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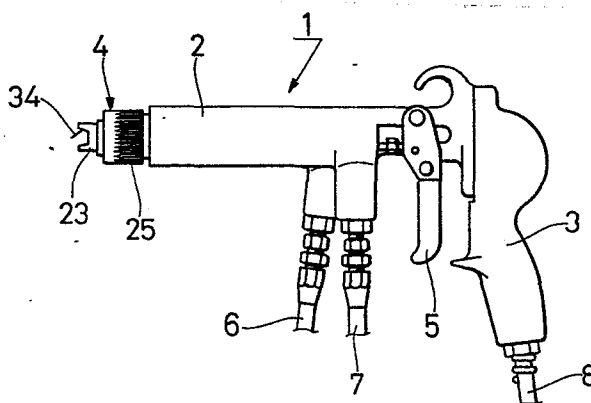
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54 **Electrostatic spray nozzle.**

57 An electrostatic spray nozzle including: a paint nozzle having a labial paint spout hole for spurting a paint under pre-determined liquid pressure; an air nozzle having an air blow hole forwardly of the paint spout hole for blowing air streams toward the spurting paint to accelerate atomization of the paint; and a needle electrode located forward of the air spout hole and applied with a high voltage to charge the atomized particles of the paint which is spurting from the paint spout hole is accelerated by pressurized air streams from the air spout hole, while preventing the tailing phenomenon. The atomized paint particles are charged by passage through an ionizing zone which is formed around the needle electrode, thereby promoting the efficiency of paint deposition and at the same time the efficiency of paint atomization by the electrostatic atomizing action.



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DESCRIPTIONElectrostatic Spray Nozzle

This invention relates to an electrostatic spray nozzle for electrostatically coating a work with a paint by applying a high voltage to the paint along with jets of pressurized air.

5 There has thus far been known in the art the so-called airless type spray nozzle which is adapted to spurt a paint under a predetermined pressure toward a work from a labial paint spout hole provided in a paint nozzle. However, the airless type spray nozzle of this
10 sort usually requires to pressurize a paint up to a high liquid pressure level of about 100 - 300 kg/cm², so that there arises a necessity for employing a paint pump and a hose which can endure a high liquid pressure, coupled with a problem that the paint spout hole is
15 considerably worn out by the liquid flows of high velocity. In addition, the conventional airless type spray nozzle has a problem that the so-called "tailing phenomenon" appears at the opposite ends of a paint spray pattern, which impairs the quality of coating.

20 In an attempt to solve these problems, there have been proposed a variety of spray nozzles in which pressurized air of about 0.5 - 5 kg/cm² is blown from behind a paint spout hole toward paint jets spurted from the paint spout hole for the purpose of promoting the
25 efficiency of paint atomization and preventing the

tailing phenomenon even if the paint pressure is at a relatively low level of about 30 - 100 kg/cm².

However, in the above-mentioned prior art nozzles, the air blow hole is provided rearward or
5 sideward of a paint spout hole in order not to disturb the paint jets from the paint spout hole, so that there is still a problem that it is difficult to collide the air streams against the paint jets in a sufficient degree, resulting in a low atomization efficiency.
10 Further, in case where an air blow hole is provided forward of the paint spout hole, there is also a problem that jet streams of the paint are wastefully scattered away, failing to coat a workpiece in a sufficient degree and thus lowering the efficiency of paint deposition.

15 The present invention aims at elimination of the above-mentioned defects or problems of the prior art, and has as its object the provision of an electrostatic spray nozzle which can form a coating of high quality with a high efficiency.

20 It is another object of the present invention to provide an electrostatic spray nozzle which can enhance the efficiency of paint atomization and prevent the tailing phenomenon in a reliable manner.

It is still another object of the present
25 invention to provide an electrostatic spray nozzle which can improve the efficiency of paint deposition on a workpiece by effectively charging paint particles.

According to the present invention, in order to achieve the above-mentioned objects, there is
30 provided an electrostatic spray nozzle which is characterized by the provision of: a paint nozzle having a labial paint spout hole for spurting a paint under predetermined liquid pressure; an air nozzle having a labial air blow hole forwardly of the paint
35 spout hole for blowing air streams toward the paint

spurted from the paint spout hole to accelerate atomization of the paint; and a needle electrode located forward of the air spout hole and applied with a high voltage for electrically charging the atomized particles
5 of the paint sprayed by the air jets.

The above and other objects, features and advantages of the present invention will become apparent from the following description and the appended claims, taken in conjunction with the accompanying
10 drawings which show by way of example some preferred embodiments of the invention.

In the accompanying drawings:

Figure 1 is a schematic side view of a hand gun type electrostatic sprayer incorporating the
15 electrostatic spray nozzle according to the present invention;

Figure 2 is an enlarged vertical sectional view of the electrostatic spray nozzle of Figure 1;

Figure 3 is a front view of the electrostatic
20 spray nozzle, seen from the left side of Figure 2;

Figure 4 is a schematic side view of an auto gun type electrostatic sprayer incorporating the electrostatic spray nozzle according to the present
invention;

Figure 5 is a view similar to Figure 2 but
25 showing the details of the electrostatic spray nozzle in the second embodiment of Figure 4;

Figure 6 is a front view of the electrostatic
spray nozzle, seen from the left side of Figure 5;

Figure 7 is a view similar to Figure 2 but
30 showing a third embodiment of the present invention; and

Figure 8 is a front view of the electrostatic
spray nozzle of Figure 7.

