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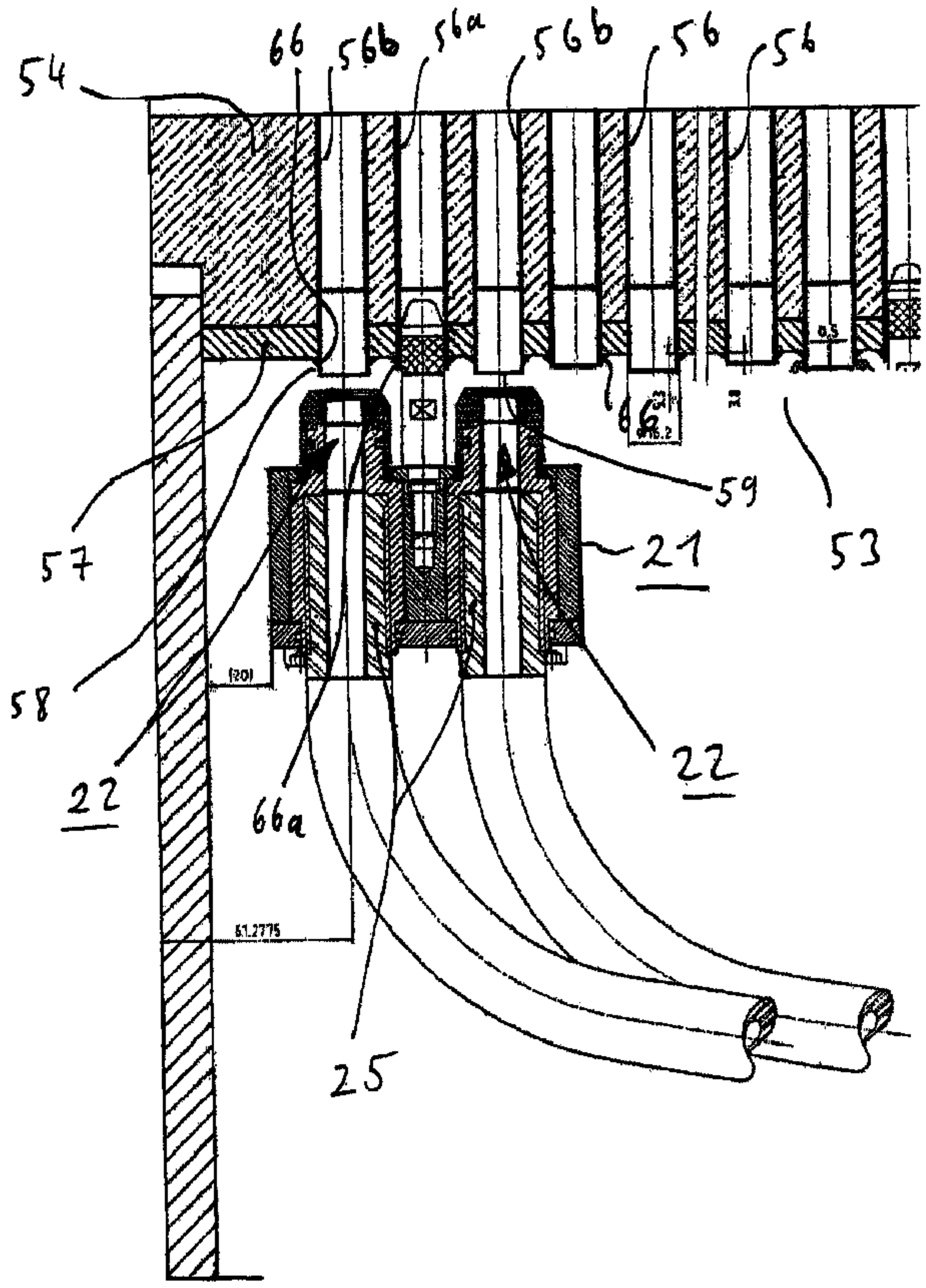
(54) Titre : METHODE DE NETTOYAGE DES TUBES D'UN ECHANGEUR THERMIQUE AU MOYEN D'UN ABRASIF ET DISPOSITIF APPROPRIE A CETTE METHODE

(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

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

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.

According to Claim 1 or Claim 6, respectively, this objective is achieved 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, 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 another 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 and air that contains an abrasive is blown through the tube, wherein an unchoked nozzle is used.

