Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2605884 C 2009/04/14

(11)(21) 2 605 884

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 2004/07/07

(41) Mise à la disp. pub./Open to Public Insp.: 2005/09/24

(45) Date de délivrance/Issue Date: 2009/04/14

(62) Demande originale/Original Application: 2 473 145

(30) Priorité/Priority: 2004/03/24 (DE10 2004 014 822.8)

(51) Cl.Int./Int.Cl. *F28G 1/16* (2006.01),
B24C 3/32 (2006.01), *B24C 5/04* (2006.01),
F28G 15/00 (2006.01)

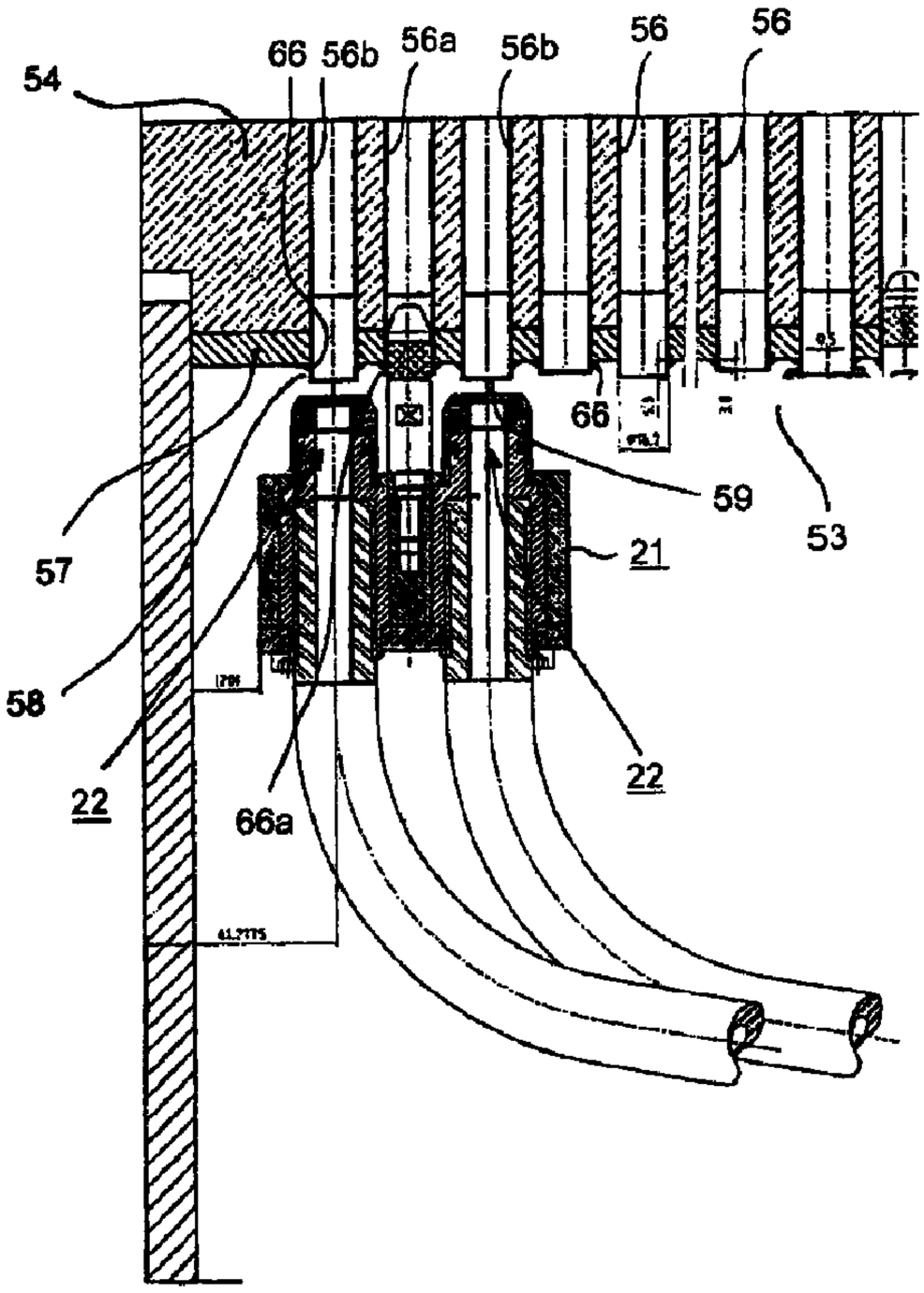
(72) Inventeurs/Inventors:
KRAEMER, GEORG, DE;
HYNEK, KONRAD MEIER, DE

(73) Propriétaire/Owner:
AREVA NP GMBH, DE

(74) Agent: FETHERSTONHAUGH & CO.

(54) Titre : METHODE DE NETTOYAGE DES TUBES D'UN ECHANGEUR THERMIQUE AU MOYEN D'UN ABRASIF ET DISPOSITIF APPROPRIE A CETTE METHODE

(54) Title: METHOD FOR CLEANING THE TUBES OF A HEAT EXCHANGER USING AN ABRASIVE AND A DEVICE SUITABLE FOR THE METHOD



(57) Abrégé/Abstract:
Method for cleaning the tubes of a heat exchanger (54) in which a nozzle is applied to one end of a tube (56) and air that contains an abrasive is blown through the tube, an unchoked nozzle (22) being used.

Abstract

Method for cleaning the tubes of a heat exchanger (54) in which a nozzle is applied to one end of a tube (56) and air that contains an abrasive is blown through the tube, an unchoked nozzle (22) being used.

Figure 2

30146-23D

Method for Cleaning the Tubes of a Heat Exchanger Using an Abrasive and a Device Suitable for the Method

This is a divisional of Canadian Application Serial No. 2,473,145 filed July 7, 2004.

The present invention relates to a method for cleaning a heat exchanger by using an abrasive and a device that is designed for using the method. From time to time it is necessary to remove deposits from heat-exchanger tubes. Even though there are many chemical cleaning methods available, these require a major technical outlay because of the large number of heat exchanger tubes and the correspondingly large number of openings that are involved. For this reason, exchanger tubes are mainly cleaned by mechanical means. In addition to cleaning with brushes, in many instances blast cleaning methods are used; in such methods, an abrasive is blown through a tube with the help of a nozzle that is applied to one end of the tube. Such a method is described, for example, in DE 195 46 788 A1. As an example, steel or carborundum particles are used as the abrasive. The particles that emerge for the other end of the tube are collected in a trap and returned to the abrasive cycle. DE 198 37 683 C2 describes such a trap. As is shown in Figure 1, in a conventional cleaning method two jet nozzles 2 that are mounted on a carrier 1 are attached, for example, to the inlet side 3 of a heat exchanger 4. The ends of the jet nozzles 2 that point in the direction 5 of the jet are constricted to form a cylindrical connector that is introduced into the end 7 of the tube. At their other end, which faces against the direction 5 of the jet, the nozzles have an inlet opening that is connected to a delivery line 8. A venturi jet with a choke point 13 is disposed between the outlet opening 10, which is surrounded by the front end of the connector 6, and the inlet opening 9.