Referring to Figure 1, there is shown by way
35 of example a hand gun type electrostatic sprayer

employing the spray nozzle according to the present invention, wherein indicated at 1 is the hand gun type electrostatic sprayer including a nozzle body 2 internally provided with a paint passage and an air passage as described later, a handle 3 provided at one end of the nozzle body 2, an electrostatic spray nozzle 4 provided at the other end of the nozzle body 2 in the manner as explained later with reference to Figures 2 and 3, a trigger 5 for manual operation located between the nozzle body 2 and handle 3 for manually opening and closing the paint and air passages, a paint hose 6 and an air hose 7 connected to the nozzle body 2, and a high voltage cable 8 for receiving a supply of high voltage from a high voltage generator (not shown).

As seen in Figures 2 and 3 which show details of the electrostatic spray nozzle 4 of Figure 1 in an enlarged vertical section and a left-hand end view, respectively, the nozzle body 2 is internally provided with a paint passage 11 which communicates with the paint hose 6 and an air passage 12 which communicates with the air hose 7 and an annular groove 13 is formed on an end face 2A of the nozzle body 2. On the other hand, provided in and along the paint passage 11 is a valve rod 14 which has one end thereof connected to the trigger 5 and has a valve member 15 mounted at the other end, so that the valve member 15 is moved toward and away from a valve seat 16 by manipulation of the trigger 5 to open and close the paint passage 11, in synchronism with another valve mechanism which is also operated by the trigger 5 to open and close the air passage 12.

Designated at 17 is a nozzle holder which is provided on the end face 2A of the nozzle body 2, the nozzle holder 17 being formed in a semi-spherical shape and provided with a plural number of axial air passages 18 in communication with the annular passage 13. An

intermediate seat member 19 of a resilient material such as Teflon and the like which is fitted in the nozzle holder 17 is centrally provided with an axial paint passage 20 in communication with the paint passage 11.

5 The reference numeral 21 denotes a paint nozzle which is fitted in the nozzle holder 17 with its distal spherical portion 21A projected forwardly out of the nozzle holder 17. The paint nozzle 21 is retained in position by the intermediate seat member 19, gripped
10 between the intermediate seat member 19 and the nozzle holder 17. The paint nozzle 21 is provided with a labial paint spout hole 22 which is formed by cutting the spherical portion 21A in V-shape in section. A paint which is supplied through the paint passages 14
15 and 20 is spurted from the paint spout hole 22 in the form of a jet stream of sectoral shape.

Designated at 23 is an air nozzle which is formed with a concave surface 24 on one side thereof, and located in such a manner as to circumvent the paint
20 nozzle 21 as well as the nozzle holder 17. Upon tightening a nut 25 relative to the nozzle body 2, the air nozzle 23 is gripped between the end face 2A of the nozzle body 2 and the nut 25, while shoulders 17A of the nozzle holder 17 are abutted on the concave surface 24,
25 gripping the nozzle holder 17 between the concave surface 24 and the end face 2A and thus as a whole securing the nozzle holder 17 and air nozzle 23 to the nozzle holder 2.

The air nozzle 23 is formed with a labial air
30 blow hole 26 at a position forward of the distal spherical portion 21A of the paint nozzle 21. The air blow hole 26 is formed by cutting a groove of V-shape 27 across a center plateau 23A (see Figure 3) to define a labial opening between the V-shaped groove 27 and the
35 concave surface 24. The angle θ of the V-groove 27 is

set at the same value as the V-shaped labial paint spout hole 22.

On the other hand, an annular groove 28 which communicates with the air passage 18 is formed between
5 the outer peripheral surface of the nozzle holder 17 and the spherical concave surface 24 of the air nozzle 23, and the nozzle holder 17 is provided with a head portion 17B of a diameter which is reduced toward the air blow hole 26 and smaller than the abutting shoulder portion
10 17A, defining an air passage 29 between the head portion 17B and the spherical concave surface 24 around the entire circumference of the head portion 17B. Upon feeding pressurized air successively through the air passage 12, annular groove 13, air passage 18 and
15 annular groove 28 and from the air passage 29 to the air blow hole 26, the jet stream of the paint which is spurted from the paint spout hole 22 is wrapped in air streams thereby accelerating atomization of the paint and preventing the tailing phenomenon.

20 Further, indicated at 30 is a high resistance which is provided in the nozzle body 2 for safety purposes, one end of the high resistance 30 being connected to the high voltage cable 8 and the other end to a conductor 31 which is extended to the end face 2A
25 of the nozzle body 2. Denoted at 32 is a conductor which is embedded in the air nozzle 23 and has one end thereof connected to the conductor 31 through a connecting spring 33, forming a needle electrode 34 at the other end which is projected from a horn portion 23B
30 of the air nozzle 23 at a position forward of the air blow hole 26. Upon applying a high voltage to the needle electrode 34 through the high voltage cable 8, high resistance 30, conductor 31, spring 33 and conductor 32, air around the needle electrode 34 is
35 ionized and a corona zone is formed there, charging

atomized particles sprayed from the air blow hole 26 to a potential of the same polarity as the applied voltage, and, in case where the needle electrode 34 or the horn portion 23B is of a metal, flying the atomized paint particles along lines of electric force formed between the distal end of the electrode or horn and a workpiece to deposit the paint thereon.

