

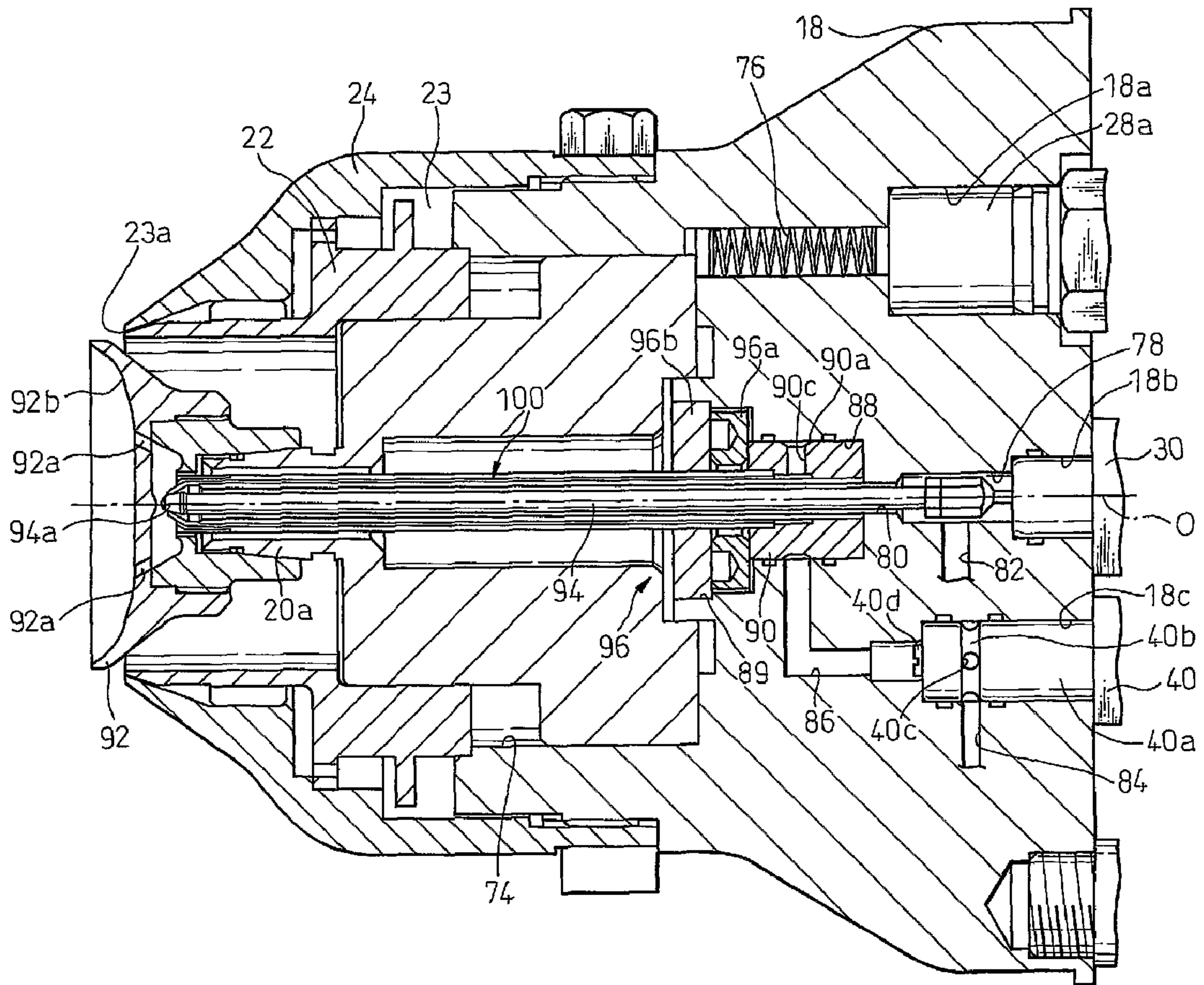


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(54) Titre : VAPORISATEUR DE PEINTURE AVEC PULVERISATEUR ROTATIF  
 (54) Title: ROTARY ATOMIZER

Fig. 4



(57) Abrégé/Abstract:

A paint sprayer (10) with rotary atomizer has a rotary bell (92) fastened on a rotary shaft (20a) of an air motor (20) held on the paint sprayer and made with multiple nozzle orifices (92a) to jet out paint to an object to be coated. Paint atomized with revolution of the

(57) **Abrégé(suite)/Abstract(continued):**

rotary bell sprays out towards the object to be coated. Moreover, there are provided a paint passage (102a) having at the foremost end thereof a paint port (112c) communicating with the nozzle orifices of the rotary bell, and a water passage (108) lying outside the paint passage and having at the foremost end thereof a water port communicating with the nozzle orifices of the rotary bell. A needle (94) may be installed to open and close the paint port.

ROTARY ATOMIZER

5

ABSTRACT OF THE DISCLOSURE

In a rotary atomizer (10) including a rotating bell (92) secured to a rotating shaft (20a) of an air motor (20) held in an atomizer body, the rotating bell having a plurality of orifices (92a) for supplying paint to an object to be painted, the rotating bell being rotated to spray the paint toward the object to be painted, the rotary atomizer comprises a paint passage (102a) with a paint port (112c) at an end thereof fluidly communicating with the orifices of the rotating bell, and a water passage (108) arranged outside of the paint passage and having a water port at an end of the water passage leading to the orifices of the rotating bell. A needle (94) for opening and closing the paint port may be provided.

## SPECIFICATION

ROTARY ATOMIZER

## 5 TECHNICAL FIELD

The present invention relates to a rotary atomizer.

## BACKGROUND ART

10 A rotary atomizer includes a rotating bell which is coupled to a rotating shaft of an air motor and has a plurality of orifices and a paint passage for supplying paint from a paint source to the orifices of the rotating bell, thus dispensing the paint through the orifices toward an object to be painted. In a painting operation, 15 when the rotating shaft of the air motor and the rotating bell are rotated, the paint discharged through the orifices flows radially outwardly along a distal end face of the rotating bell, due to the centrifugal force, toward the peripheral edge of the rotating bell, then the 20 paint is sprayed when separating from the peripheral edge of the rotating bell.