It is the objective of the present invention to describe an alternative method and an alternatively configured device for realizing the method described in the introduction hereto, which permits, in particular, more efficient cleaning of a heat exchanger.

This objective is achieved according to one aspect of the invention, in that an unchoked nozzle is used, it being preferred that the outlet opening of this be of equal size or slightly smaller than the internal cross-sectional area of the tube. This configuration makes it possible to act on a tube that is to be cleaned with a large flow of abrasive. This is not possible to the same extent using the usual nozzles. In such a case, the velocity of the abrasive in a delivery line that is connected to the nozzle is greatly increased because of a relatively small constriction in a venturi nozzle. The consequence is that particles of abrasive are emitted with a large amount of kinetic energy. However, these particles are decelerated within a relatively short section of line. Then, only an abrasive flow with a low concentration of particles is available for cleaning the tube. This is not the case with the present invention, in which—because there is no choke effect or constriction in the nozzle—an abrasive flow with a very high concentration of particles and a concomitant high degree of abrasiveness is available. A configuration that permits large outlet openings ensures that the nozzle is pressed against a face of the delivery line with a contact surface that surrounds the outlet opening. In contrast to this, in the prior art, a constricted connector is inserted into one end of the tube, when the outlet opening of the connector must be reduced by an amount that at least corresponds to its wall thickness relative to the cross-sectional area of the tube.

The time required for the cleaning method can be reduced in that a plurality of tubes is cleaned simultaneously. This is effected in that a plurality of nozzles that are held in a

carrier in the tube grid of the heat exchanger is used. Whereas, in the case of conventional methods and devices, the position of the nozzles is fixed in that a constricted connector of the nozzle is introduced into an end of a tube, according to the present invention a locating pin that protrudes in the direction of the jet is provided, and this is inserted into one tube end during the cleaning process. This can be done without any problems if the locating pin is disposed on the carrier in a position that corresponds to the tube grid.

A choke-free nozzle can be realized in that a duct that is defined by an inlet opening and an outlet opening passes through the nozzle, in the region adjacent the outlet opening said duct being of a diameter that is essentially constant and having a cross-sectional area that corresponds approximately to the size of the outlet opening. As described heretofore, the outlet opening is surrounded by a contact surface that, during the cleaning process, is pressed against the end face of the tube that is to be cleaned. It is preferred that this contact surface be enclosed by a collar that is disposed radially on the outside and projects axially. The contact surface and the collar form a receptacle for the end of a tube. This configuration permits better sealing of the end area of the tube and also provides an additional way by which the device can be fixed in position on the heat exchanger. This prevents a carrier that supports a plurality of nozzles from twisting around the locating pin as an axis of rotation. In one preferred embodiment of the present invention, in order to enhance the seal between the end of the tube and the nozzle, provision is made such that the area that contains the receptacle and the outlet opening is of an elastomer. In addition, this also makes it possible to compensate for tolerances and unevenness in the face area of a tube end. In order to provide a measure of mechanical protection and to prevent the collar

that encloses the face area of a tube being made wider by the pressurized stream of abrasive, this collar is surrounded by a reinforcing sleeve that is of a rigid material such as a metal. It is preferred that the elastomer area be formed by an end piece that resembles a section of tube and is positively connected to the nozzle.

In accordance with an aspect of the present invention, there is provided a method for cleaning the tubes of a heat exchanger, in which a nozzle is set on one end of a tube wherein the nozzle has an outlet opening of a size that is equal to or slightly smaller than the inside cross-sectional area of the tube and air that contains an abrasive is blown through the tube, wherein an unchoked nozzle is used.

In accordance with another aspect of the present invention, there is provided a jet device for cleaning the tubes of a heat exchanger wherein the jet device comprises an unchoked nozzle, wherein the nozzle blows air containing an abrasive through a tube of the heat exchanger, wherein the jet device carries out the method as defined herein, wherein a flow channel that is delimited by an inlet and an outlet opening, passes through the nozzle, the flow channel being of an essentially constant cross-sectional area that approximately corresponds to the size of the outlet opening, and wherein the outlet opening is surrounded by a contact surface that extends in the plane of the opening and functions in combination with the face end of a tube.

30146-23D(S)

In accordance with yet another aspect of the invention, there is provided a blasting nozzle for delivering a pressurized air mixture containing an abrasive to a tube of a heat exchanger, the heat exchanger tube having an internal diameter, the blasting nozzle being connectable to a supply line providing the pressurized air mixture, the supply line having a conduit through which the pressurized air mixture may flow, the blasting nozzle comprising: a nozzle body having an outer surface, a first end, an opposed second end and a channel defined therethrough extending between the first and second ends; the first end of the nozzle body having an inlet opening defined therein for receiving therethrough the pressurized air mixture from the supply line; the second end of the nozzle body having an outlet opening defined therein through which the pressurized air mixture may exit the nozzle body; the channel having a first diameter at the inlet opening and a second diameter at the outlet opening, the second diameter being sized to correspond substantially to the internal diameter of the heat exchanger tube, the first diameter being sized at least as large as the second diameter, and the nozzle body further having at the second end thereof a third diameter defined by the outer surface, the third diameter being at least as large as the internal diameter of the heat exchanger tube.

In accordance with yet another aspect of the invention, there is provided a blasting nozzle head assembly for delivering a pressurized air mixture containing an abrasive to a plurality of heat exchanger tubes, each heat exchanger tube having an internal diameter, the blasting nozzle head assembly comprising: a carrier, and a plurality of blasting nozzles held by the carrier, each blasting nozzle of the plurality having: a nozzle body having an outer surface, a first end, an opposed second end and a channel defined

therethrough extending between the first and second ends; the first end of the nozzle body having an inlet opening defined therein for receiving therethrough the pressurized air mixture from a supply line; the second end of the nozzle body having an outlet opening defined therein through which the pressurized air mixture may exit the nozzle body; the channel having a first diameter at the inlet opening and a second diameter at the outlet opening, the second diameter being sized to correspond substantially to the internal diameter of the heat exchanger tube, the first diameter being sized at least as large as the second diameter; and the nozzle body further having at the second end thereof a third diameter defined by the outer surface, the third diameter being at least as large as the internal diameter of the heat exchanger tube.

In accordance with yet another aspect of the invention, there is provided a method for cleaning heat exchanger tubes using a pressurized air mixture delivered from a supply line, the pressurized air mixture containing an abrasive, the method comprising: providing at least one blasting nozzle, the at least one blasting nozzle having: a nozzle body having an outer surface, a first end, an opposed second end and a channel defined therethrough extending between the first and second ends; the first end of the nozzle body having an inlet opening defined therein for receiving therethrough the pressurized air mixture from the supply line; the second end of the nozzle body having an outlet opening defined therein through which the pressurized air mixture may exit the nozzle body; the channel having a first diameter at the inlet opening and a second diameter at the outlet opening, the second diameter being sized to correspond substantially to the internal diameter of the heat exchanger tube, the first diameter being sized at least

30146-23D(S)

as large as the second diameter; the nozzle body further having at the second end thereof a third diameter defined by the outer surface, the third diameter being at least as large as the internal diameter of the heat exchanger tube; connecting the first end of the nozzle body of the at least one blasting nozzle to the end of the supply line; coupling the second end of the nozzle body of the at least one blasting nozzle to the end of the heat exchanger tube to be cleaned; and urging the flow of the pressurized air mixture from the supply line through the at least one blasting nozzle and into the heat exchanger tube to be cleaned.