According to the nozzle construction of the invention as described above, the valve 15 is opened by manipulation of the trigger 5 to supply a paint from the hose 6 to the paint nozzle 21 under a pressure of, for example, 50 kg/cm^2 through the paint passages 11 and 20, shooting the paint toward the air blow hole 26 from the paint spout hole 22 in the form of a jet stream of sectoral shape of the angle θ . By manipulation of the trigger 5, the air passage 12 is also opened, and pressurized air from the air hose 7 is supplied to the air nozzle 23 under a pressure of, for example, 2 kg/cm^2 through the air passage 12, annular groove 13, air passage 18, annular groove 28 and air passage 29, spurting from the air blow hole 26 an air stream of sectoral shape of the angle θ .

In this instance, as the jet stream of the paint which is spurting under a high pressure from the paint spout hole 22 breaks through the air stream of low pressure during its trip forward of the paint spout hole 22, its atomization is accelerated by contact with air. Besides, the air stream wraps in the jet stream of the paint as a whole after leaving the paint nozzle, preventing disturbances of the shape of spray pattern as well as the occurrence of the tailing phenomenon in a reliable manner. In this connection, it is to be noted that the paint spout hole 22 and air blow hole 26 are formed by V-shaped grooves of the same angle, so that the paint which is spurting out from the paint spout hole

22 is securely guided toward the air blow hole 26, without spoiling the air nozzle by depositing on the spherical concave surface 24 on the inner side of the air nozzle, especially the marginal edge portions of the
5 air blow hole 26.

Further, the needle electrode 34 which is located forward of the air blow hole 26 is applied with a high voltage, for example, a voltage of minus 90 KV through the high voltage cable 8, high resistance 30,
10 conductor 31, spring 33 and conductor 32. Therefore, air around the needle electrode 34 is negatively ionized, forming an ionized zone therearound, so that the paint particles are negatively charged as they pass through the ionized zone and urged to fly toward a
15 workpiece along lines of electric force. Consequently, the charged paint particles are caused to go around even to the back side of the workpiece, enhancing the efficiency of paint deposition to a considerable degree.

The paint spray nozzle according to the
20 present invention is not limited to a hand gun type sprayer and may be applied to an auto gun type electrostatic sprayer 41 as shown in Figure 4. In this case, the electrostatic sprayer 41 employs a nozzle body 42 which is internally provided with an air drive type
25 valve operating mechanism instead of a manual trigger. In a manner similar to the foregoing embodiment, the nozzle body 42 is provided with an electrostatic spray nozzle 4, a paint hose 6 and an air hose 7. Further, the nozzle body 42 is provided with an arm 43 to be
30 attached to a reciprocator or the like, mounting on the arm 43 an attaching bracket 44 and a high voltage cable 8. In the case of the auto gun type electrostatic sprayer 41, the nozzle body 42, the paint spray nozzle 6 and the like may be formed of a conductive metal if
35 desired.

Referring now to Figures 5 and 6, there is shown a second embodiment of the invention, which is arranged to prevent deposition of paint on the center plateau 123A of the air nozzle 123, namely, on the surface 123B which faces a workpiece.

More particularly, if pressurized air is blown off from the air blow hole 126 along with paint particles, a negative pressure appears around the air stream, producing vortical flow of air there. Accordingly, there is a possibility of the paint particles being trapped in the vortical flow and caused to flow in a reverse direction toward the plateau surface 123B which faces the workpiece. In order to prevent such reverse flow of paint particles, the air nozzle 123 is provided with a plural number of air holes 135 in the center plateau 123A for blowing off paint purge air therefrom. Each air hole 135 is opened at one end into an air passage 129 and at the other end into the plateau face 123B which faces the workpiece. As shown particularly in Figure 6, a plural number of air holes 135 are arranged in parallel rows which are located on opposite sides of the V-shaped groove 127. In this instance, since the air holes 135 are communicated with the air passage 129, pressurized air is blown off not only from the air blow hole 126 but also from the air holes 135 during a coating operation to send forth paint purge air therefrom.

Consequently, the paint purge air suitably prevents paint deposition on the end face 123B as well as spitting, contributing to the improvement in quality of coated products and to the reduction of the washing time of the paint spray nozzle.

The construction and operational effects which are not mentioned in particular in the foregoing description, especially the electrostatic atomization of

the paint, are same as in the first embodiment, and therefore the description in this regard is omitted to avoid unnecessary repetition.

If desired, paint purge air may be supplied in
5 the manner as shown in Figures 7 and 8. Namely, a semi-circular projection 223D may be provided on the plateau surface 223B of the air nozzle which faces a workpiece, on one side of the opposing horn portions 223C and 223C' (on the left side in the case of Figure
10 8) and across the V-shaped groove 227, the semi-circular projection 223D having a height greater than the height in the axial direction of the plateau surface 223B but smaller than the height of the horn portions 223C and 223C' and being provided with a straight or upright wall
15 223E on the side of the horn portions 223C and 223C'. The air nozzle 223 is likewise provided with a pair of paint purge air holes 235 on the opposite sides of the V-groove 227. Each paint purge air hole 235 is opened at one end thereof into the air passage 229 and has the
20 other end curved in the semi-circular projection 223 and opened on the upright wall 223E (see Figure 7).

