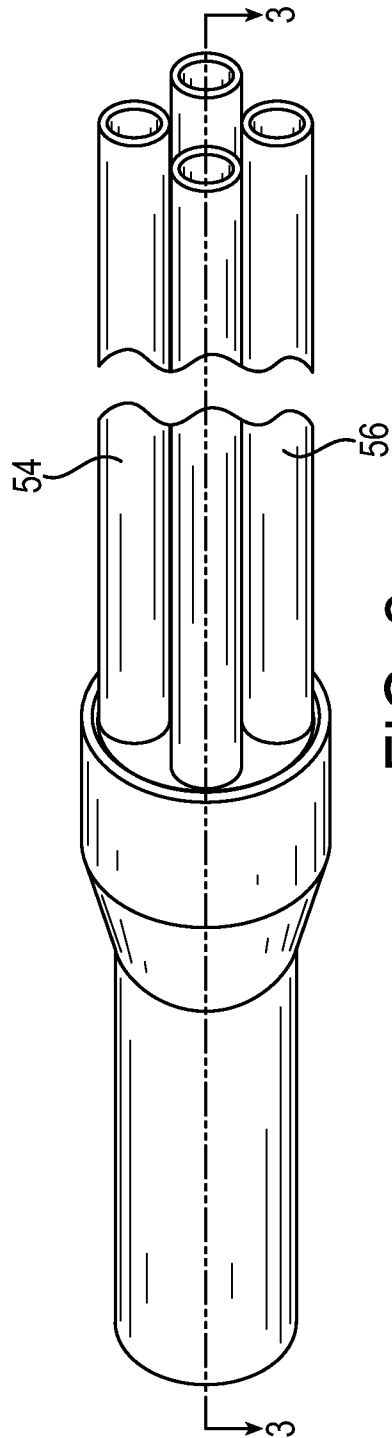


FIG. 2

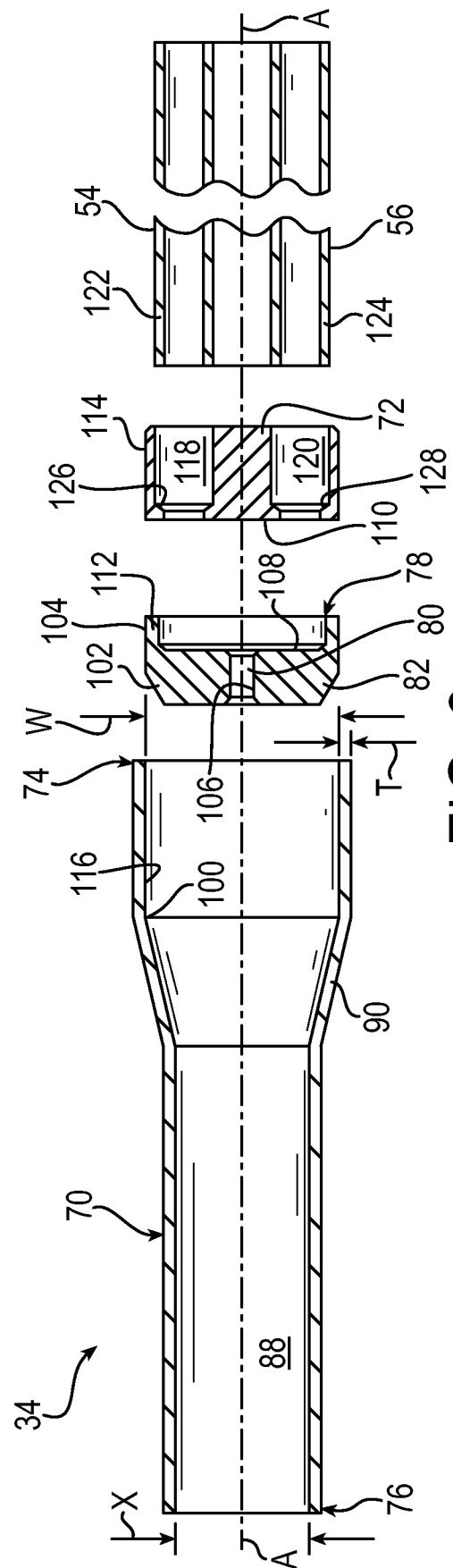