The present invention is described in greater detail below on the basis of an embodiment shown in the drawings appended hereto. These drawings show the following:

Figure 1: A conventional device positioned on a heat exchanger, in a longitudinal cross section;

Figure 2: A device according to the present invention, corresponding to Figure 1;

Figure 3: The device shown in Figure 2, in cross section at a greater scale;

Figure 4: A detail from Figure 3;

Figure 5: A perspective view of the device shown in Figure 2.

The device shown in Figure 2 to Figure 5 comprises a nozzle head with a carrier 21 in which two nozzles 22 are supported. It is, of course, possible to have nozzle heads that incorporate only one or more than two nozzles. Essentially, the carrier 21 is formed from a hollow, cuboid

30146-23D(S)

housing 23. Two parallel bores 24 that each accommodate a nozzle 22 pass through the housing 23. A nozzle 22 is essentially formed as a housing 25 in the form of a section of tube. The housing 25 has three different longitudinal sections, a middle section 26 being of a greater diameter than the other two sections; namely, a front section 27 and a rear section 28. The transition between the middle section 26 and the narrower sections 27, 28 is formed in each instance by a radial shoulder 29, 30. A stop flange 32 extends radially inward from the wall of the bore 24.

The side of this stop flange that is proximate to a middle section 26 functions with the radial shoulder 29 to fix the axial position of the housing 25. The radial shoulder 30 of the housing 25 rests against a cover plate 33 that closes off the rear of the carrier housing 23. Between the cover plate 33 and the rear section 28 of the of the nozzle 22 there is an O-ring seal 31. An elastomer seal 34 that encloses the periphery of the section 27 is installed is the area of the bore 24 that extends away from the stop flange 32 and surrounds the section 27. In the front face of the nozzle housing 25 there is a swallow-tail groove 35 and one end of the essentially tubular-section end piece 36 that is of elastomer material is inserted into this so as to form a positive fit.

A duct 37 passes through the front section 27. The mid-line longitudinal axis 38 of the duct simultaneously forms the mid-line longitudinal axis of the nozzle housing 25. The duct 37 is limited at the front by an outlet opening 39 and at its other end by an inlet opening 40. In the region adjacent the outlet opening 39, the duct 37 is essentially of constant cross-sectional area or constant diameter 42.

The cross-sectional area or the diameter 42 correspond to the cross sectional area or the diameter 43, respectively, of a supply line 46, an external thread of which is screwed into the internal thread 45 of the middle section 25. The front face end 47 of the supply line 46 abuts against a radial shoulder 48 in the transition area between section 26 and section 27. A wedge-shaped projection 49 that encloses the inlet opening 40 like a ring protrudes from the radial shoulder 48 in the axial direction and this digs into the elastomer material of the supply line 46. This enhances the seal between the supply line 46 and the housing section 26. The diameter 50 of the inlet opening 40 is slightly greater than the diameter 43 of the supply line 46. The difference in the diameter is to be such that that it corresponds to a widening of the diameter 43 that occurs when the hose

is acted upon by a pressurized flow of abrasive. This ensures that the flow of abrasive does not encounter an edge of the housing that protrudes into the flow channel. The area 52 of the flow channel 37 that is adjacent to the inlet opening 40 is slightly tapered conically, approximately as far as its mid-point, a cylindrical section of the channel of diameter 42 adjoining the area 52. The nozzle may be considered to be unchoked or choke-free even when it includes such a taper.

As is shown in Figure 2, in order to carry out the cleaning method, the carrier 21 is arranged in front of the inlet side 53 or in front of the outlet side of a heat exchanger 54. If the heat exchanger is part of a nuclear power station, the carrier 21 will, as a rule, be held by a manipulator (not shown herein) to which the carrier 21 is attached by means of a mounting device 55 (Figure 5). The tubes 56 of a heat exchanger are arranged in a regular grid pattern, and their ends pass through a retaining plate 57. The end sections 58 of the tubes 56 protrude through the retaining plate 57. The nozzles 22 are so spaced apart from one another on the carrier plate 21 that they can be positioned on the face ends 59 of two tubes 56b that are separated by a tube 56a. To this end, the end piece 36 has a contact surface 60 that functions in conjunction with the face end 59 and surrounds the outlet opening 39. The contact surface 60 extends transversely to the mid-line axis 38. The contact surface 60 is also surrounded by a collar 62 that extends in the axial direction, or in the direction of flow 5. The collar 62 is of a wedge-shaped cross section and has an inclined surface 63 that is oriented radially inward, and an inclined surface 61 that is oriented radially outward. The inclined surface 63 serves as an inclined surface that simplifies insertion when the nozzle 22 is installed on the end of a tube. During the cleaning process, this tube end is accommodated in a recess 64 that is enclosed by the stop surface 60 and the collar 62, a cylindrical edge section 63 of the collar 62 lying

against the outside periphery of a tube 56b. The inclined surface 63 lies snugly against a welded seam 66 by which the tube 56 is attached to the retaining plate 57. The collar 62 thus acts as a sealing lip that functions in conjunction with the outer periphery and the welded seam 66 of a tuber 56b. In order to ensure that the collar cannot widen radially when under pressure, it is completely surrounded by a reinforcing sleeve 67. A flange 68 that extends radially inward from its end that is proximate to the carrier 21 lies in a radial groove 71 in the end piece 36. The face end of the reinforcing sleeve 67 that is applied to the flange 68 is inclined, and together with the inclined surface 61 of the collar 62 forms a flush inclined surface 69. The bevel of the end piece, in the form of the inclined surfaces 61 and 69 prevents it from coming into contact with a welded seam 66a of an adjacent tube 56a, and under certain circumstances preventing an effective seal being formed between the end piece 3 and the tube 56b that is to be cleaned. Between the section 27 of the nozzle housing 25 and the reinforcing sleeve 67 there is a radial groove 70 in the end piece 36 that increases its elasticity in the axial direction.

On the front side of the carrier 21 there is a locating pin 73 for fixing the position of the carrier 21—from which the section 72 of the nozzles 22 protrudes—on the retaining plate 57, and this retaining pin extends from the carrier 21 in the direction of the mid-line axis 38. A threaded section 74 of the locating pin 73 is screwed into a threaded bore 75 in the carrier 21. Its front end, which is remote from the threaded section 74, is tapered conically. The longitudinal section adjacent to the tapered section is of a diameter that is slightly smaller than the inside diameter of a tube 56, During the cleaning process, the locating pin 76 extends into a tube 56a that is disposed between two tubes 56b that are to be cleaned. The carrier is prevented from rotating about the

locating pin 73 as an axis of rotation by the positive combined function of the tube ends with the end pieces 36.

A mechanical distance sensor is disposed on the front side of the carrier 21. This ensures that the carrier 21 can be moved into a predetermined position with respect to the retaining plate 57 with the help of a manipulator (not shown herein).

