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U1S S1004 S1635

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GB 2157592 A **GB 1312052 A** **GB 0721421 A**

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(54) Liquid-spraying nozzles

(57) A liquid-spraying nozzle has a lower inner peripheral face 2 substantially coaxial with a nozzle axis P and a laterally-elongate orifice 3 extending substantially normal to the nozzle axis. An inner peripheral face 4, upstream of the lower peripheral face 2, has a larger inner diameter so providing a stepped portion 4*a* between the peripheral faces 2, 4. A pair of opposed elongated grooves 5 are provided in the lower peripheral face 2. Each elongated groove 5 has a downstream end relative to the spraying direction extending to the vicinity of the orifice 3 and an upstream end opened at the stepped portion 4*a*.

FIG.2

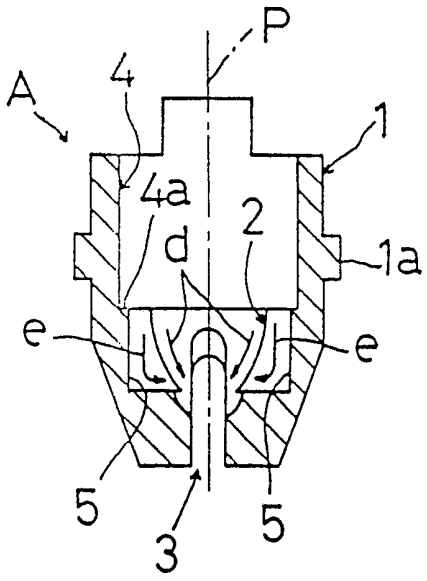

FIG.3

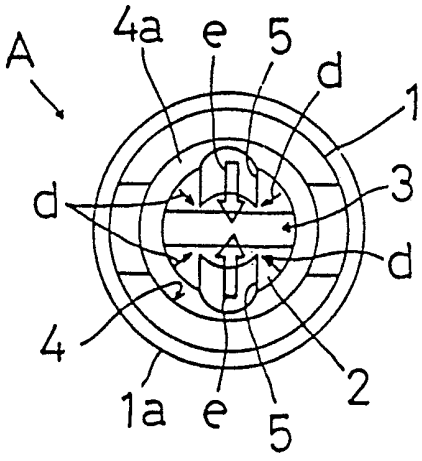

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FIG.1

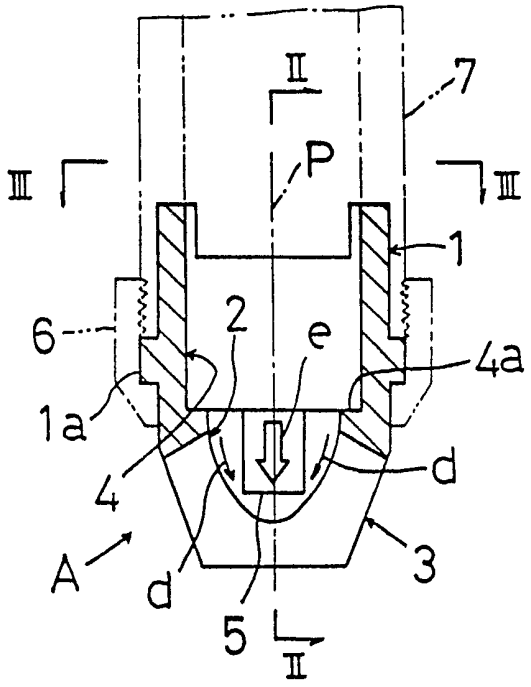


FIG.2

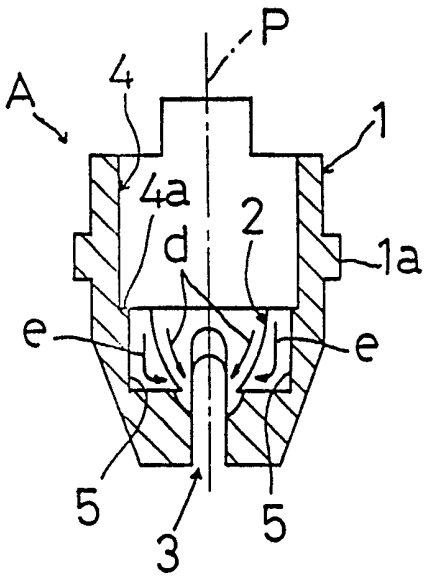


FIG.3

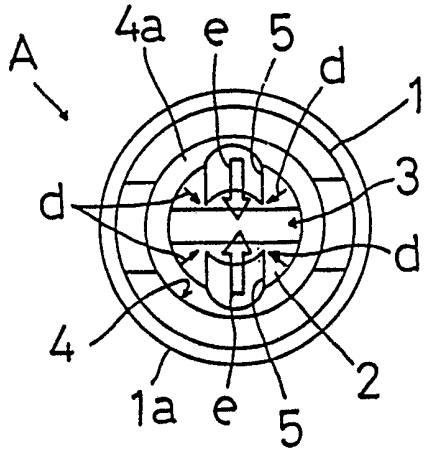


FIG.5

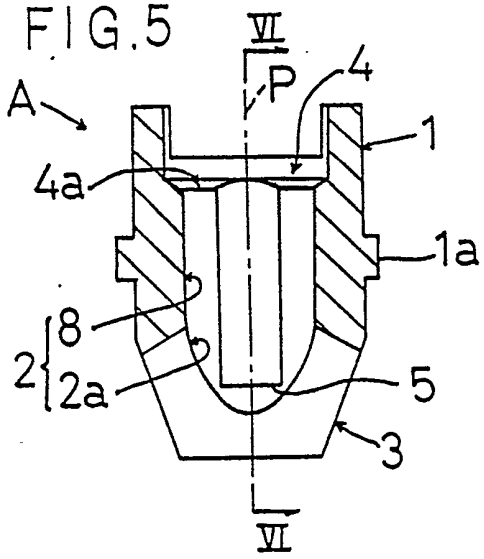


FIG.6

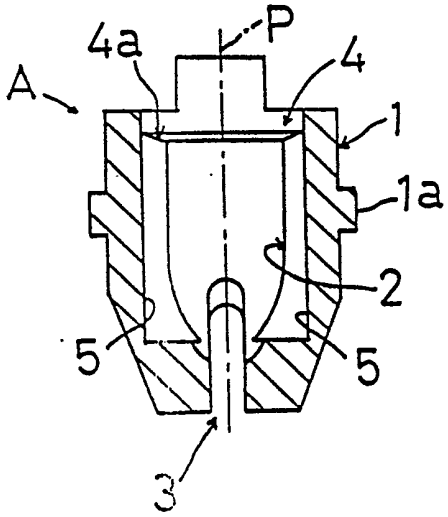


FIG.8

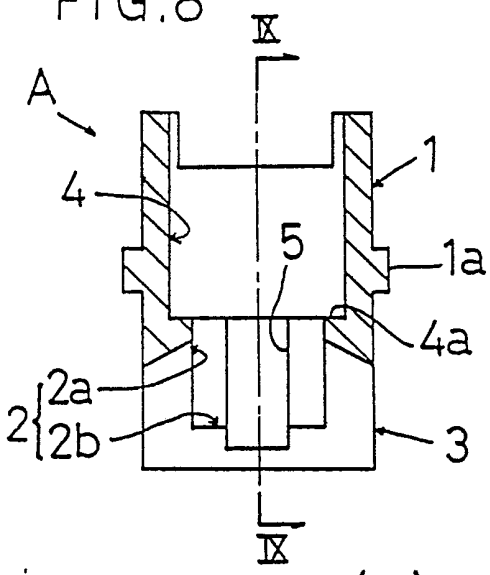


FIG.9

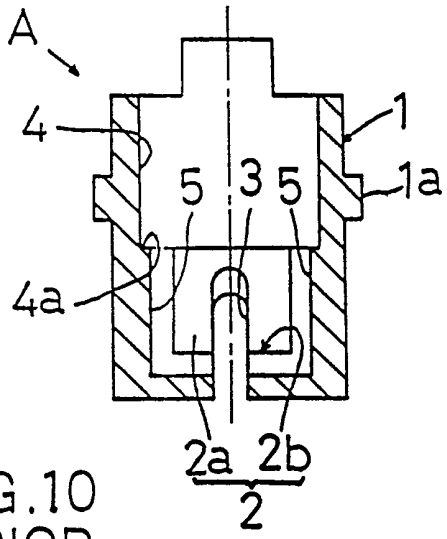
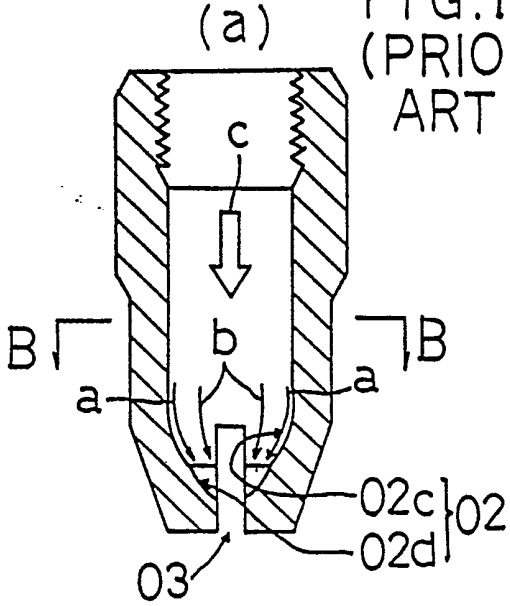


FIG.10 (PRIOR ART)