With this arrangement, the paint purge air can be blown off from the air holes 235 substantially in a direction parallel with the plateau surface 223B, so
25 that the plateau surface 223B can be constantly covered with paint purge air during operation, preventing the deposition of paint particles on the plateau surface 223B which would otherwise be caused by vacuum pressure developing around the air stream from the air blow hole
30 226.

Although the labial paint spout hole and the labial air blow hole have been described in the foregoing embodiments as being formed by cutting a V-shaped groove in the distal spherical portion of the
35 paint nozzle and the center plateau of the air nozzle,

respectively, they may be formed by a groove of U-shape
in section if desired. Further, instead of providing a
needle electrode on one horn portion, a pair of needle
electrodes may be provided on the radially opposing two
5 horn portions. When the paint spray nozzle of the
invention is applied to a hand gun type electrostatic
sprayer, it is preferred from the standpoint of safety
to use a synthetic resin with an insulating property for
the nozzle body, nozzle holder, air nozzle, cap and the
10 like.

Although the invention has been described in
terms of specific embodiments, it is to be understood
that other forms of the invention may readily adapted
with the scope of the invention.

CLAIMS

1. An electrostatic spray nozzle, comprising in combination:
 - a paint nozzle provided with a labial paint spout hole;
 - 5 an air nozzle provided with a labial air blow hole at a position forward of said paint spout hole for blowing off air stream toward jet stream of paint spurting from said paint spout hole; and
 - a needle electrode located forward of said air
 - 10 blow hole and applied with a high voltage for charging atomized paint particles sprayed from said air blow hole.
2. An electrostatic spray nozzle as set forth in
- 15 claim 1, wherein said air nozzle is provided with a spherical concave surface on the inner side thereof to accommodate said paint nozzle therein, defining an air passage between said spherical surface and said paint nozzle around the entire circumference thereof.
- 20
3. An electrostatic spray nozzle as set forth in claim 1, wherein said paint spout hole and air blow hole are formed by grooves of V- or U-shape in section, said V- or U-shaped grooves being formed in an identical
- 25 form.
4. An electrostatic spray nozzle as set forth in claim 1, wherein said air nozzle is provided with paint
- 30 purge air holes to prevent paint deposition on an air nozzle surface facing a work to be coated.
5. An electrostatic spray nozzle as set forth in

claim 4, wherein said air holes are provided in positions around said labial air blow hole.

6. An electrostatic spray nozzle as set forth in
5 claim 4, wherein said air holes are opened in a direction parallel with an air nozzle surface facing said work.