Reference Numbers

1	Carrier
2	Nozzle
3	Inlet side
4	Heat exchanger
5	Direction of jet
6	Connector
7	Tube end
8	Supply line
9	Inlet opening
10	Outlet opening
12	Venturi
13	Choke point
21	Carrier
22	Nozzle
23	Housing
24	Bore
25	Housing
26	Middle section
27	Front section
28	Rear section
29	Radial shoulder
30	Radial shoulder
31	O-ring seal
32	Contact surface
33	Cover
34	Elastomer seal
35	Groove
36	End piece
37	Flow channel
38	Mid-line axis
39	Outlet opening
40	Inlet opening
42	Diameter
43	Diameter
44	Outside thread
45	Inside thread
46	Supply line
47	Face end
48	Radial shoulder
49	Projection
50	Diameter
52	Area
53	Inlet side
54	Heat exchanger
56	Tube
57	Retaining plate
58	End section
59	Face end
60	Contact surface
61	Inclined surface
62	Collar
63	Inclined surface
64	Recess
65	Cylindrical wall section
66	Welded seam
67	Reinforcing sleeve
68	Flange

69 Inclined surface

70 Radial groove

72 Protruding section

73 Locating pin

74 Threaded section

75 Threaded bore

76 Front end

77 Distance sensor

30146-23D(S)

CLAIMS:

1. A blasting nozzle for delivering a pressurized air mixture containing an abrasive to a tube of a heat exchanger, the heat exchanger tube having an internal diameter, the blasting nozzle being connectable to a supply line providing the pressurized air mixture, the supply line having a conduit through which the pressurized air mixture may flow, the blasting nozzle comprising:

a nozzle body having an outer surface, a first end, an opposed second end and a channel defined therethrough extending between the first and second ends; the first end of the nozzle body having an inlet opening defined therein for receiving therethrough the pressurized air mixture from the supply line; the second end of the nozzle body having an outlet opening defined therein through which the pressurized air mixture may exit the nozzle body;

the channel having a first diameter at the inlet opening and a second diameter at the outlet opening, the second diameter being sized to correspond substantially to the internal diameter of the heat exchanger tube, the first diameter being sized at least as large as the second diameter, and

the nozzle body further having at the second end thereof a third diameter defined by the outer surface, the third diameter being at least as large as the internal diameter of the heat exchanger tube.

2. The blasting nozzle of claim 1 wherein the second diameter of the channel is equal to the internal diameter of the heat exchanger tube.

30146-23D(S)

3. The blasting nozzle of claim 1 wherein the second diameter of the channel is slightly smaller than the internal diameter of the heat exchanger tube.

4. The blasting nozzle of claim 1 wherein the diameter of the channel remains constant in the region of the nozzle body adjacent the outlet opening.

5. The blasting nozzle of claim 4 wherein in the region of the nozzle body adjacent the outlet opening, the diameter of the channel is sized to correspond to the inner diameter of the supply line conduit.

6. The blasting nozzle of claim 1 wherein the first diameter is sized slightly greater than the second diameter.

7. The blasting nozzle of claim 6 wherein the first diameter is sized slightly greater than the inner diameter of the supply line conduit measured when empty.

8. The blasting nozzle of claim 7 wherein:

at a location intermediate the inlet opening and the outlet opening, the channel has a third diameter; and

the third diameter is sized slightly smaller than the first diameter.

9. The blasting nozzle of claim 8 wherein the diameter of the channel tapers between the inlet opening and the intermediate location.

10. The blasting nozzle of claim 8 wherein the third diameter is sized equal to the second diameter.

11. The blasting nozzle of claim 10 wherein the diameter of the channel remains constant between the intermediate location and the outlet opening.

12. The blasting nozzle of any of one of claims 8, 9, 10 and 11 wherein the intermediate location is situated midway between the inlet opening and the outlet opening.

13. The blasting nozzle of claim 1 wherein the channel has a length measured between the first and second ends of the nozzle body, and the channel is free of constriction along at least one portion of its length.

30146-23D

14. The blasting nozzle of claim 13 wherein the at least one portion of the length along which the channel is free of constriction, is defined between the outlet opening and a location intermediate the inlet opening and the outlet opening.

15. The blasting nozzle of claim 14 wherein the intermediate location is situated midway between the inlet opening and the outlet opening.

16. The blasting nozzle of claim 1 wherein the channel includes a first portion adjacent the inlet opening and a second portion adjacent the outlet opening, the first portion having a slight taper formed therein, and the second portion of the channel being free of any constriction.

17. The blasting nozzle of claim 16 wherein:

the first portion of the channel extends between the inlet opening and a location intermediate the inlet opening and the outlet opening; and

the second portion of the channel extends between the intermediate location and the outlet opening.

18. The blasting nozzle of claim 1 further comprising means for forming a seal between the blasting nozzle and the heat exchanger tube when the blasting nozzle is connected to the heat exchanger tube.

19. The blasting nozzle of claim 18 wherein the seal forming means includes a contact surface formed on the nozzle body for abutting a portion of the heat exchanger tube when the blasting nozzle is connected to the heat exchanger tube, the contact surface surrounding the outlet opening.

20. The blasting nozzle of claim 19 wherein:

the nozzle body has longitudinal axis;

the contact surface is defined by a plane, the plane being perpendicular to the longitudinal axis of the nozzle body; and

the portion of the heat exchanger tube which abuts the contact surface when the blasting nozzle is connected to the heat exchanger tube, is an end face of the heat exchanger tube.

21. The blasting nozzle of claim 20 wherein the seal forming means further includes a collar projecting longitudinally away from the second end of the nozzle body and extending radially along the outer edge of the contact surface, a portion of the inner periphery of the collar abutting the outer periphery of the end of the heat exchanger tube when the blasting nozzle is connected to the heat exchanger tube.

22. The blasting nozzle of claim 21 wherein the contact surface and the collar are constructed from an elastomer.

23. The blasting nozzle of claim 22 further comprising a reinforcement sleeve mounted onto the second end of the nozzle body in surrounding relation to collar.

24. A blasting nozzle head assembly for delivering a pressurized air mixture containing an abrasive to a plurality of heat exchanger tubes, each heat exchanger tube having an internal diameter, the blasting nozzle head assembly comprising:

a carrier, and

a plurality of blasting nozzles held by the carrier, each blasting nozzle of the plurality having:

a nozzle body having an outer surface, a first end, an opposed second end and a channel defined therethrough extending between the first and second ends; the first end of the nozzle body having an inlet opening

30146-23D(S)

defined therein for receiving therethrough the pressurized air mixture from a supply line; the second end of the nozzle body having an outlet opening defined therein through which the pressurized air mixture may exit the nozzle body;

the channel having a first diameter at the inlet opening and a second diameter at the outlet opening, the second diameter being sized to correspond substantially to the internal diameter of the heat exchanger tube, the first diameter being sized at least as large as the second diameter; and

the nozzle body further having at the second end thereof a third diameter defined by the outer surface, the third diameter being at least as large as the internal diameter of the heat exchanger tube.