In accordance with yet 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, the nozzle being adapted to blow air containing an abrasive through a tube of the heat exchanger.

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

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

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CLAIMS:

1. A method for cleaning the tubes of a heat exchanger, in which a nozzle is set on one end of a tube and air that contains an abrasive is blown through the tube, wherein an unchoked nozzle is used.

2. The method as defined in claim 1, 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.

3. The method as defined in claim 1 or claim 2, wherein a contact surface that surrounds the outlet opening of the nozzle is pressed against the face end of a tube end.

4. The method as defined in any one of claims 1 to 3, wherein a plurality of tubes is cleaned simultaneously, a plurality of nozzles that is held by a carrier in the tube pattern of the heat exchanger being applied to the corresponding tubes.

5. The method as defined in claim 4, wherein the carrier is locked on a tube end in that a locating pin that protrudes from it in the direction of the jet is introduced into the tube end.

6. A jet device for cleaning the tubes of a heat exchanger wherein the jet device comprises an unchoked nozzle, the nozzle being adapted to blow air containing an abrasive through a tube of the heat exchanger.

7. The jet device as defined in claim 6, wherein the jet device is adapted to carry out the method as defined in any one of claims 2 to 5.

8. The jet device as defined in claim 7, 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.

9. The jet device as defined in claim 8, 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.

10. The jet device as defined in claim 9, wherein the contact surface is delimited radially to the outside by a collar that protrudes axially, the contact surface and the collar together forming a receptacle for the tube end.

11. The jet device as defined in any one of claims 8 to 10, wherein an area of the nozzle that contains the receptacle and the outlet opening is of an elastomer.

12. The jet device as defined in claim 11, wherein the elastomer area is formed by an end piece in the form of a tubular section that is joined positively to the nozzle.

13. The jet device as defined in claim 10 or claim 11, wherein the longitudinal section of the elastomer area that surrounds the receptacle is enclosed by a reinforcing sleeve that is of a rigid material.

14. The jet device as defined in any one of claims 8 to 13, wherein a plurality of nozzles is arranged on a carrier in the tube pattern of the heat exchanger that is to be cleaned.

15. The jet device as defined in any one of claims 8 to 14, wherein on the carrier there is a locating pin that can be inserted in a tube end.