Fig. 1

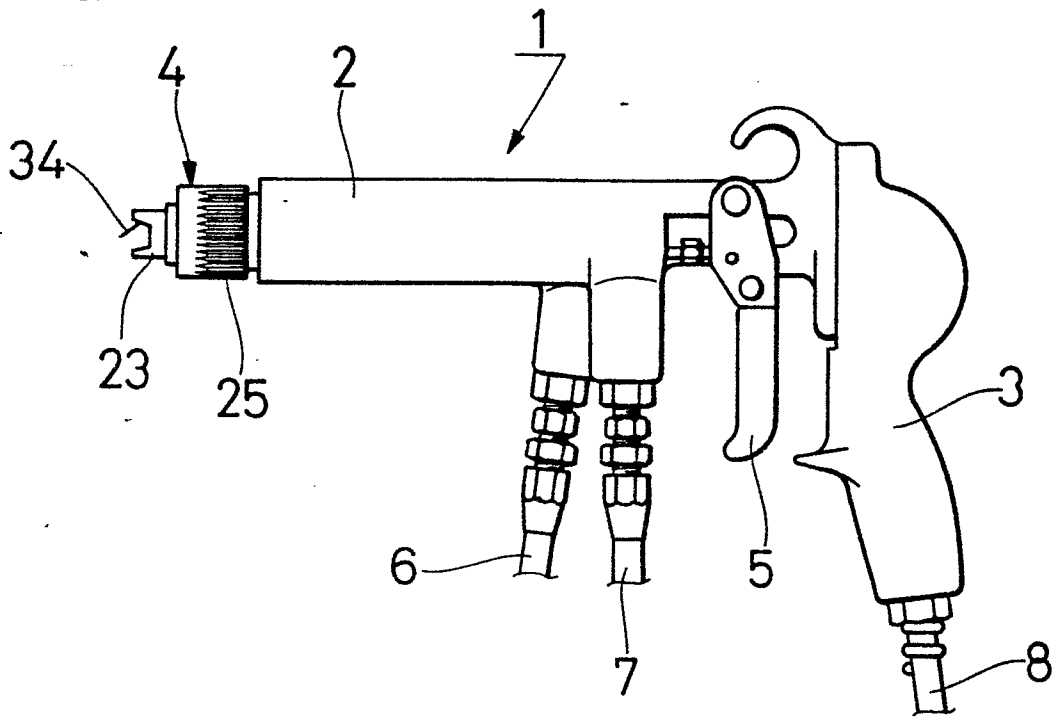


Fig. 2

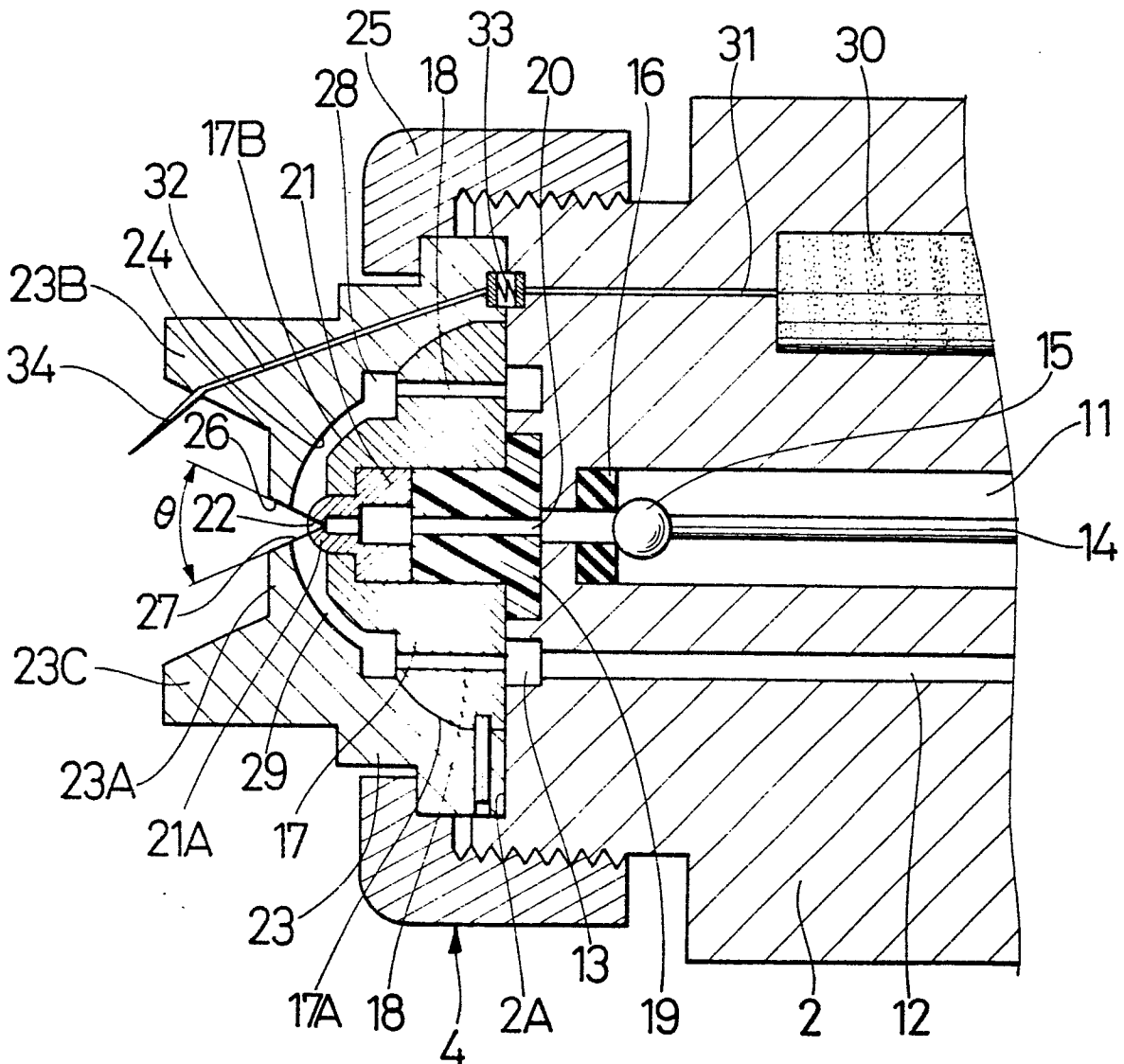