## SUMMARY OF THE INVENTION

25 Recently, water-based paints have often been used instead of solvent-based paints in view of the state and local government regulations concerning environmental issues. A water-based paint, particularly, a quick-drying water-based emulsion paint turns into a gel immediately after the material has come into contact with 30 the air. For example, when thirty minutes have passed after the start of painting operation, paint clots are deposited around the orifices, the distal end face and/or the outer periphery of the rotating bell, which causes a deformed pattern is deformed, which is a problem.

35 Further, when the supply of paint is stopped for a certain time period, the paint turns into a gel at the distal portion of the paint passage so that its paint

port would be clogged.

5 In view of the above-mentioned problem of the prior art, an object of the present invention is to provide a rotary atomizer capable of avoiding the deposition of paint clots onto the distal end face of the rotating bell.

Further, another object is to provide a rotary atomizer capable of avoiding the clogging of a paint port at the distal portion of a paint passage.

10 According to the present invention, there is provided a rotary atomizer including a rotating bell secured to a rotating shaft of an air motor held in an atomizer body, the rotating bell defining a plurality of orifices for dispensing paint to an object to be painted, 15 the rotation of the rotating bell atomizing the paint so as to spray the paint toward the object to be painted, the rotary atomizer comprising: a paint passage having a paint port, at a distal end thereof, fluidly communicating with the orifices of the rotating bell; a 20 water passage disposed outside of the paint passage and having a water port, at a distal end of the water passage, fluidly communicating with the orifices of the rotating bell, and the paint and the water being simultaneously dispensed through the orifices of the 25 rotating bell.

According to another aspect of the present invention, there is provided a rotary atomizer including a rotating bell secured to a rotating shaft of an air motor held in an atomizer body, the rotating bell having 30 a plurality of orifices for dispensing paint to an object to be painted, the rotation of the rotating bell atomizing the paint so as to spray the paint toward the object to be painted, the rotary atomizer comprising: a paint passage having a paint port, at a distal end thereof, fluidly communicating with the orifices of the 35 rotating bell; and a needle for opening and closing the paint port.

## BRIEF DESCRIPTION OF THE DRAWINGS

5 Figure 1 is a cross-sectional view illustrating a rotary atomizer taken along its axis in accordance with a preferable embodiment of the present invention.

Figure 2 is a plan view of the rear end face of the manifold of the rotary atomizer.

Figure 3 is an end view of the rotary atomizer showing a rear end face thereof.

10 Figure 4 is a partial section of the front part of the rotary atomizer.

Figure 5 is a sectional view of the dual-tube assembly taken along its axis.

15 Figure 6 is a block diagram of a preferable embodiment of a painting system suitable for incorporating with the rotary atomizer of the present invention.

## BEST MODE FOR CARRYING OUT THE INVENTION

20 With reference to the drawings, an embodiment of the present invention will be described below.

Referring to Figure 1, a rotary atomizer 10 is provided with an atomizer body formed by a cylindrical cover 12, an end plate 16 closing a rear end opening of the cylindrical cover 12, and a manifold 16 mounted on a 25 distal end opening portion opposite to the end plate 16, with an axis O of the cylindrical cover 12 defining a longitudinal axis of the atomizer body. Formed on a rear end face of the manifold 18 (Figure 2) are three screw 30 holes 56 which are equidistantly provided on the periphery direction around the axis O.

The end plate 16 defines through holes 16a which are axially aligned with the screw holes 56 of the manifold 18. Further, within an internal space 14 of the atomizer 35 body, three stays 26 extend parallel to the axis O. The stays 26 define, at the distal ends thereof, screw portions 26 which engages with the screw holes 56 of the

manifold 18, and at the rear ends thereof, screw holes 26b which receive and engage with screw bolts 25. Thus, the manifold 18, the stays 26, the cylindrical cover 12 and the end plate 16 are assembled as illustrated in Figure 1, and then, the screw bolts 25 are engaged and tightened with the screw holes 26 to unify the manifold 18, the cylindrical cover 12 and the end plate 16.

Further, the rear end face of the manifold 18 includes a screw hole 18a engaging with a screw portion 28a at the end of a high voltage cable 28 for supplying a voltage to the rotary atomizer 10 to generate an electric field between the rotary atomizer 10 and the object to be painted. The rear end face further includes a first valve receptacle 18b for receiving a trigger valve 30, described below, a second valve receptacle 18c for receiving a gate valve 40, described below, and a plurality of exhaust ports 54. Further, a paint coupling 42, a water coupling 44, a turbine air coupling 46, a bearing air coupling 48, a brake air coupling 50 and a shaping air coupling 52 are attached to the rear end face of the manifold 18 by using a coupling method well-known in the art such as a screw coupling.

The end plate 16 defines a paint hole 60 and a water hole 62 through which a paint tube 218 (Figure 6) for supplying paint to the paint coupling 42 from a paint source, described below, and a water tube 220 (Figure 6) for supplying water to the water coupling 44 from a water source, described below, are introduced into the internal space 14. Further, air holes 64 and 66 and an exhaust port 68 are formed in the end plate 16. Through the air holes, a plurality of air tubes 206-216 (Figure 6), for respectively supplying air from an air source, described below, to the turbine air coupling 46, the bearing air coupling 48, the brake air coupling 50 and the shaping air coupling 52, are introduced into the internal space 14. Reference numeral 60 designates a bracket for mounting the rotary atomizer 10 on a stand

(not shown) or a robot hand (not shown).

5 The first valve receptacle 18b is a recess formed along the axis 0 in which the trigger valve 30 is accommodated. Further, a paint chamber 78 adjacent the first valve receptacle 18a opens into the end or bottom of the first valve receptacle 18b.

10 Further, a needle passage 80 fluidly connected to the paint chamber 78 in the manifold 18. The end of the needle passage 80 opposite to the paint chamber 78 opens into a pocket 88 which opens into a stopper receptacle 89. The stopper receptacle 89 opens into a motor receptacle 74 formed at the distal end of the manifold 18.

15 As stated above, the paint chamber 78 is a recess extending along the axis where one end opens into the first valve receptacle 18b and the opposite end opens into the pocket 88. A passage 82, fluidly communicating with the paint coupling 42, opens into the side wall of the recess. In this embodiment, the passage 82, the paint chamber 78 and the needle passage 80 provide a paint supplying passage.

20 The second valve receptacle 18c is an axially extending recess which is offset in the radial direction from the first valve receptacle 18b. The gate valve 40 is held in the second valve receptacle 18c. At a distal end portion of 40a, the outer surface of the gate valve 40 defines a peripheral groove 40b which opens into a radial passage 40c. The radial passage 40c is fluidly connected to an axially extending internal passage (not shown) of the end portion 40a.