25. The blasting nozzle head assembly of claim 24 wherein:

the heat exchanger tubes of the plurality are disposed in a grid pattern; and

the plurality of blasting nozzles are disposed in the carrier in a configuration matching the grid pattern of the heat exchanger tubes.

26. The blasting nozzle head assembly of claim 24 wherein the plurality of blasting nozzles includes a first blasting nozzle and a second blasting nozzle, the first and second blasting nozzles being disposed side-by-side in the carrier.

27. The blasting nozzle head assembly of claim 26 wherein the carrier has a front portion, a rear portion and a pair of first and second bores defined in the carrier, the first and second bores extending between the front and rear portions of the carrier, the first bore configured to receive therethrough the first blasting nozzle and the second bore configured to receive therethrough the second blasting nozzle, the first end of the nozzle body of each blasting nozzle protruding from the front portion of the carrier.

28. The blasting nozzle head assembly of claim 27 further comprising means for locating the carrier in position relative to the plurality of heat exchanger tubes so as to allow coupling of the first and second blasting nozzles with corresponding heat exchanger tubes of the plurality.

29. The blasting nozzle head assembly of claim 28 wherein the locating means includes a pin standing proud of the front portion of the carrier, the pin having a diameter sized slightly smaller than the inner diameter of a given heat exchanger tube to permit insertion of the pin in the heat exchanger tube.

30. The blasting nozzle head assembly of claim 29 wherein the pin is disposed between the first blasting nozzle and the second blasting nozzle.

31. The blasting nozzle head assembly of claim 29 wherein the pin has a tip and the tip of the pin protrudes longitudinally beyond the most forwardly extending portions of the first and second blasting nozzles.

30146-23D(S)

32. A method for cleaning heat exchanger tubes using a pressurized air mixture delivered from a supply line, the pressurized air mixture containing an abrasive, the method comprising:

providing at least one blasting nozzle, the at least one blasting nozzle having:

a nozzle body having an outer surface, a first end, an opposed second end and a channel defined therethrough extending between the first and second ends; the first end of the nozzle body having an inlet opening defined therein for receiving therethrough the pressurized air mixture from the supply line; the second end of the nozzle body having an outlet opening defined therein through which the pressurized air mixture may exit the nozzle body;

the channel having a first diameter at the inlet opening and a second diameter at the outlet opening, the second diameter being sized to correspond substantially to the internal diameter of the heat exchanger tube, the first diameter being sized at least as large as the second diameter;

the nozzle body further having at the second end thereof a third diameter defined by the outer surface, the third diameter being at least as large as the internal diameter of the heat exchanger tube;

connecting the first end of the nozzle body of the at least one blasting nozzle to the end of the supply line;

coupling the second end of the nozzle body of the at least one blasting nozzle to the end of the heat exchanger tube to be cleaned; and

30146-23D(S)

urging the flow of the pressurized air mixture from the supply line through the at least one blasting nozzle and into the heat exchanger tube to be cleaned.

33. The method of claim 32 wherein:

the at least one blasting nozzle includes a first blasting nozzle and a second blasting nozzle;

the connecting step includes connecting the first end of the nozzle body of each blasting nozzle to the end of a corresponding supply line;

the coupling step includes coupling the second end of the nozzle body of each blasting nozzle to the end of a corresponding heat exchanger tube to be cleaned; and

the urging step includes simultaneously urging the flow of the pressurized air mixture from the respective supply line through each of the first and second blasting nozzles and into the respective heat exchanger tube to be cleaned.

34. The method of claim 32 wherein the coupling step further includes forming a seal between the second end of the nozzle body of the at least one blasting nozzle and the heat exchanger tube to be cleaned.

35. The method of claim 34 wherein:

the at least one blasting nozzle has a contact surface formed on the nozzle body and surrounding the outlet opening, the contact surface being defined by a plane, the plane being perpendicular to the longitudinal axis of the nozzle body; and

the seal forming step includes abutting the contact surface of the nozzle body against the end face of the heat exchanger tube to be cleaned.

36. The method of claim 35 wherein:

the at least one blasting nozzle further includes a collar projecting longitudinally away from the second end of the nozzle body and extending radially along the outer edge of the contact surface; and

the seal forming step further includes abutting a portion of the inner periphery of the collar against the outer periphery of the end of the heat exchanger tube to be cleaned.

37. The method of claim 36 further comprising locating the at least one blasting nozzle in position relative to the heat exchanger tube to be cleaned prior to coupling.

38. The method of claim 37 wherein:

the method further includes providing a carrier holding the at least one blasting nozzle; the carrier having a front portion, a rear portion and at least one bore defined in the carrier, the at least one bore extending between the front and rear portions of the carrier, the at least one bore

being configured to receive therethrough the at least one blasting nozzle, the front portion having a pin extending forwardly therefrom; and

the locating steps includes inserting the pin into one of the heat exchanger tubes adjacent the heat exchanger tube to be cleaned.