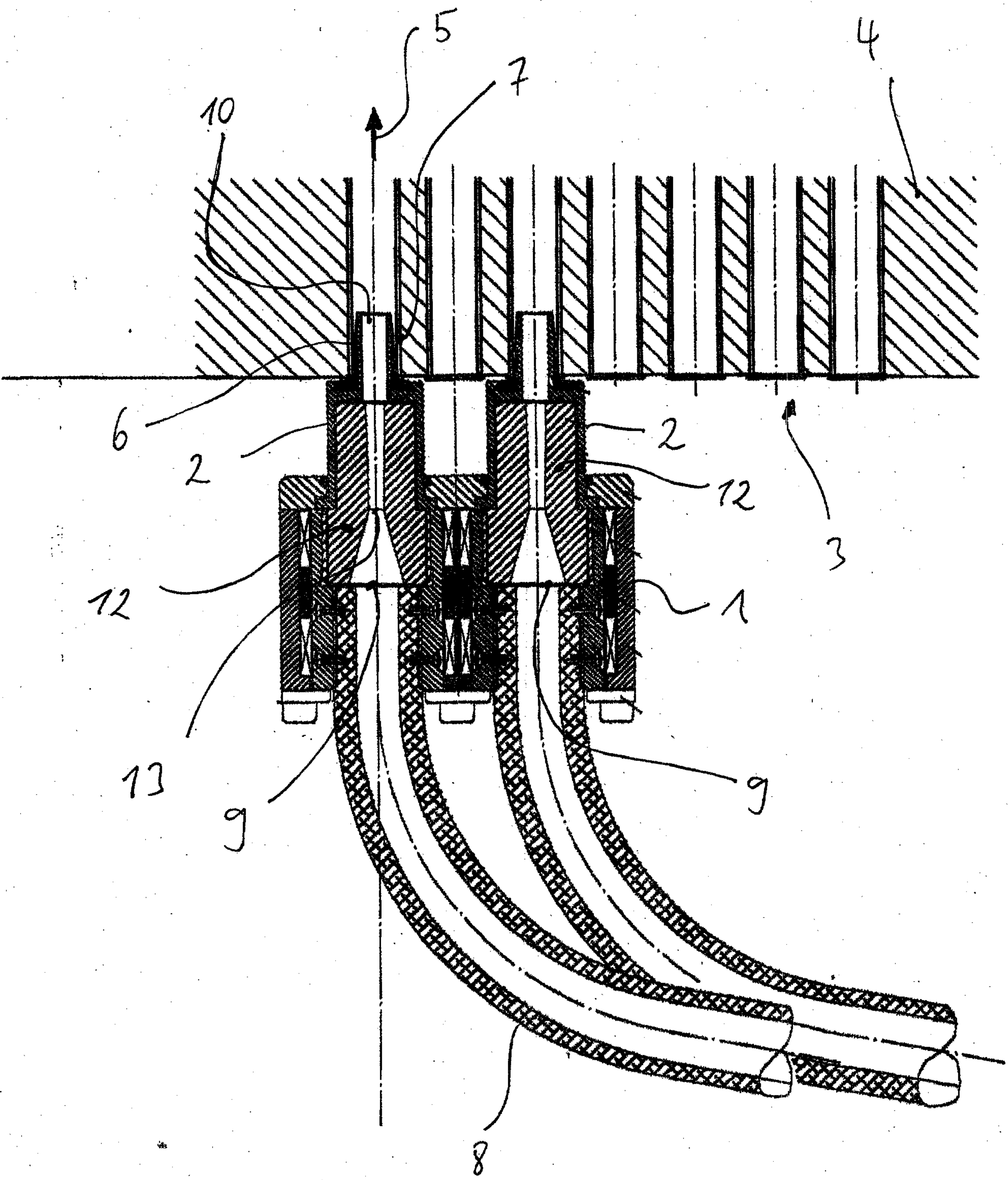