30 Further, the gate valve comprises an axially reciprocating valve body 40d, for opening and closing the internal passage of the end portion 40a, and a coupling 41 for receiving air to activate the valve body 40d.

35 Further, a passage 84, fluidly connected to the water coupling 42, opens into the side wall of the second valve receptacle 18c. Furthermore, the second valve receptacle

18c is fluidly connected via the passage 86 to the pocket 88.

A substantially cylindrical confluence member 90 is provided in the pocket 88.

5           The confluence member 90 includes a peripheral groove 90a formed in its outer surface, a central through hole 90b and a radial passage 90c extending between the central through hole 90b and the peripheral groove 90a. The passage 86 extending from the second valve receptacle 10 18c is positioned at the side wall of the pocket 88 so that the passage 86 opens into the peripheral groove 90a of the confluence member 90. In this embodiment, the passage 84, the peripheral groove 40b, the radial passage 40c, the internal passage of the end portion 40a, the 15 passage 86, the peripheral groove 90a, the radial passage 90c and the central through hole 90b provide a water supplying passage.

Accommodated in the air motor receptacle 74 is an air motor 20 having a rotating shaft 20a extending along 20 the axis O. A rotating bell 92 is secured to the rotating shaft 20a of the air motor 20. The air motor 20 incorporates a turbine (not shown) coupled to the rotating shaft 20a and driven by turbine air, as described below.

25           A dual-tube assembly 100 extends through the body portion and the rotating shaft 20a of the air motor 20 along the axis O. Referring to Figure 5, the dual-tube assembly 100 comprises an inner tube 102 defining an inner passage 102a which provides a paint passage, an 30 outer tube 104 having an inner diameter larger than the outer diameter of the inner tube 102, a tip member 112 attached to the distal end of the inner tube 102 and a sleeve 106 attached to the distal end of the outer tube 104.

35           The inner tube 102, the outer tube 104, the tip member 112 and the sleeve 106 are concentrically disposed around the axis O so that an annular outer passage 108 is

defined between the inner tube 102 and the outer tube 104 to provide a water passage. At the rear end of the dual-tube assembly 100, the outer passage 108 is attached to the confluence member 90 so that the outer passage 108 is fluidly connected via the central through hole 90b of the confluence member 90 to the radial passage 90c.

The tip member 112 has an annular proximal end portion 112a and a tapered portion 112b coupled to the proximal end portion 112a. The tapered portion has a diameter gradually decreased toward the distal end and defines a paint port 112c fluidly connected to the inner passage 102. An inner surface of the tapered portion 112b, converging toward the distal end, provides a valve seat which sealingly contacts with a valve body 94a, described below. Further, in order to maintain the radial position of the sleeve 106 with respect to the tip member 112, a ring member 116 with a plurality of axial orifices (not shown) is arranged between the tip member 112 and the sleeve 106. Thus, an annular water port 114 is defined between the tip member 112 and the sleeve 106.

The trigger valve 30 comprises a pneumatically reciprocating valve stem 30a along the axis O and a coupling 32 which receives air for driving the valve stem 30a. Coupled to the distal end of the valve stem 30a is a needle 94 extending along the axis O and defining a valve body 94a at the distal end thereof. Thus, the needle 94 extends along the axis O from the valve stem 30a via the paint chamber 78, the needle passage 80 and the inner tube 102 of the dual-tube assembly 100 to the valve body 94a.

A rotating bell 92b is mounted to the rotating shaft 20a of the air motor 20. The rotating bell 92b includes, as well known in the art, a bell-shaped or cup-shaped distal end face 92b and a plurality of orifices 92a opening into the distal end face 92b.

Mounted on the distal end of the manifold 18 are an inner ring 22 enclosing the air motor 20 and an outer

ring 24 arranged concentrically with the inner ring 22. A shaping air passage 23, fluidly connected to the shaping air coupling 52, is defined between the inner ring 22 and the outer ring 24.

5           With reference to Figure 6, a painting system which is suitable for incorporating with the rotary atomizer of the present invention will be described below. A painting system 200 comprises a compressor 204 providing an air source (AS), a header 202 fluidly connected to an outlet port of the compressor 204, a turbine air tube 206  
10 for supplying turbine air to the turbine air coupling 46 to drive the air motor, a bearing air tube 208 for supplying bearing air to the bearing air coupling 48 to suspend the rotating shaft 20a, a brake air tube 210 for supplying brake air to the brake air coupling 50 to  
15 reversely rotate the rotating shaft 20a, a shaping air tube 212 for supplying shaping air to the shaping air coupling 52 to control the spray pattern, a first valve driving air tube 214 for supplying air to the coupling 32 of the trigger valve 30 to rearwardly drive the valve  
20 stem 30a along the axis O, a second valve driving air tube 216 for supplying air to the coupling 41 of the gate valve 40 to drive the valve body 40d, a paint tube 218 for supplying paint to the paint coupling 42 and a water  
25 tube 220 for supplying water to the water tube 44.

          Provided on the turbine air tube 206 is a pneumatically-operating normally-closed ON/OFF valve 224 for controlling the supplying and shutting-off of turbine air. The opening and closing of the ON/OFF valve 224 is  
30 controlled by opening and closing a solenoid valve 228 provided on a control air tube 226. The bearing air tube 208 is continuously opened so that bearing air is continuously supplied to the air motor 20 from the activation to the shutoff of the compressor 204.

35           Provided on the brake air tube 210 is a pneumatically-operating normally-closed ON/OFF valve 236 for controlling the supplying and shutting-off of brake

air. The opening and closing of the ON/OFF valve 236 is controlled by opening and closing a solenoid valve 240 provided on a control air tube 238.

5 Provided on the shaping air tube 212 is a pneumatically-operating normally-closed ON/OFF valve 242 for controlling the supplying and shutting-off of shaping air. The opening and closing of the ON/OFF valve 242 is controlled by opening and closing a solenoid valve 246 provided on a control air tube 244.

10 Provided on the first valve driving air tube 214 is a pneumatically-operating normally-closed ON/OFF valve 248 for controlling the supplying and shutting-off of air for driving the valve stem 30a. The opening and closing of the ON/OFF valve 248 is controlled by opening and  
15 closing a solenoid valve 252 provided on a control air tube 250.