Fig. 3

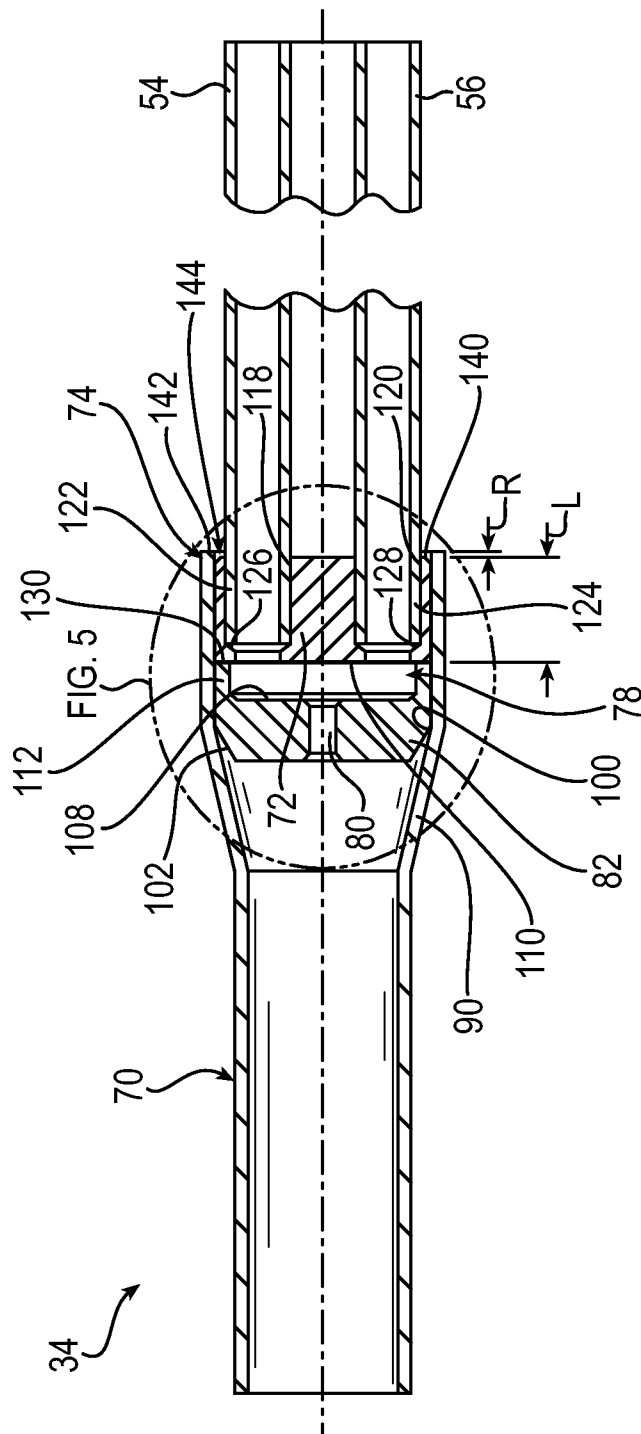


FIG. 4