Fetherstonhaugh
Ottawa, Canada
Patent Agents

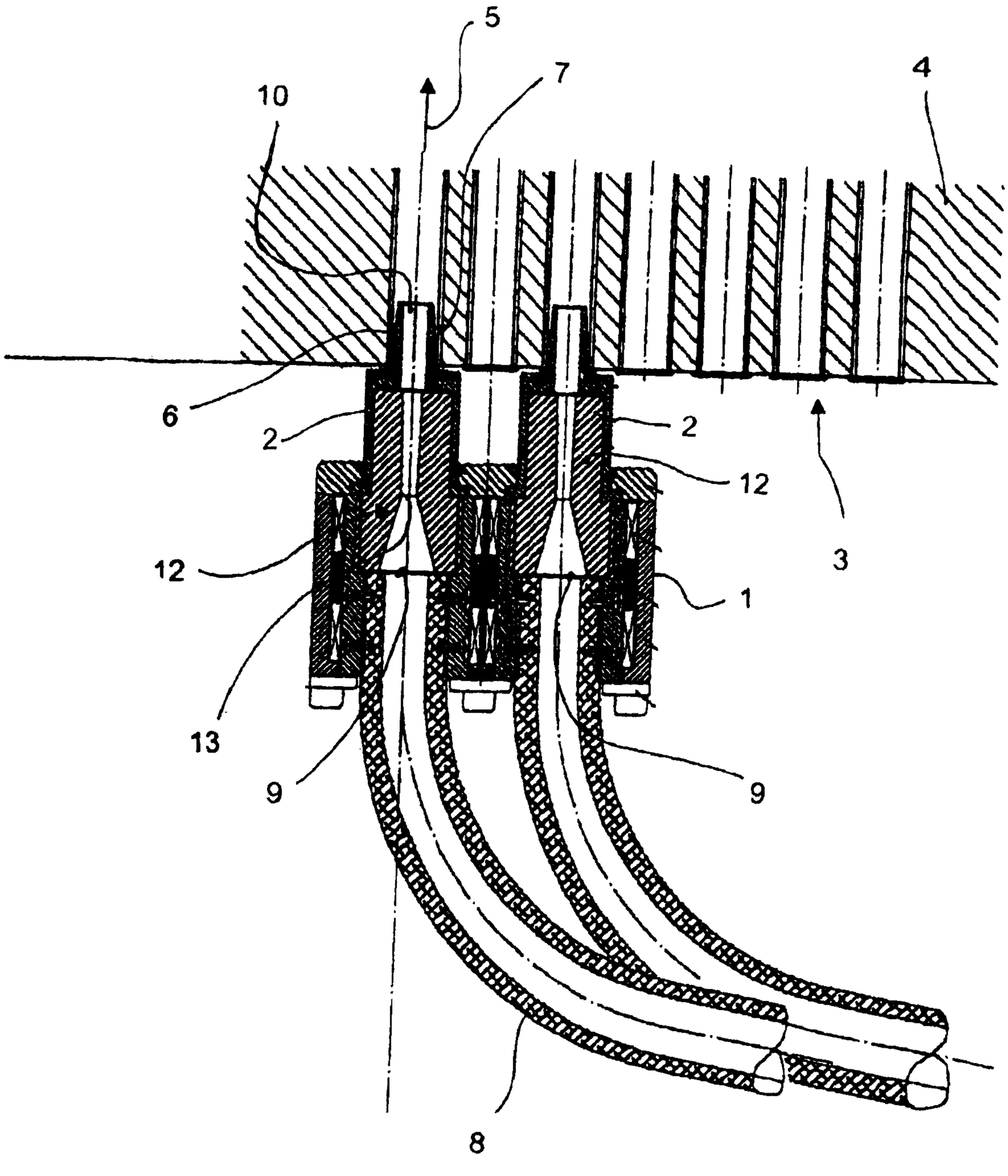


FIG. 1
Prior Art

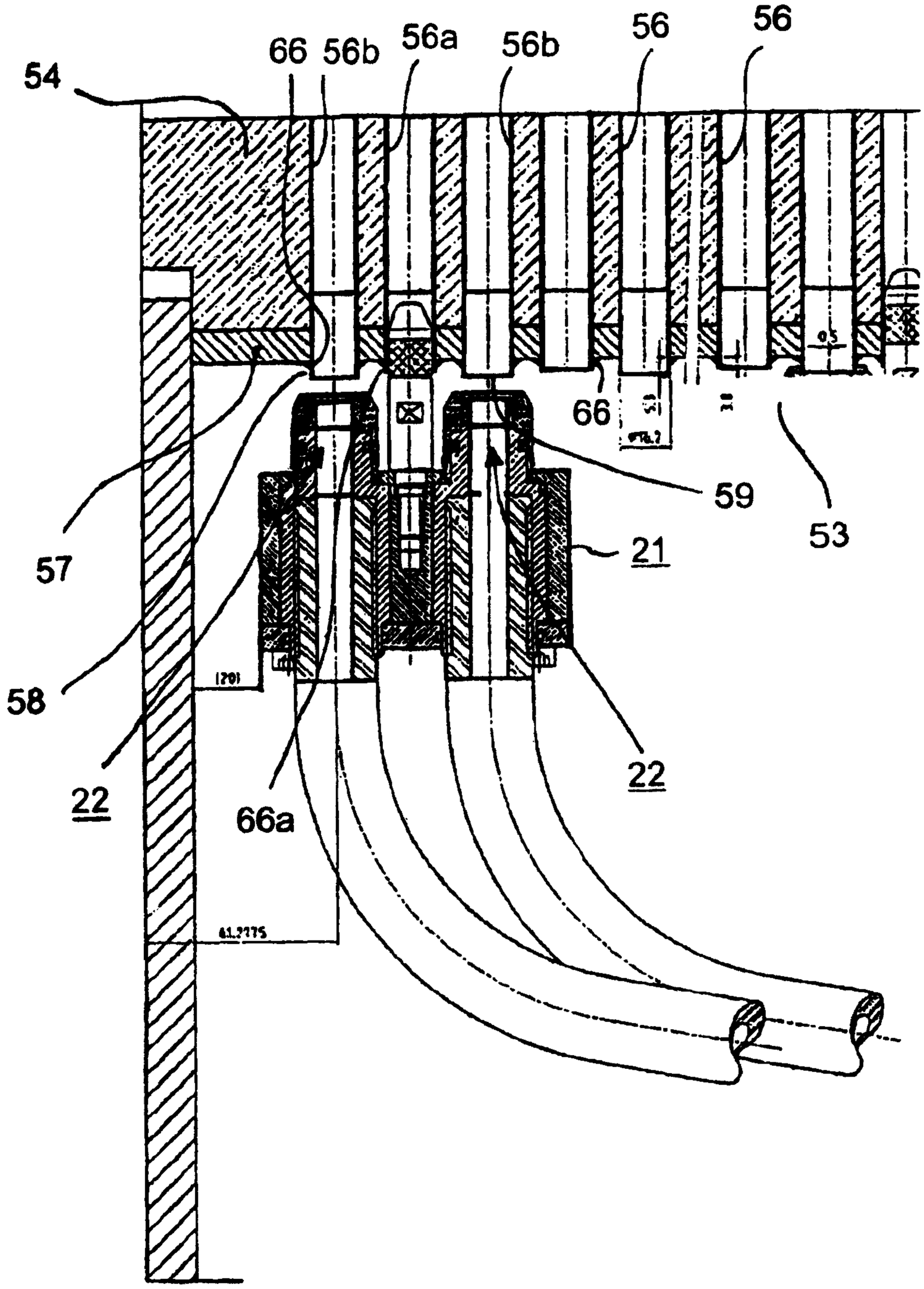


FIG. 2

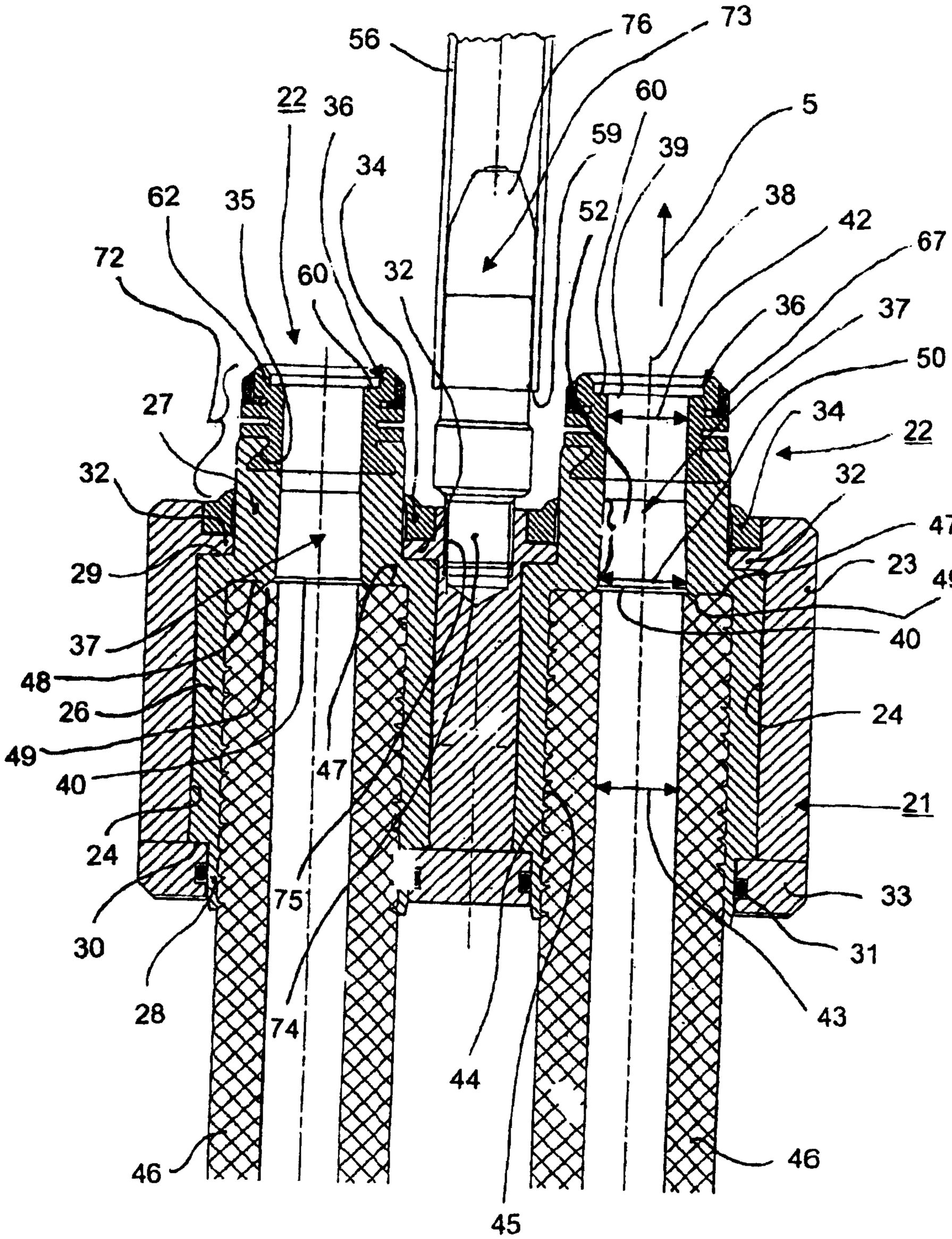

56
76
73
22
36
60
5
59
39
34
62
35
52
38
42
72
60
32
67