Provided on the second valve driving air tube 216 is a pneumatically-operating normally-closed ON/OFF valve 254 for controlling the supplying and shutting-off of air  
20 for driving the valve stem 40d. The opening and closing of the ON/OFF valve 254 is controlled by opening and closing a solenoid valve 258 provided on a control air tube 256.

Paint is supplied by a paint pump 266 from a paint  
25 reservoir 268 via a paint tube 218 to the rotary atomizer 10. Provided on the paint tube 218 are a pneumatically-operating normally-closed ON/OFF valve 260 for controlling the supplying and shutting-off of paint and a circulation tube 268 for returning paint discharged from  
30 the paint pump 266 to the paint reservoir 268 when the ON/OFF valve 260 is closed. The opening and closing of the ON/OFF valve 260 is controlled by opening and closing a solenoid valve 264 provided on a control air tube 262. A power supply unit 272 supplies electrical power to the  
35 paint pump 266.

Water is supplied by a water pump 274 from a water tank 276 via a water tube 220 to the rotary atomizer 10.

5 Provided on the water tube 220 are a pneumatically-  
operating normally-closed ON/OFF valve 230 for  
controlling the supplying and shutting-off of water and a  
circulation tube 278 for returning water discharged from  
the water pump 274 to the water tank 276 when the ON/OFF  
valve 230 is closed. The opening and closing of the  
ON/OFF valve 230 is controlled by opening and closing a  
solenoid valve 234 provided on a control air tube 232. A  
power supply unit 280 supplies electrical power to the  
10 water pump 274.

Herein after, the operation of the present  
embodiment will be described below.

15 In advance of starting a painting operation, the  
compressor 204, the paint pump 266 and the water pump 274  
are activated. When the compressor 204 is activated,  
bearing air is supplied from header 202 via the bearing  
air tube 208 and the bearing air coupling 218 to the air  
motor 20 so that the rotating shaft 20a of the air motor  
20 is suspended.

20 Next, when the ON/OFF valve 224 is opened, turbine  
air is supplied from the header 202 via the turbine air  
tube 206 and the turbine air coupling 46 to the air motor  
20, to thereby rotate the rotating shaft 20a and the  
rotating bell 92 secured to the rotating shaft 20a.  
25 Next, when the ON/OFF valve 242 is opened, shaping air is  
supplied from the header 202 via the shaping air tube 206  
and the shaping air coupling 32 to the shaping air  
passage 23 so that shaping air is discharged through the  
shaping air port 23a between the distal ends of the inner  
30 ring 22 and the out ring 24. In this connection, the  
supply of shaping air can be started at the same time as  
the supply of turbine air.

35 Water is supplied from the water tank 274 via the  
water tube 220 to the water coupling 44. Simultaneously,  
when the ON/OFF valve 254 of the second valve driving air  
tube 216 is opened, air is supplied from the header 202  
via the second valve driving air tube 216 and the

coupling 41 of the gate valve 40 to the gate valve 40, so that the valve body 40d thereof is forwardly driven, i.e., moved in the left direction in Figures 1 and 4. Thus, together with paint, water is discharged from the orifices 92a of the rotating bell 92 via the water coupling 44, the passage 84, the peripheral groove 90a, the radial passage 90c and the central through hole 90b of the confluence member 90, the outer passage 108 of the dual-tube assembly 100 and the water port 114. In particular, the water discharged through the orifices 92a flows outwardly in the radial direction of the rotating bell 92 between the paint discharged through the orifices 92a and the distal end faces 92b of the rotating bell 92.

When the ON/OFF valve 260 is opened, paint is supplied from the paint reservoir 268 via the paint tube 218 to the paint coupling 42. Further, when the ON/OFF valve 248 of the first valve driving air is opened, air is supplied from the header 202 via the first valve driving air tube 214 and the trigger valve 30 to the trigger valve 30 so that the valve stem 30a thereof is backwardly driven, i.e., moved in the right direction in Figures 1 and 4. Thus, the valve body 94a is disengaged from the inner surface of the tapered portion 112b of the tip member 112 providing a valve seat so that the paint port 112c is opened. Thus, paint is discharged through the orifices 92a via the paint coupling 42, the passage 82, the paint chamber 78, the needle passage 80 the inner passage 102a of the dual-tube assembly 100 and the paint port 112c of the tip member 112.

Note that the air motor 20 can be of a two speed type where the speed is increased when paint is supplied.

In the above-described embodiment, a water film is formed between the paint discharged through the orifices 92a and the distal end face 92b of the rotating bell 92, which would prevent paint clots from depositing on the distal end face 92b of the rotating bell 92.

Further, in a non-painting operation, since the

- 12 -

paint port 112c is closed by the valve body 94a of the needle 94, the clogging of the paint port 112c in the prior art can be avoided.

What is claimed is:

1. A rotary atomizer including a rotating bell secured to a rotating shaft of an air motor held in an atomizer body, the rotating bell defining a plurality of orifices for dispensing a paint toward an object to be painted, the rotation of the rotating bell atomizing the paint so as to spray the paint toward the object to be painted, the rotary atomizer comprising:

a paint passage having a paint port, at a distal end thereof, fluidly communicating with the orifices of the rotating bell;

a water passage, disposed outside of the paint passage, having a water port, at a distal end thereof, fluidly communicating with the orifices of the rotating bell; and

the paint and water being simultaneously dispensed through the orifices.

2. A rotary atomizer according to claim 1, in which the paint passage has a circular section about a longitudinal axis of the rotating shaft of the air motor; and

the water passage having a circular section concentric with the that of the paint passage.

3. A rotary atomizer according to claim 1, further comprising a needle for opening and closing the paint port at the distal end of the paint passage.

4. A rotary atomizer, comprising:

a manifold defining a paint supply passage, an air supply passage and a supply water passage;

an air motor held in a front part of the manifold, the air motor having a rotating shaft rotatable about a predetermined axis, the rotating shaft being rotationally driven by air supplied through the air supply passage;

a double tube assembly including an inner tube extending through the rotating shaft along the axis

and a concentric outer tube having a inner diameter larger than the outer diameter of the inner tube, the outer tube extending through the rotating shaft along the axis so as to define a passage between the outer surface of the inner tube and the inner surface of the outer tube;

5 a rotating bell secured to the rotating shaft to rotate therewith, and defining a plurality of orifices for dispensing a paint toward an object to be painted;

10 the inner tube of the double tube assembly fluidly communicating with the paint supply passage of the manifold and the orifices of the rotating bell;

15 the passage between the inner and outer tubes of the double tube assembly fluidly communicating with the water supply passage of the manifold and the orifices of the rotating bell; and

the paint and water being simultaneously dispensed through the orifices.