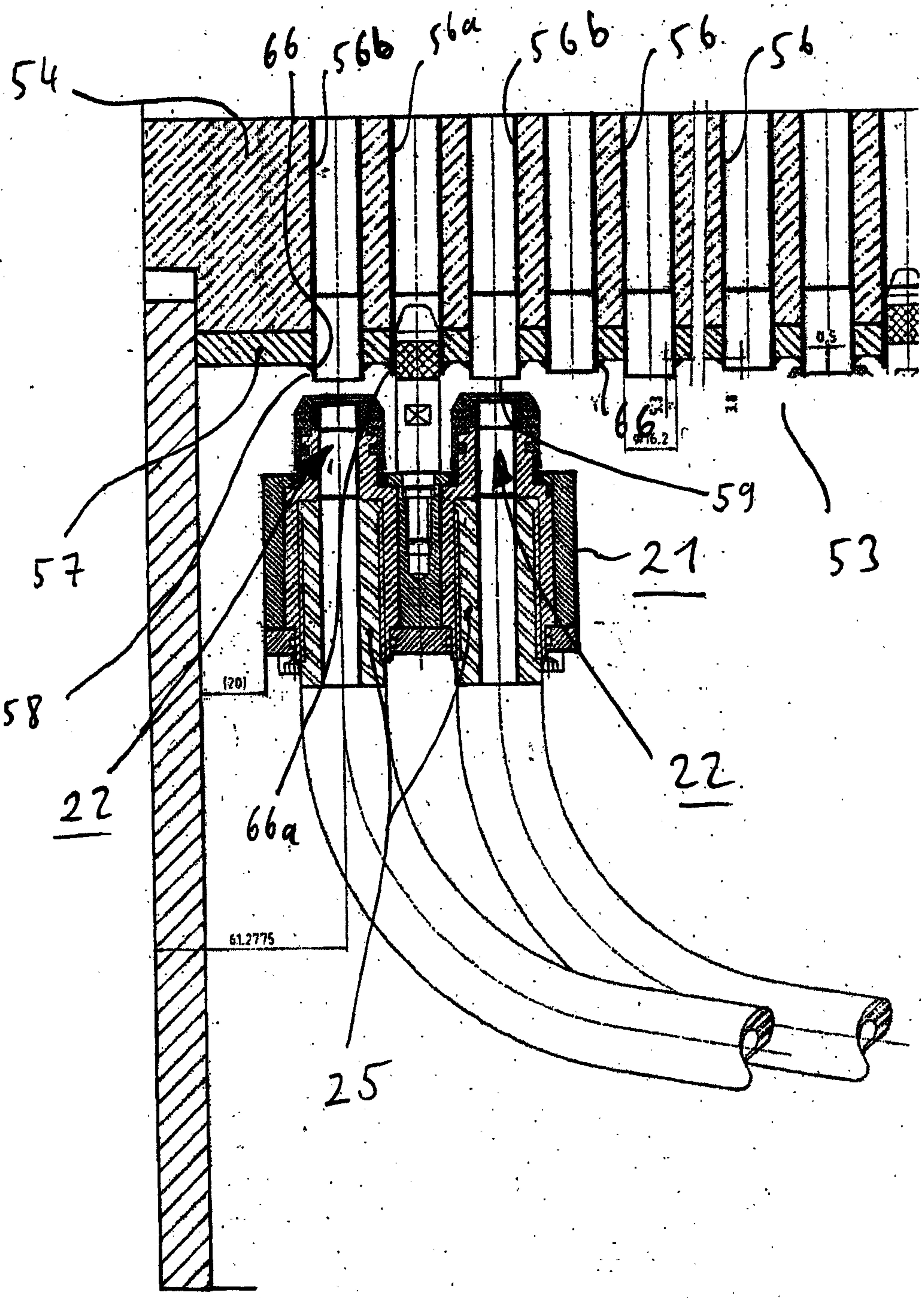