36
37
50
27
34
22
32
32
47
29
23
49
37
48
26
24
49
40
47
40
24
21
75
33
30
31
28
74
43
44
46
46
45

FIG. 3

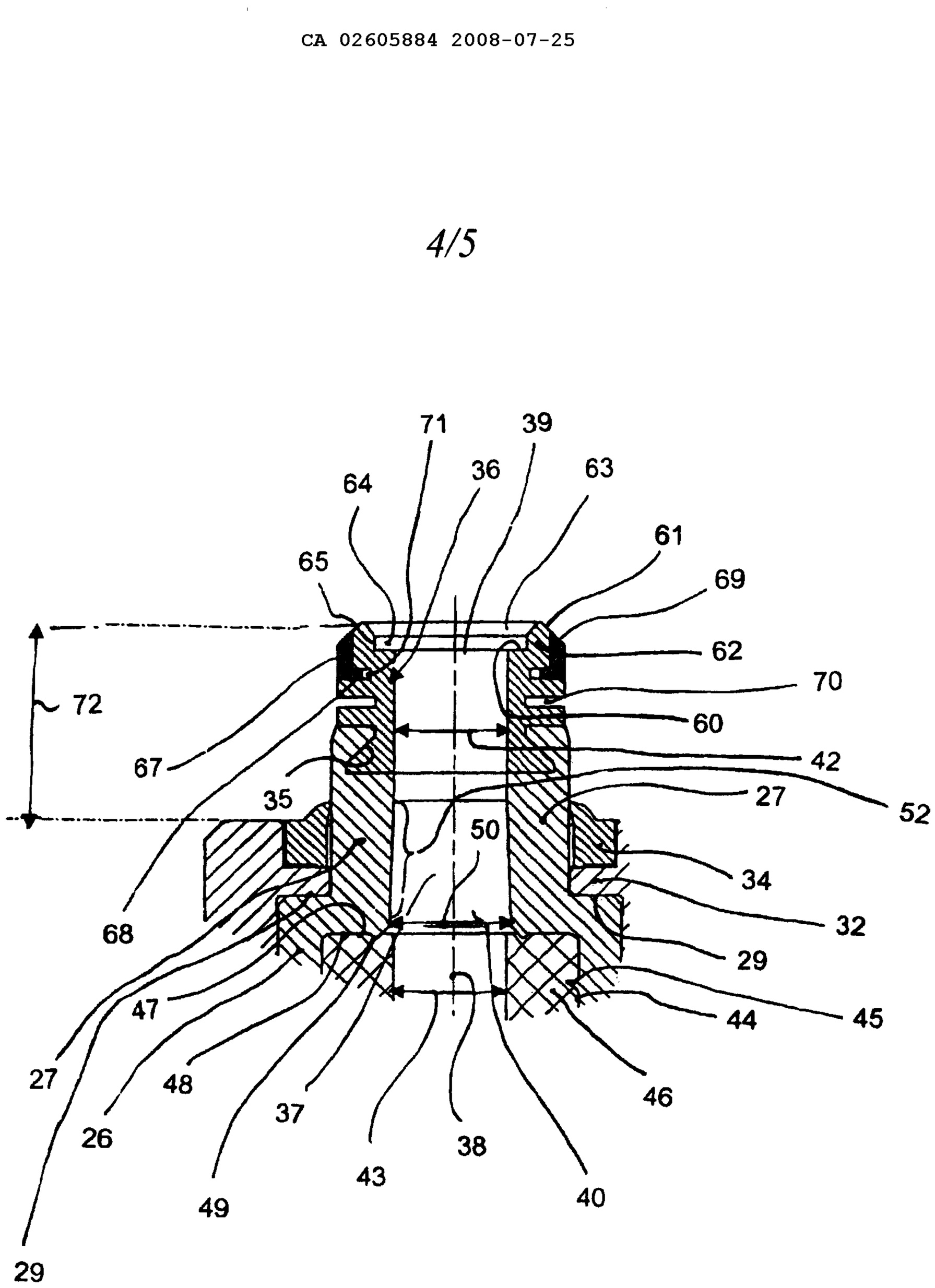

71
39
64
36
63
61
65
69
62
70
72
60
67
42
35
27
52
50
34
68
32
29
47
44
45
27
48
26
37
38
43
46
49
40
29