20 5. A rotary atomizer according to claim 4, further comprising a pneumatic trigger valve attached to the manifold;

25 the trigger valve including a valve stem movable along the axis of the rotating shaft of the air motor between an open position and a closed position, a needle attached to the valve stem and extending through the inner tube of the double tube assembly, and the needle defining a valve body at the distal end thereof;

30 the double tube assembly further including a tip member attached to the distal end of the inner tube, the tip member defining an annular proximal end and a tapered part, attached to the proximal end, converging in the distal direction; and

35 the tapered part defining, at the distal end thereof, a paint port fluidly communicating with the orifices of the rotating bell, the valve member being sealingly engagable with the inner surface of the tapered

part and extendable from the paint port.

5 6. A rotary atomizer including a rotating bell secured to a rotating shaft of an air motor held in an atomizer body, the rotating bell defining a plurality of orifices for dispensing a paint toward an object to be painted, the rotation of the rotating bell atomizing the paint so as to spray the paint toward the object to be painted, the rotary atomizer comprising:

10 a paint passage having a paint port, at a distal end thereof, fluidly communicating with the orifices of the rotating bell; and

a needle for opening and closing the paint port at the distal end of the paint passage.

15 7. A rotary atomizer according to claim 6, further comprising a water passage, disposed outside of the paint passage, having a water port, at a distal end thereof, fluidly communicating with the orifices of the rotating bell; and

20 the paint and water being simultaneously dispensed through the orifices.

8. A rotary atomizer, comprising:

a manifold defining a paint supply passage, an air supply passage and a supply water passage;

25 an air motor held in a front part of the manifold, the air motor having a rotating shaft rotatable about a predetermined axis, the rotating shaft being rotationally driven by air supplied through the air supply passage;

30 a double tube assembly including an inner tube extending through the rotating shaft along the axis and a concentric outer tube having a inner diameter larger than the outer diameter of the inner tube, the outer tube extending through the rotating shaft along the axis so as to define a passage between the outer surface of the inner tube and the inner surface of the outer tube;

35

a rotating bell secured to the rotating shaft to rotate therewith, and defining a plurality of orifices for dispensing a paint toward an object to be painted;

5 a pneumatic trigger valve attached to the manifold, the trigger valve including a valve stem movable along the axis of the rotating shaft of the air motor between an open position and a closed position, a  
10 needle attached to the valve stem and extending through the inner tube of the double tube assembly; and

the needle defining a valve body, at the distal end thereof, extendable beyond the distal end of the inner tube of the double tube assembly.

9. A rotary atomizer according to claim 8, wherein  
15 the double tube assembly further includes a tip member attached to the distal end of the inner tube, the tip member defining an annular proximal end and a tapered part, attached to the proximal end, converging in the  
distal direction; and

20 the tapered part defining, at the distal end thereof, a paint port fluidly communicating with the orifices of the rotating bell, the valve member being sealingly engageable with the inner surface of the tapered part and extendable from the paint port.

25 10. A rotary atomizer according to claim 9, wherein the inner tube of the double tube assembly communicates with the paint supply passage of the manifold and the orifices of the rotating bell;

30 the passage between the inner and outer tubes of the double tube assembly fluidly communicating with the water supply passage of the manifold and the orifices of the rotating bell; and

the paint and water being simultaneously dispensed through the orifices.