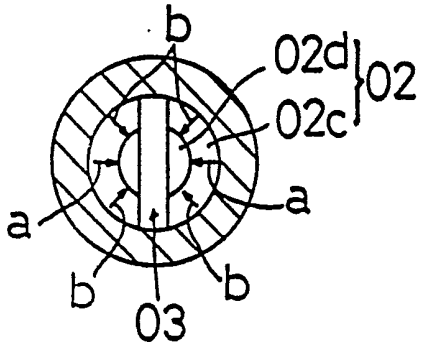


FIG.4

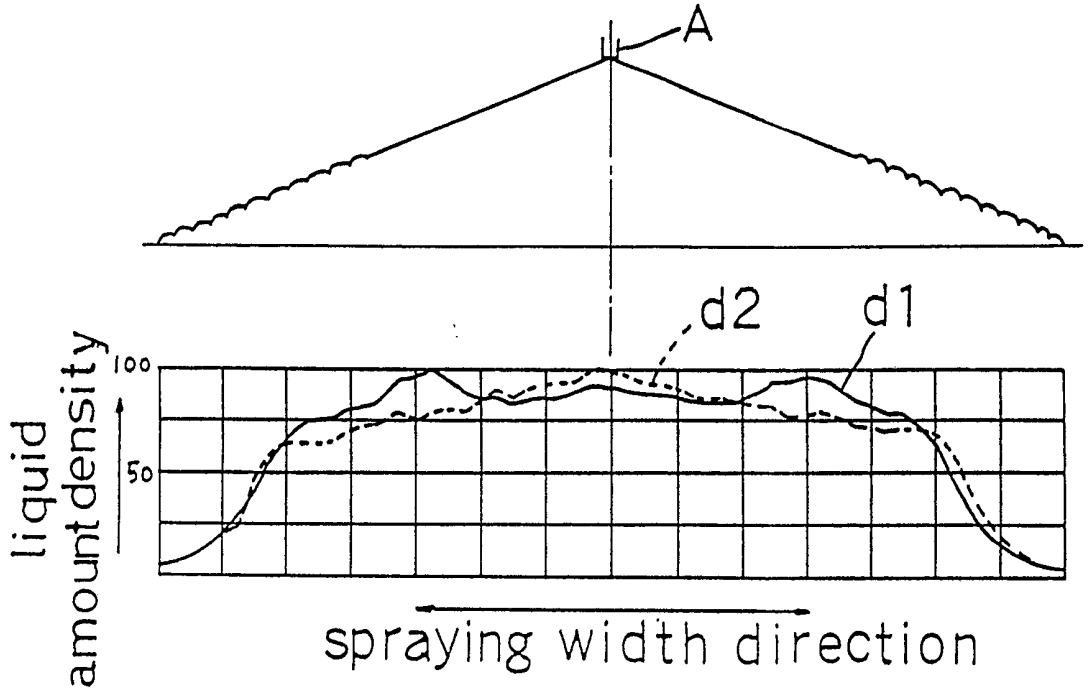
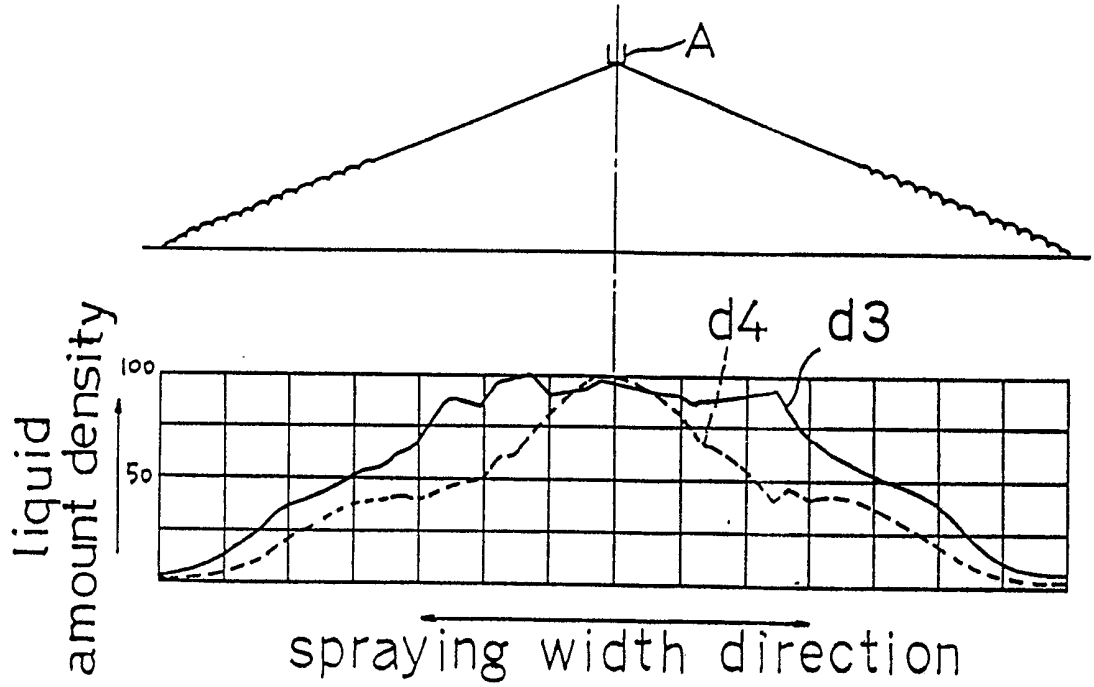

A
d2
d1
liquid amount density
100
50
spraying width direction

FIG.7


A
d4
d3
liquid amount density
100
50
spraying width direction

LIQUID-SPRAYING NOZZLE

BACKGROUND OF THE INVENTION

1 FIELD OF THE INVENTION

The present invention relates to a flat-spraying type liquid-spraying nozzle widely used e.g. for spray-cooling a red-heated steel or a roller conveyor transporting the same or for spraying chemicals onto crops or plants in a vegetable-growing field, an orchard and so on, and more particularly to a liquid-spraying nozzle of the above-noted type including a bottom-equipped cylindrical nozzle body having an inner bottom portion defining an inner peripheral face formed coaxial or substantially coaxial relative to a nozzle axis, at least a bottom portion of the nozzle body having a laterally-elongated orifice defined normal or substantially normal to the nozzle axis when viewed from the direction of the nozzle axis.