Fig. 1

Prior Art

Fig. 2



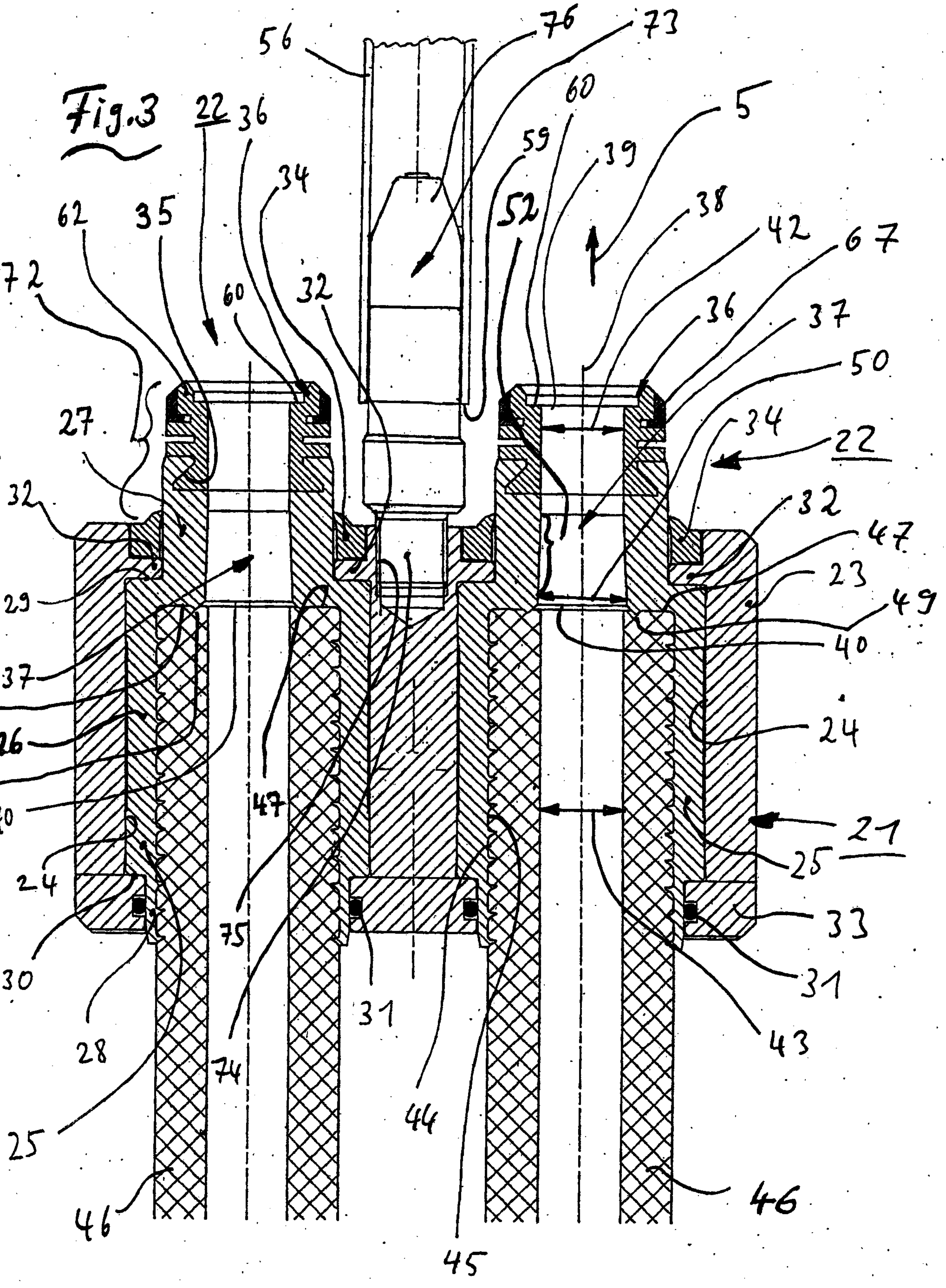


Fig.3
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Fig. 4