Fig. 3

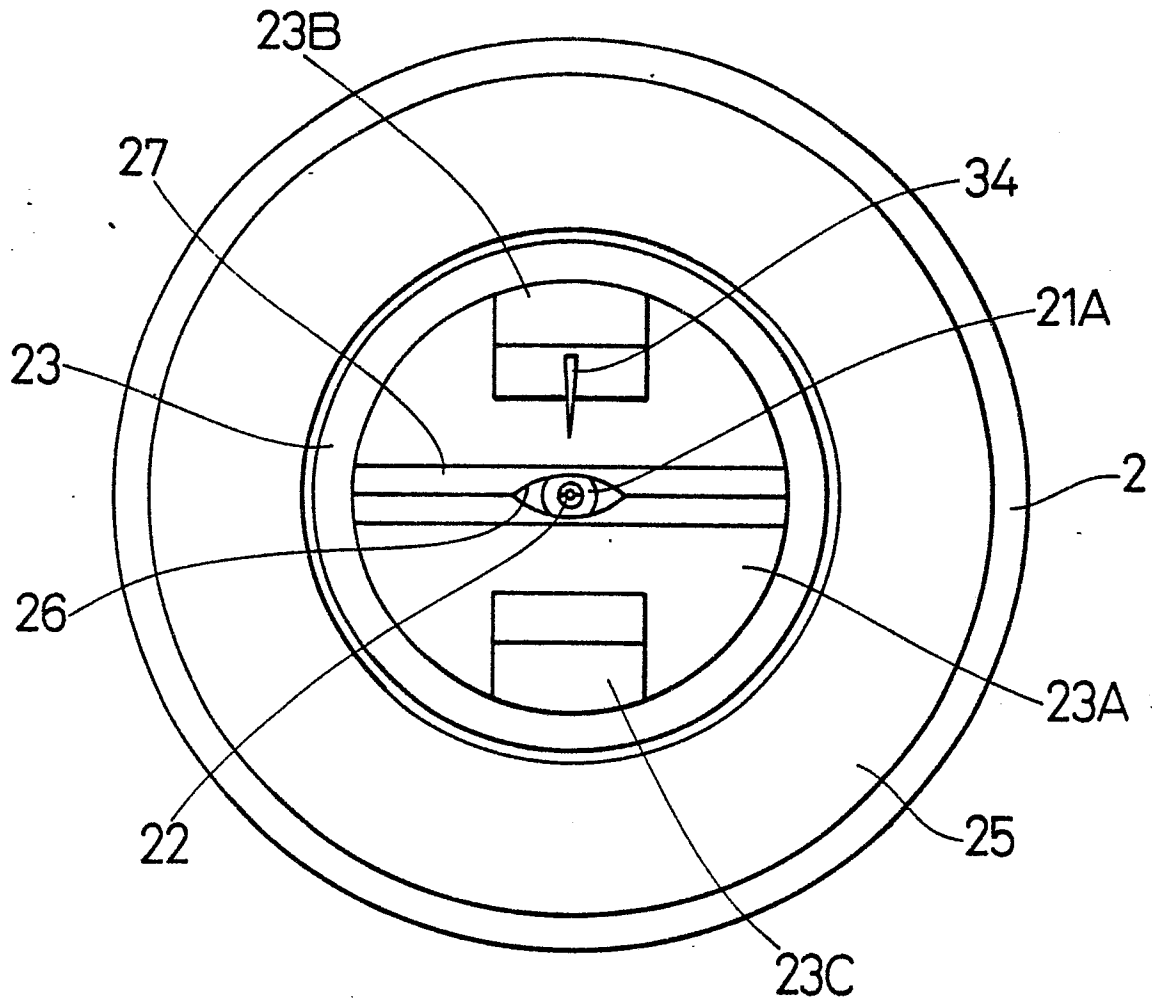


Fig. 4

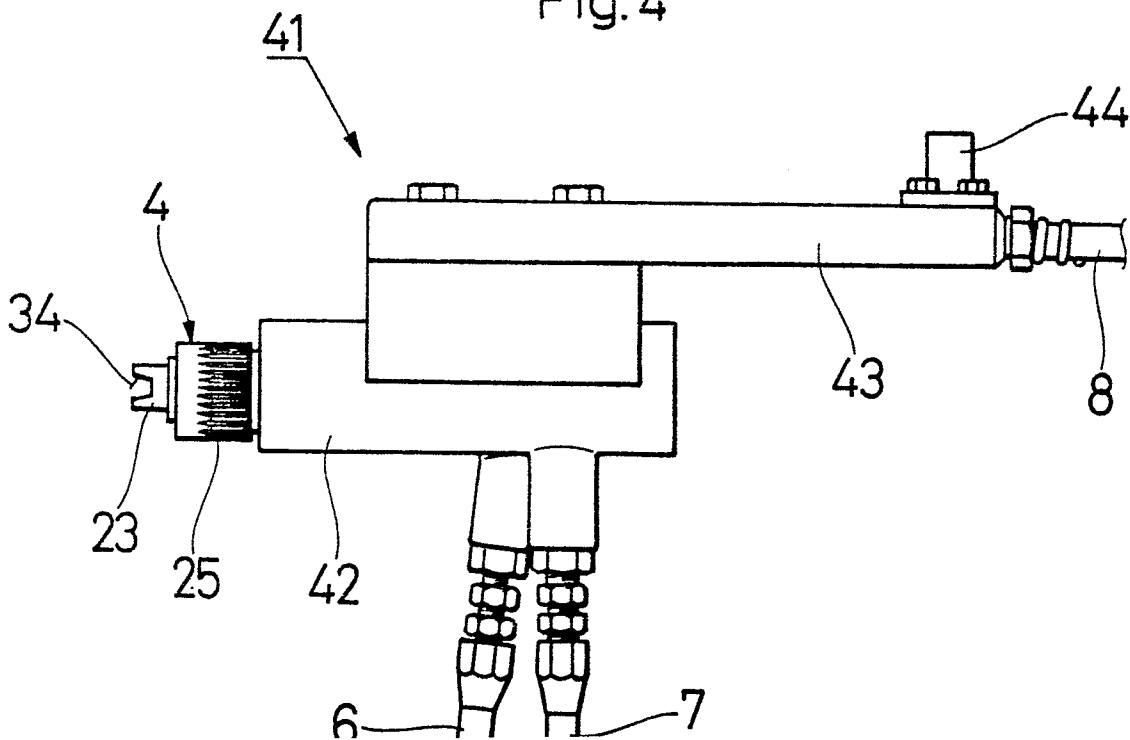


Fig. 5