FIG. 4

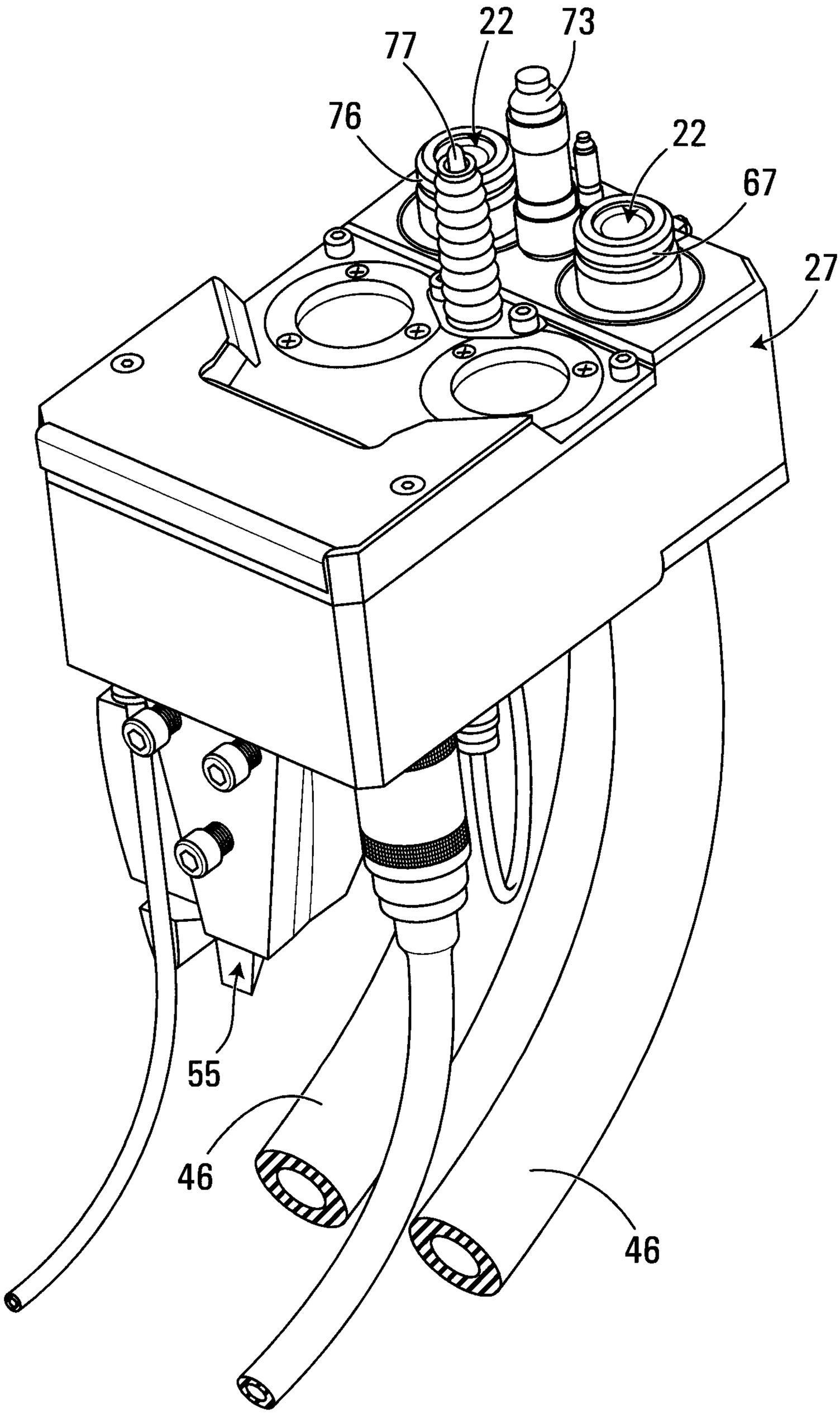
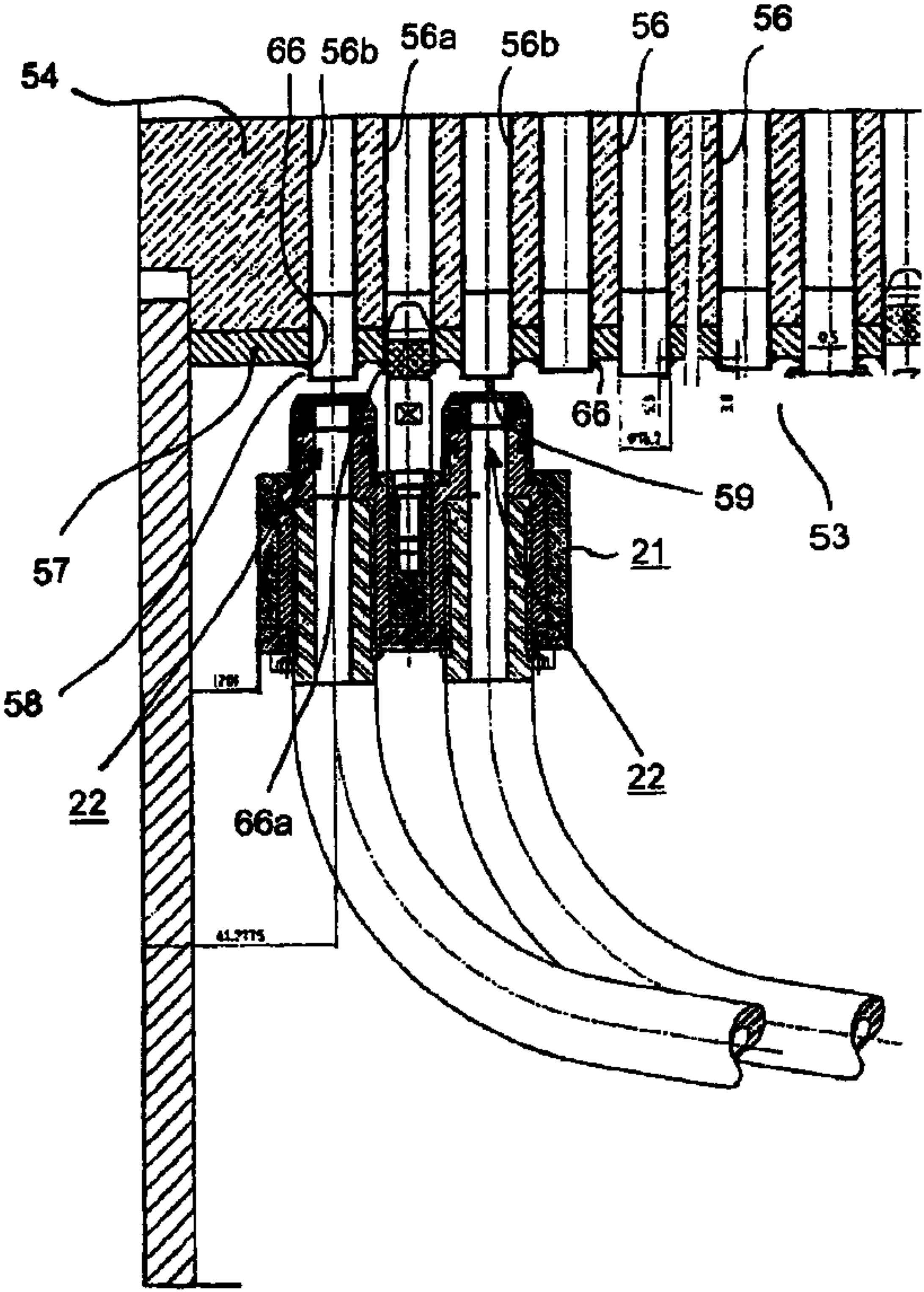


FIG. 5


54
66
56b
56a
56b
56
56
66
59
53
57
21
58
22
22
66a