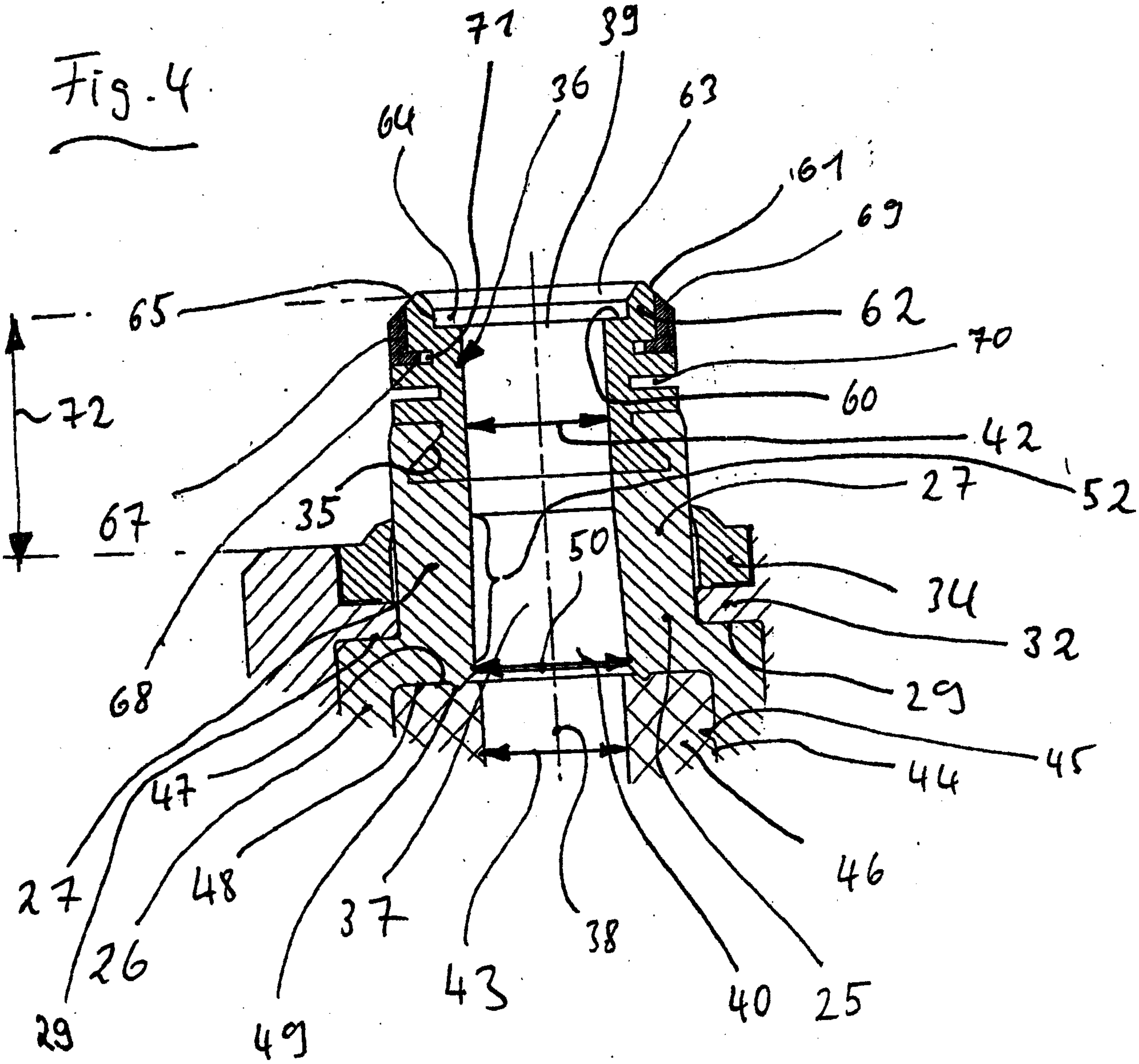
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