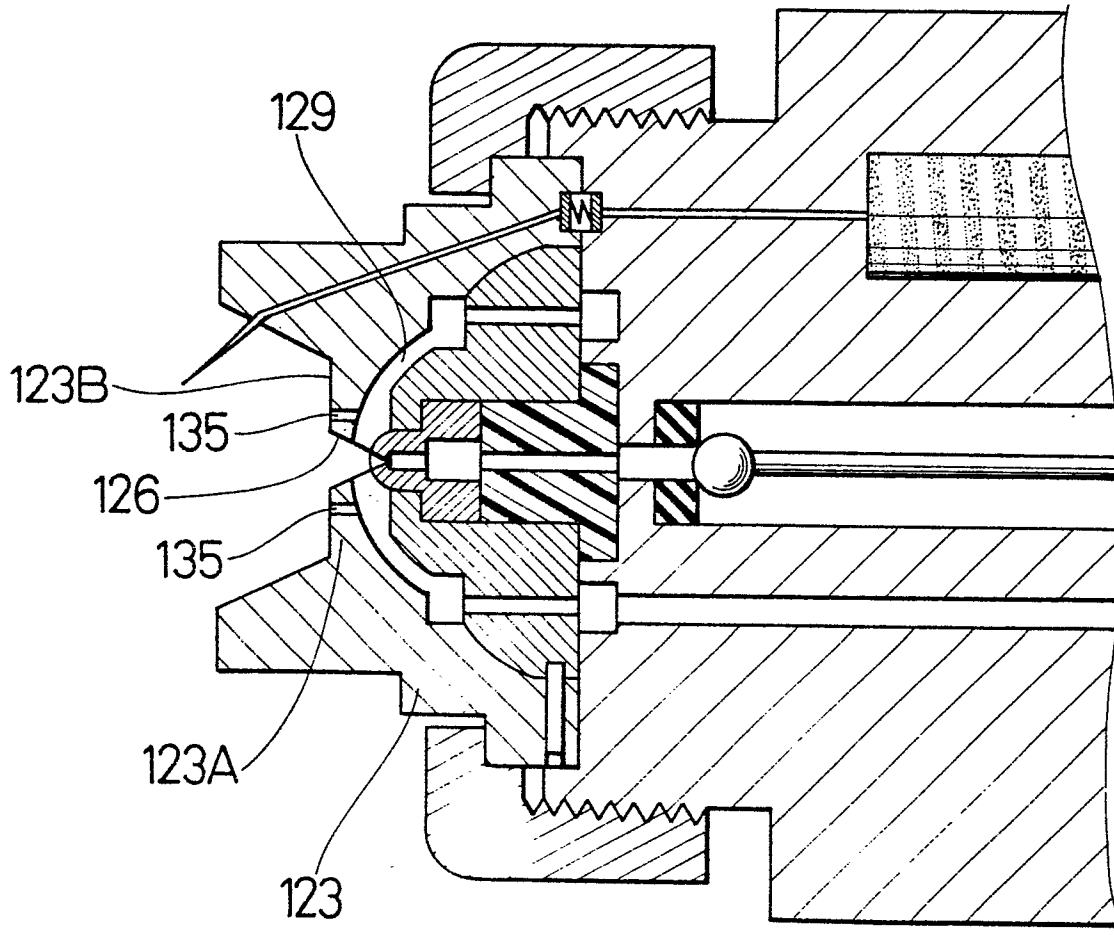


Fig. 6

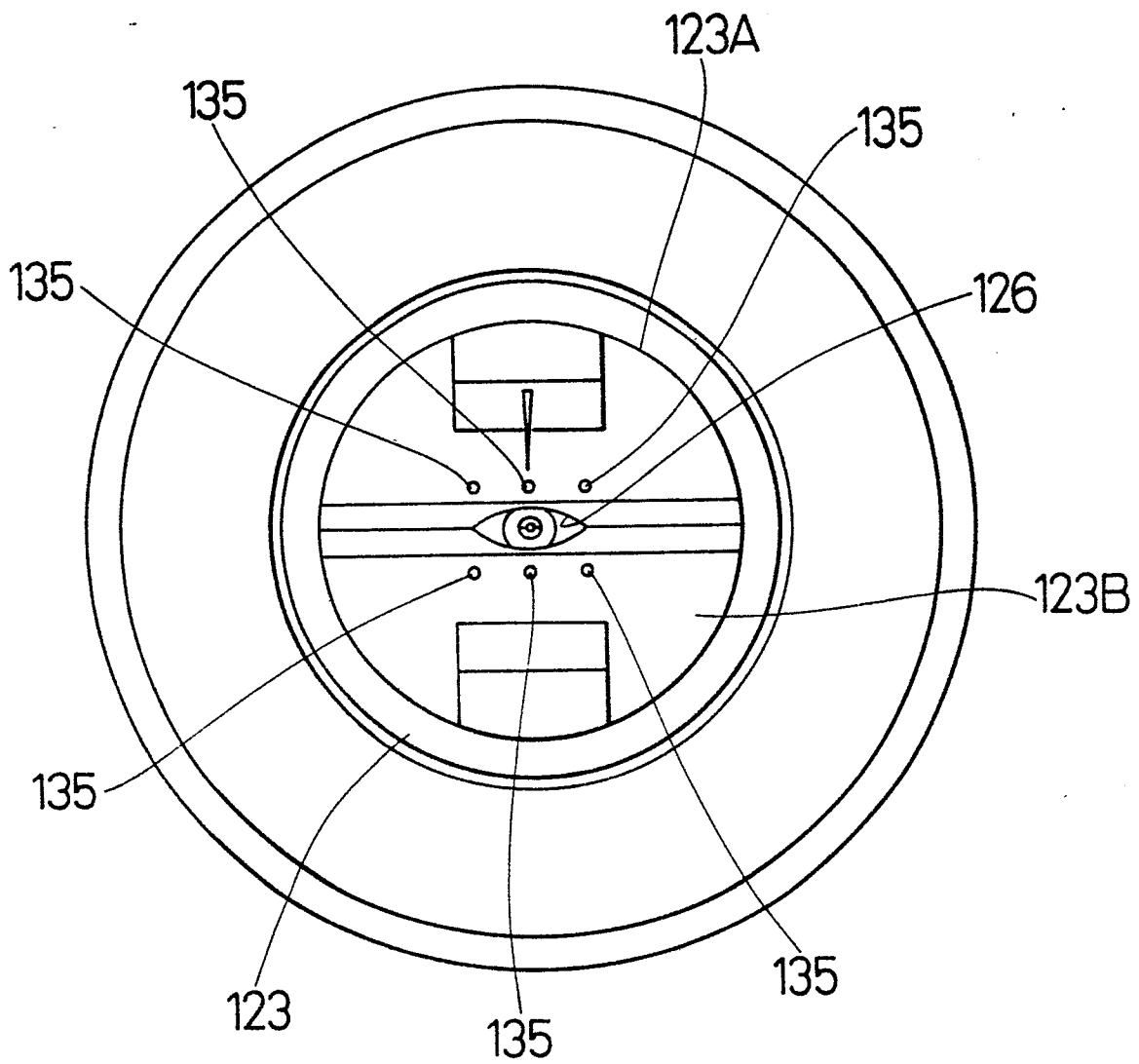