Fig.1

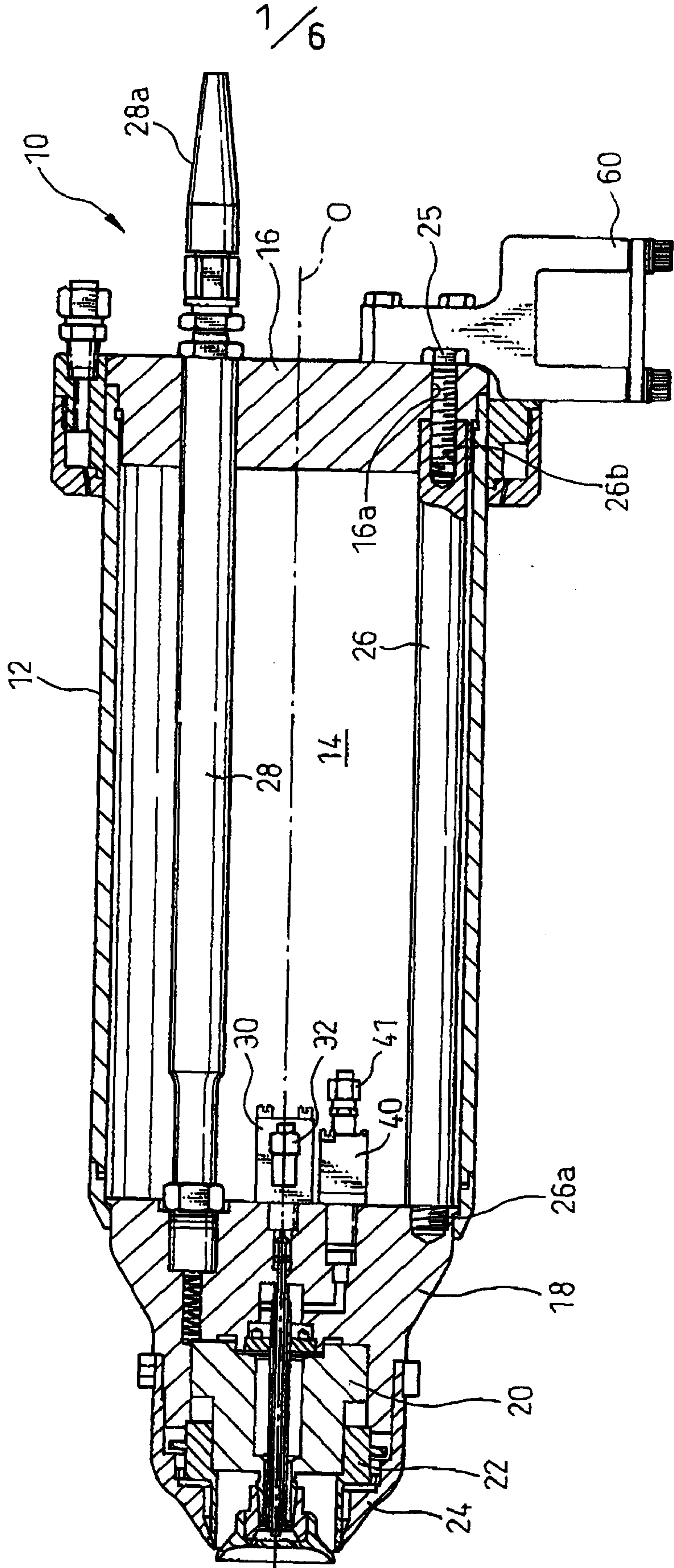