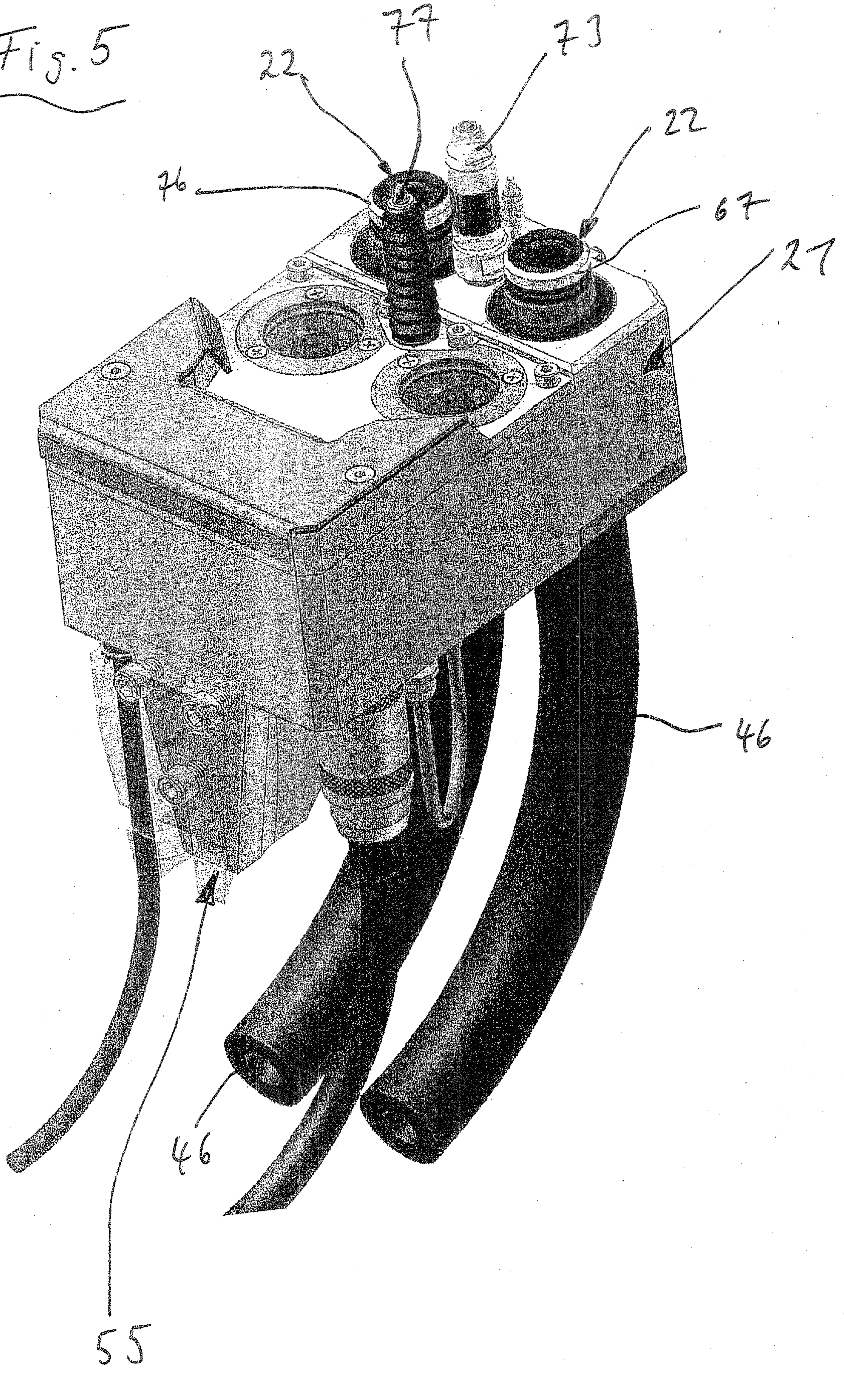
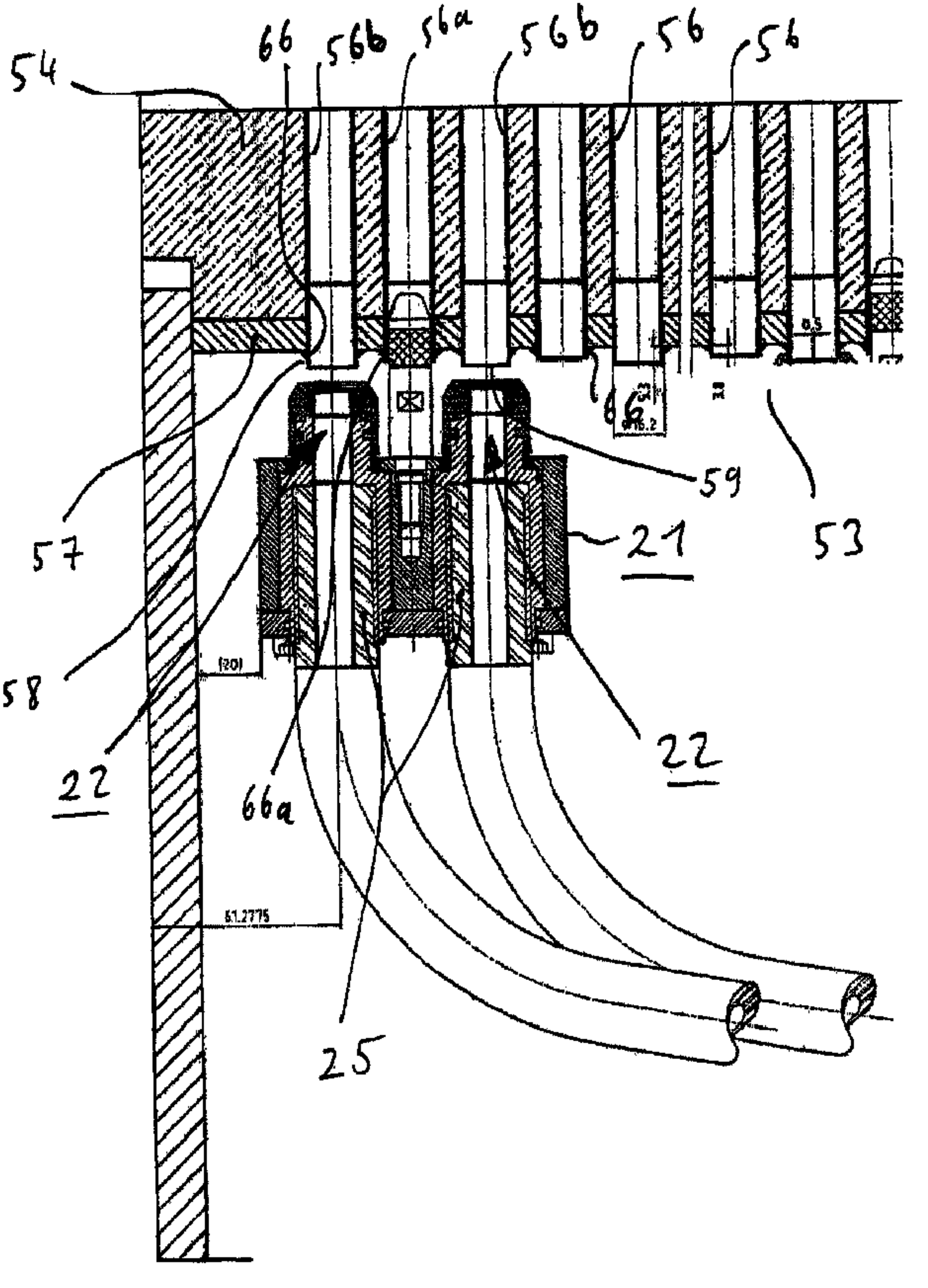
Fig. 5

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