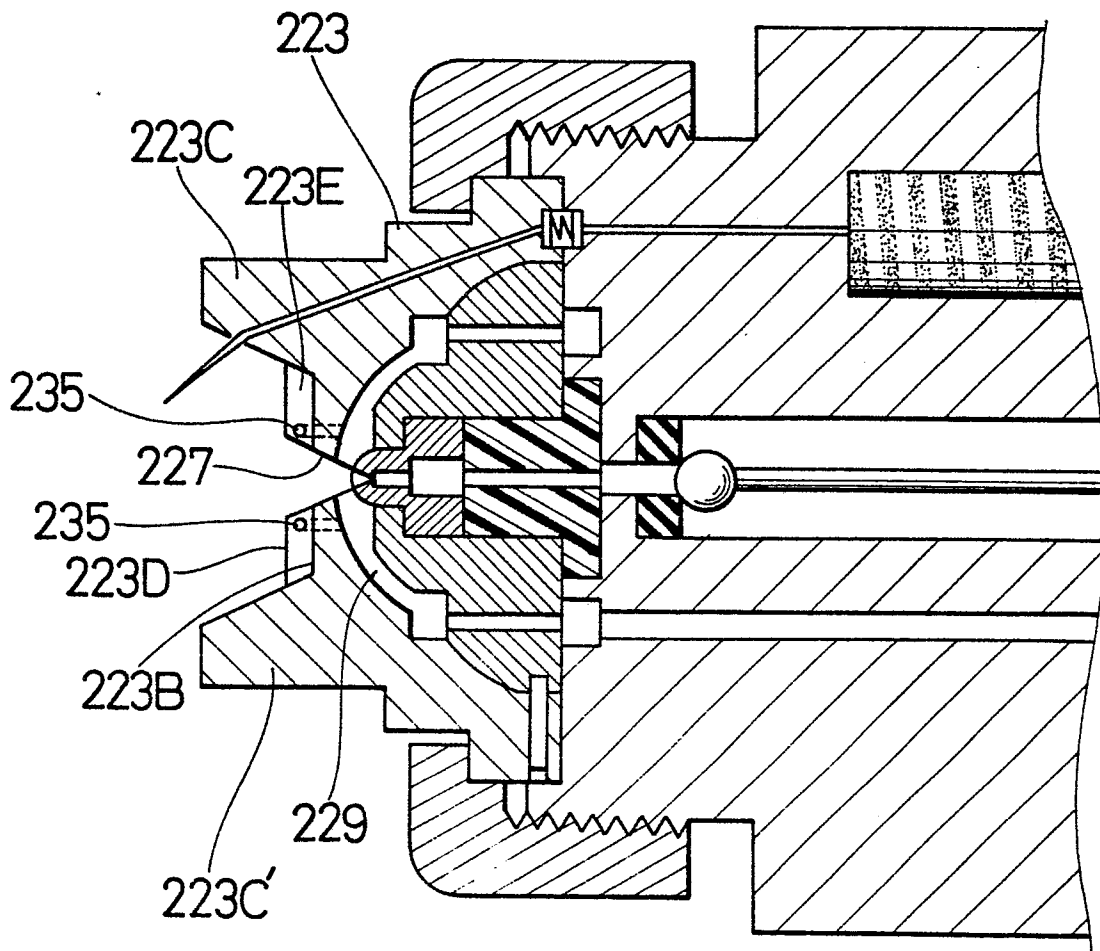


Fig. 7



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Fig. 8