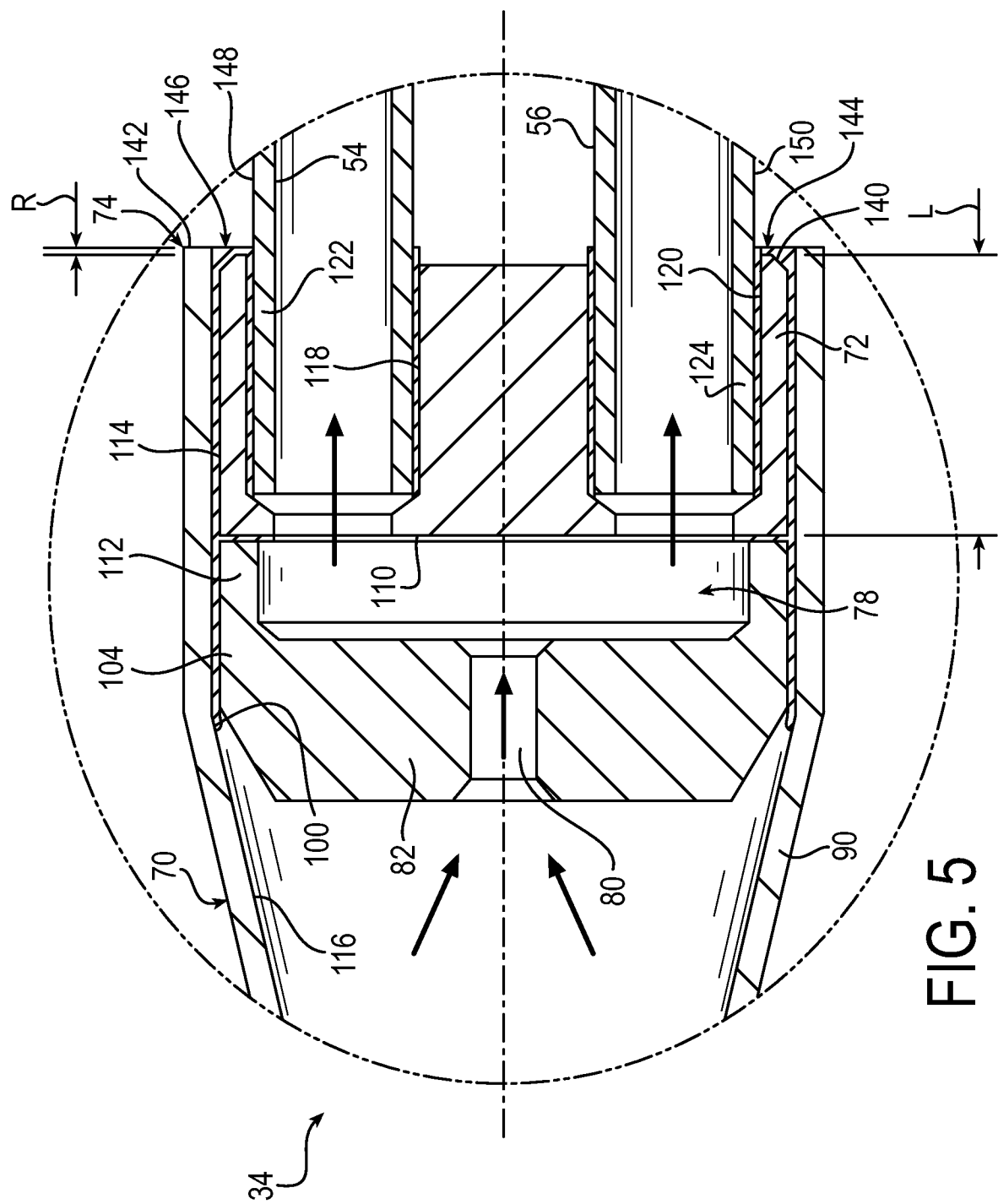


FIG. 5

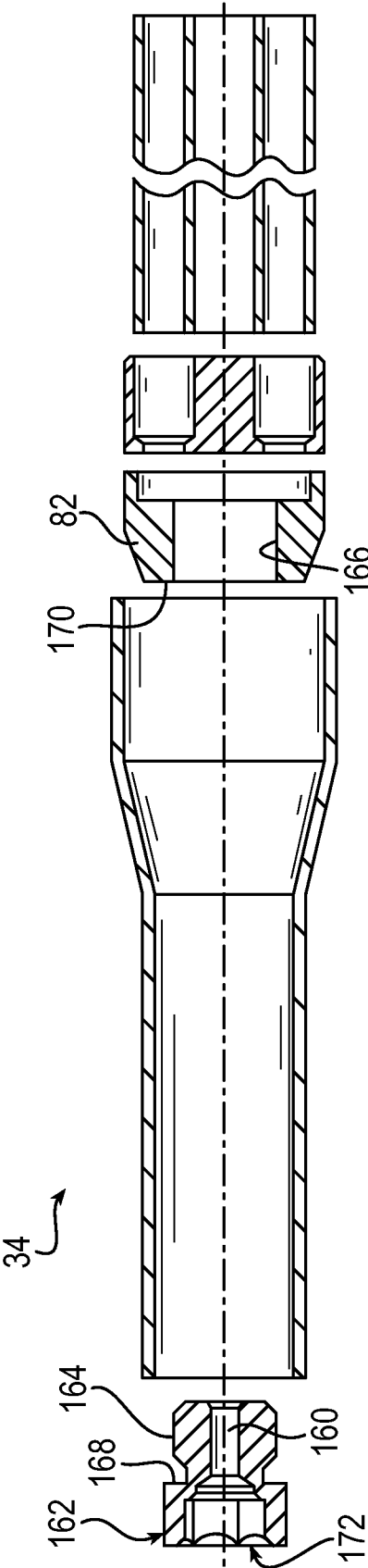