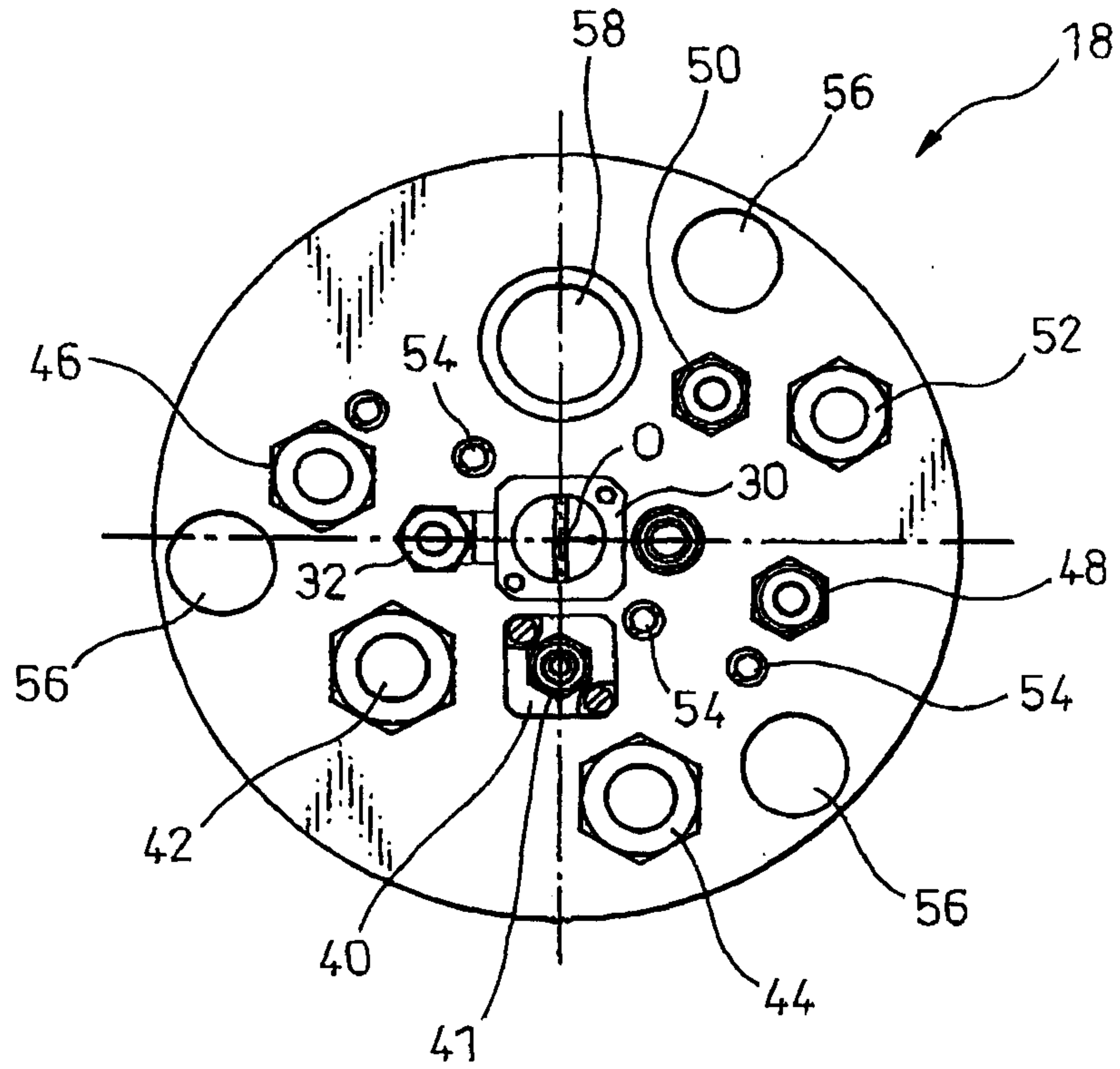
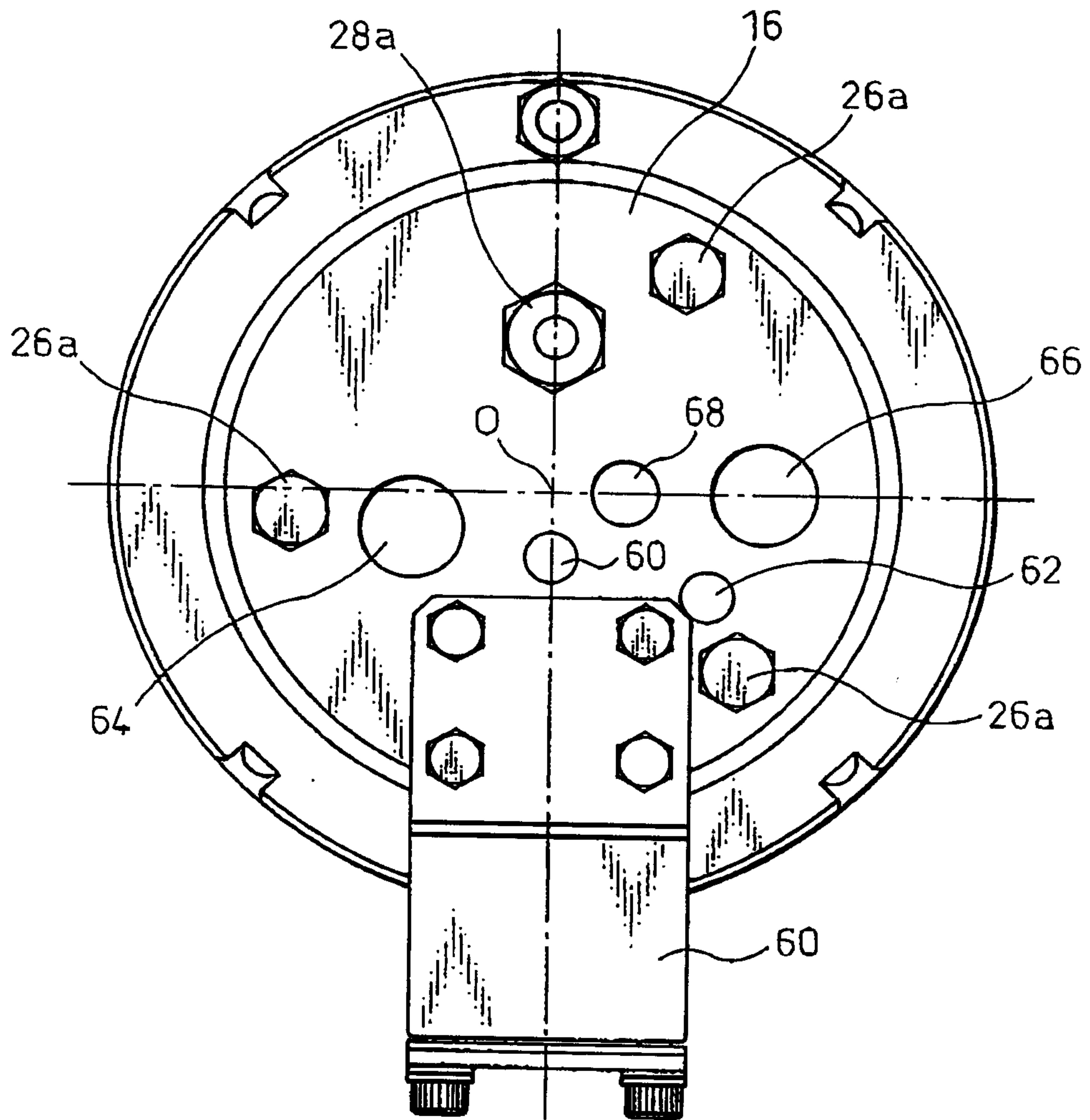