FIG. 6

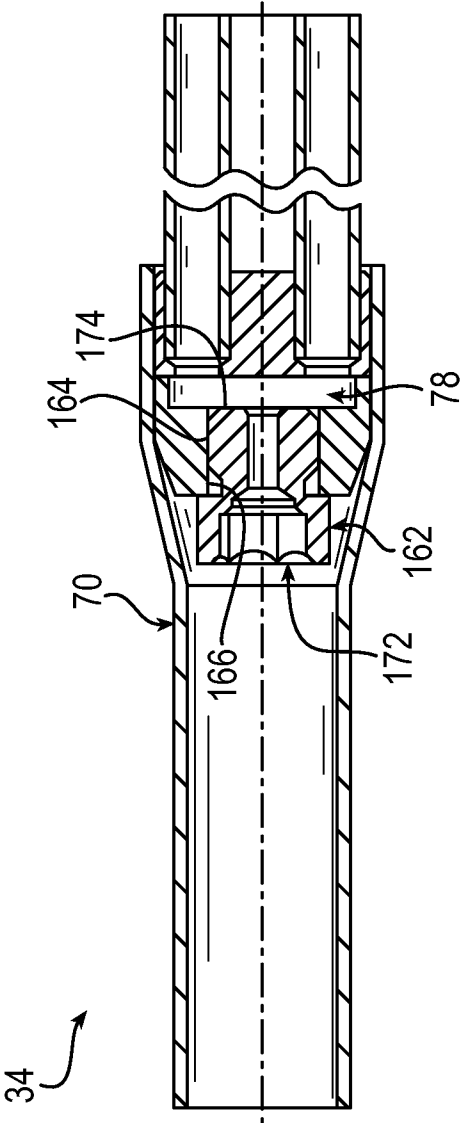


FIG. 7

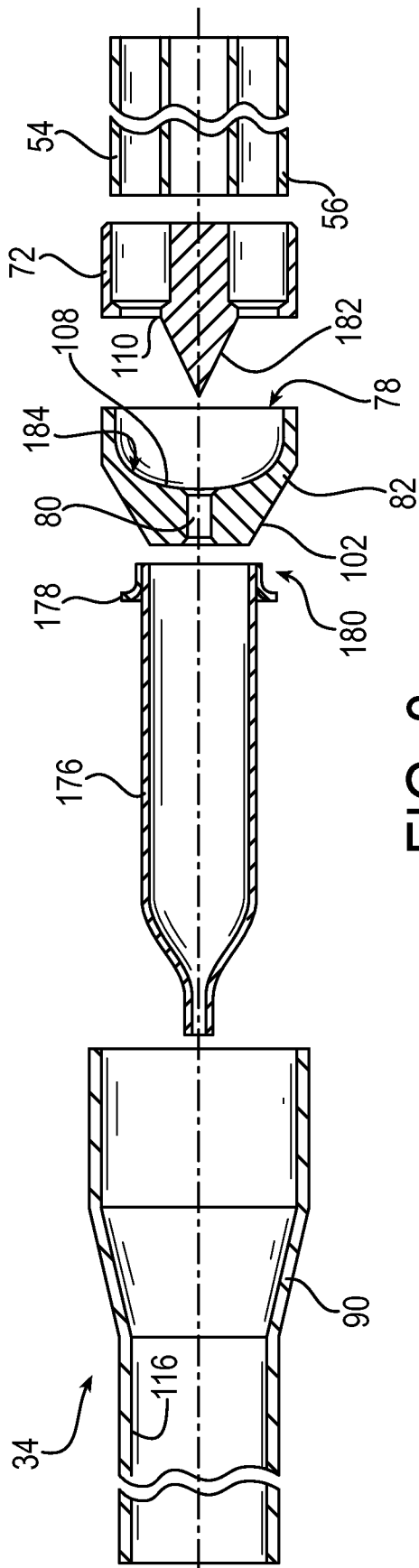
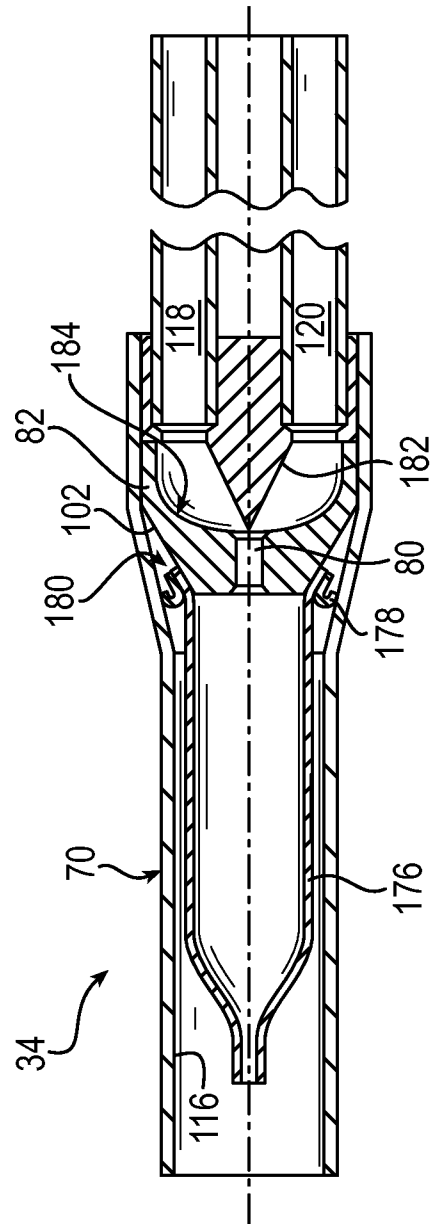