Fig. 2



3/6

Fig. 3



4/6

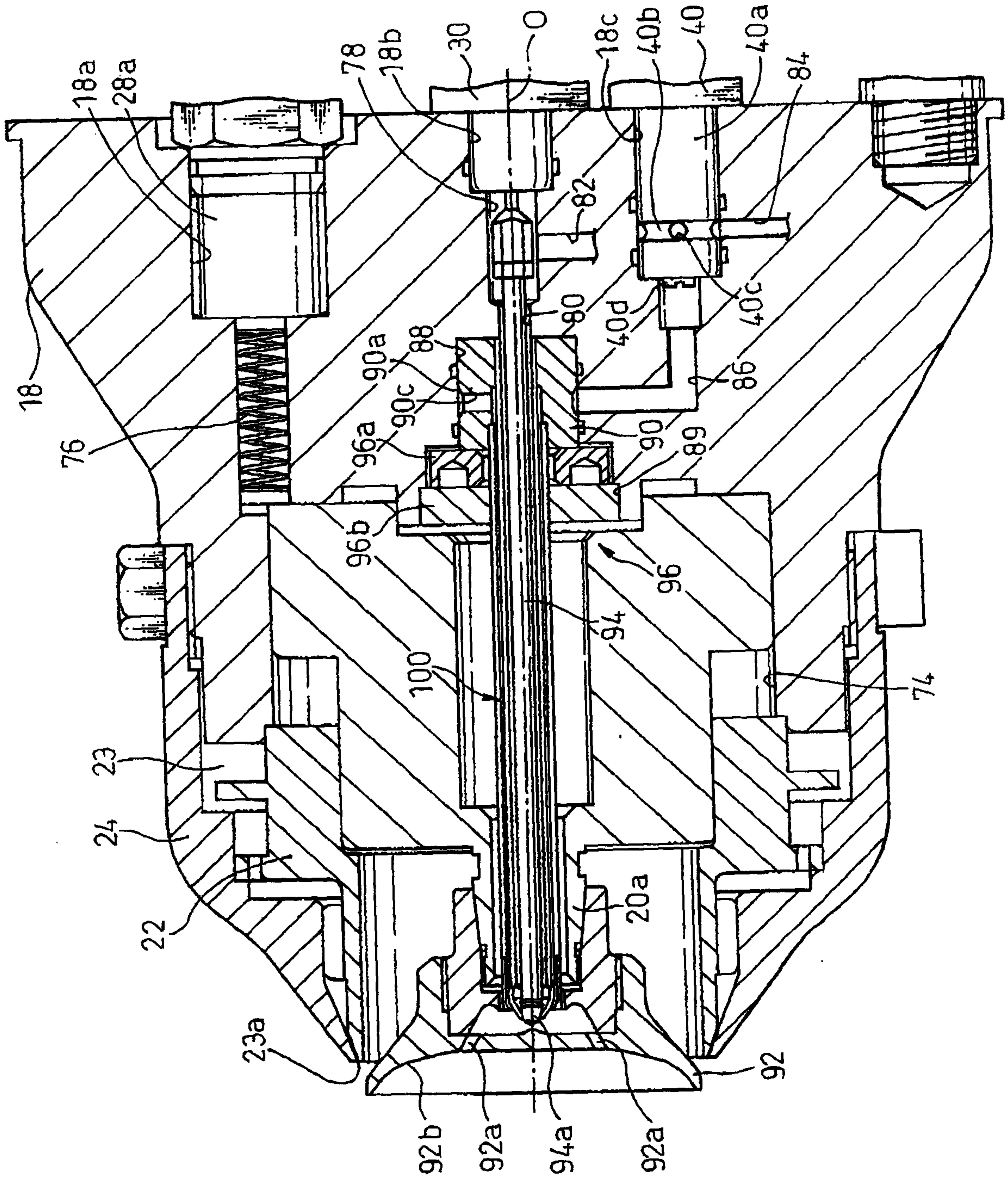


Fig. 4

Fig. 5

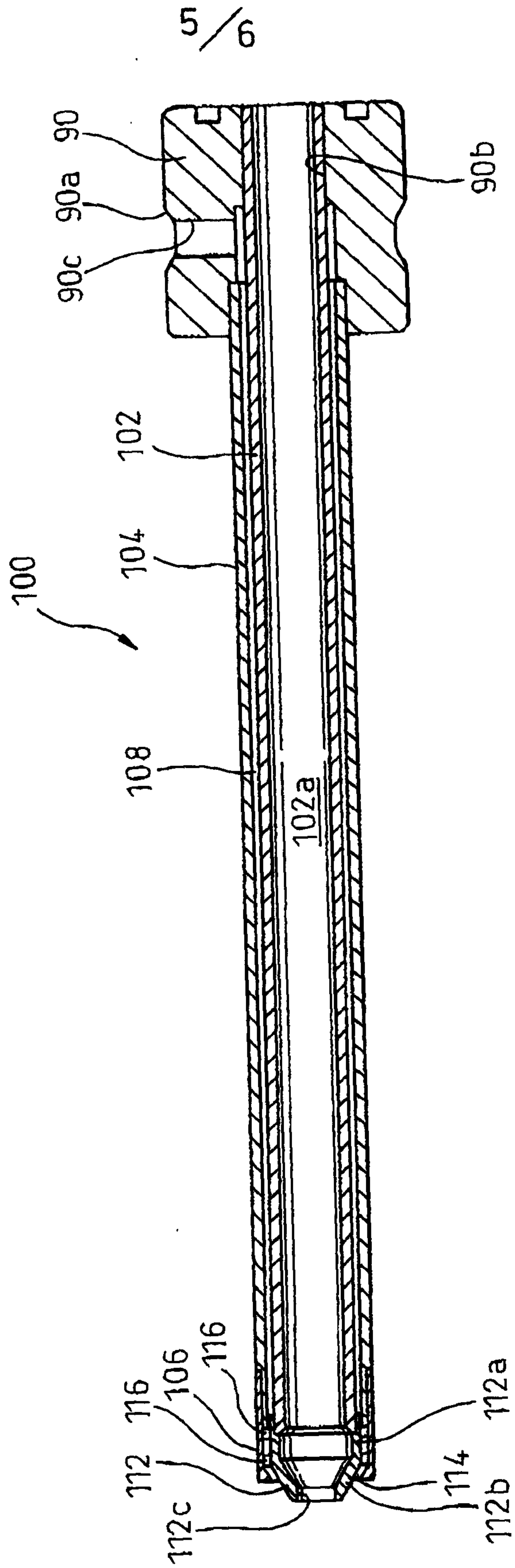


Fig.6

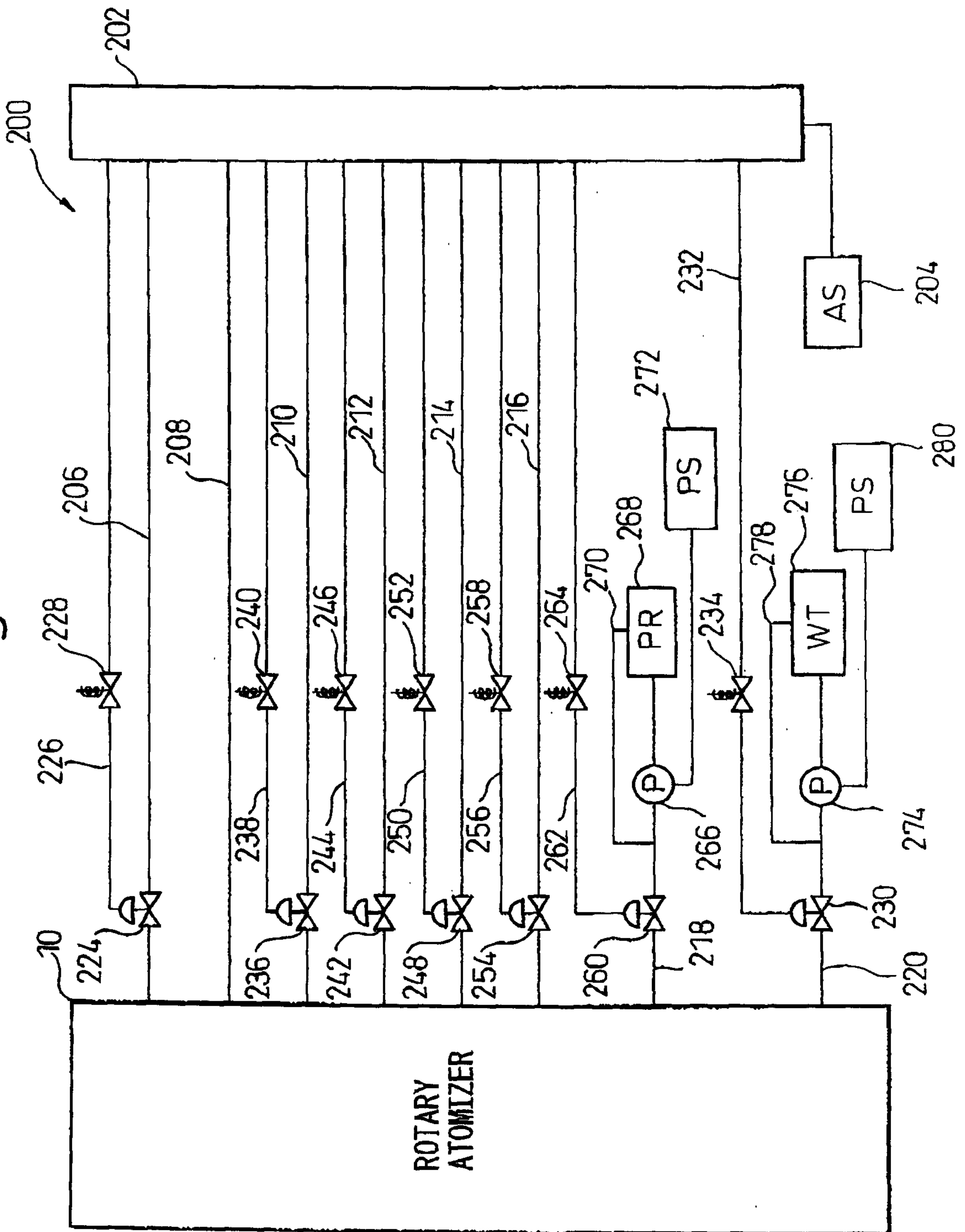


Fig. 4