$$\frac{\infty}{F|G}$$


Fig. 9

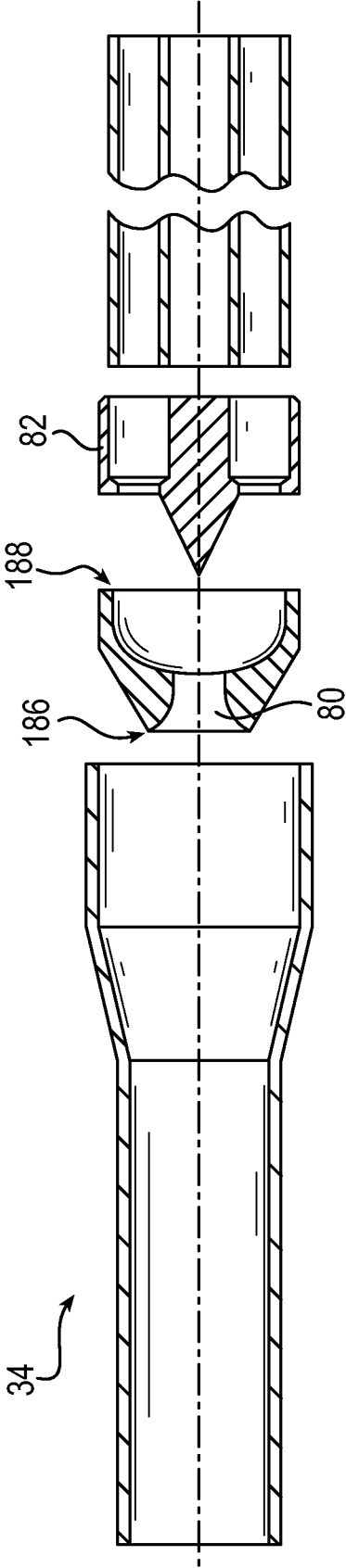


FIG. 10

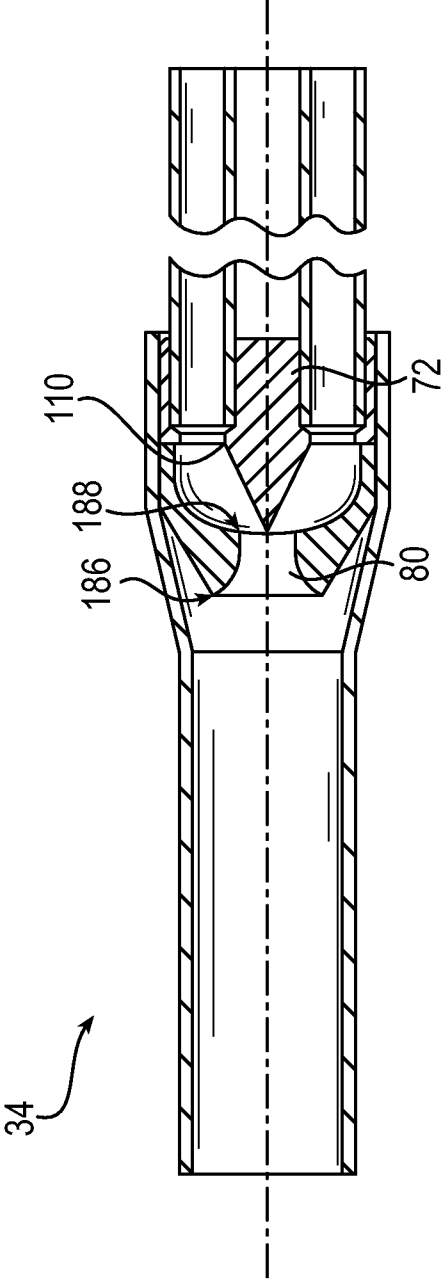


FIG. 11

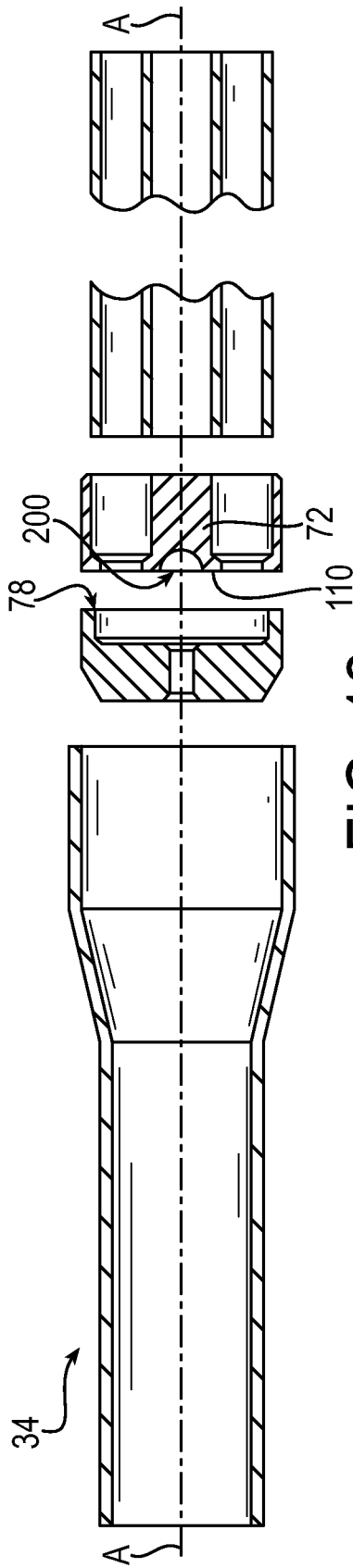


FIG. 12

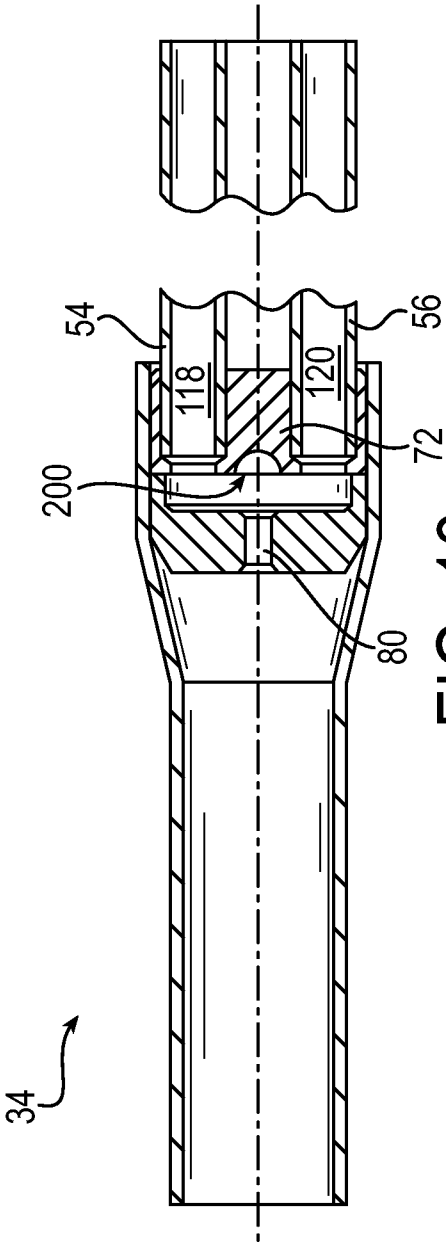


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/014564

A. CLASSIFICATION OF SUBJECT MATTER
 INV. F25B39/02 F25B41/06
 ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 F25B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2002 039644 A (TENSEI KOGYO KK) 6 February 2002 (2002-02-06) the whole document	1-24, 32-53
X	JP H10 9716 A (TENSEI KOGYO KK) 16 January 1998 (1998-01-16) the whole document	1-53
X	JP 2004 177059 A (TOYO RADIATOR CO LTD) 24 June 2004 (2004-06-24) the whole document	1,2,36, 40
X	JP 2005 114214 A (SHARP KK) 28 April 2005 (2005-04-28) the whole document	1,2,36, 40
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

21 April 2016

Date of mailing of the international search report

02/05/2016

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Authorized officer

Szilagyi, Barnabas

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/014564

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2 409 661 A (CARTER FRANKLYN Y) 22 October 1946 (1946-10-22) column 1, line 37 - column 4, line 35; figures 1-5 -----	32-35

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2016/014564

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			JP 3076522 B2	14-08-2000

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US 2409661	A	22-10-1946	NONE	