2 DESCRPITION OF THE PRIOR ART

With a conventional liquid-spraying nozzle of the above-noted type, since its spraying amount tends to be largest at the longitudinal center of the orifice,

it has been necessary to render the spraying amount uniform with respect to the longitudinal direction of the orifice. Thus, according to the prior art, as shown in Figs. 10(a) and 10(b), the inner peripheral face 02 is formed of a plurality of steps of curved inner peripheral face portions 02c and 02d which diameters are gradually reduced towards the downstream in the liquid-spraying direction. In operation, of these curved inner peripheral face portions 02c and 02d, the liquid portion guided in the directions a and b along the outermost portion 02c is caused to collide with liquid portion guided in the direction c towards the second outermost curved inner peripheral portion 02d, whereby the liquid as passing through the nozzle is provided with a diffusing-distributing force towards the outer diameter direction away from the nozzle axis. In this way, the prior art has attempted to achieve uniform distribution of the spraying amount (e.g. Japanese patent laid open under Showa 61-161162).

With the above-described construction; however, at the outermost curved inner peripheral portion 02c, the liquid portion quided in the direction b adjacently along the longitudinal direction of the orifice 03 has a significant force towards the longitudinal center of the orifice 03. Hence, this

liquid portion may disadvantageously offset or weaken the diffusing-distributing force of the liquid towards the outer diameter direction. Accordingly, this prior construction has often failed to achieve the intended uniform distribution of the spraying amount.

In view of the above-described state of the art, the primary object of the present invention is to provide an improved liquid-spraying nozzle capable of achieving efficient and uniform distribution of its spraying amount through an improvement of the inner peripheral face configuration of the nozzle.

SUMMARY OF THE INVENTION

In order to achieve the above-noted object, a liquid-spraying nozzle related to the present invention comprises: a bottom-equipped nozzle body including an inner peripheral face formed at an inner bottom portion of the body and coaxial or substantially coaxial with a nozzle axis and a laterally-elongated orifice defined normal or substantially normal to the nozzle axis when viewed from the direction of the nozzle axis; a large-diamter peripheral face formed upstream of the inner peripheral face and having a larger inner diameter than the inner peripheral face; a stepped portion

formed between the inner peripheral face and the large-diameter peripheral face; and a pair of elongated grooves disposed along the nozzle axis and at positions opposing to each other across a longitudinal center of the orifice of the inner peripheral face, each elongated groove having a downstream end relative to the spraying direction with an arcuate cross section extending to the vicinity of the orifice and an upstream end opened at the stepped portion.

The spraying-liquid nozzle having the above-described features of the invention has functions and effects to be described next with reference to Figs. 1 through 3.

As shown, the inner peripheral face 2 is divided into two face portions across the laterally-elongated orifice when viewed in the direction of nozzle axis P. Then, a liquid portion flowing in a direction d along one side portion of the face 2 and another liquid portion flowing in the direction d along the other side portion of the face 2 are are caused to collide with each other when the both liquid portions enter the orifice 3, through which collision the combined liquid acquires a diffusing-distributing force along the longitudinal direction of the orifice 3 to be sprayed flatly through the orifice 3. Further, at

positions opposing to each other across a longitudinal center of the orifice 3 of the inner peripheral face 2, there are provided the pair of elongated grooves 5 each having a downstream end thereof adjacent the orifice 3. Accordingly, a further liquid portion guided in a direction e along these elongated grooves 5 is also caused to collide in the vicinity of the orifice 3 with the combined liquid portions guided in the direction d along the inner peripheral face portions. Consequently, compared with the conventional arrangement where the liquid portions guided in the direction d along the inner peripheral face portions alone are caused to collide with each other, the second-mentioned collision may advantageouly add to the diffusing-distributing force provided to the sprayed liquid.

Moreover, since the elongated grooves 5 are formed at a middle position longitudinally of the orifice 3, the liquid portions guided in the direction e along the respective elongated grooves 5 collide with each other at a position substantially on the nozzle axis P to be diffused therefrom to the right and left, i.e. in the direction normal to the longitudinal direction of the orifice 3, thereby effectively increasing the diffusing-distributing force of the liquid.

In addition, since each elongated groove 5 is formed along the nozzle axis P and having its upstream end opened at the stepped portion, the liquid portion passing the vicinity of the large-diameter peripheral face 4 may flow smoothly into the grooves 5 without much energy loss. Also, the manufacturing of the elongated grooves 5 is facilitated when compared e.g. with a case where the elongated grooves alone are to be formed concave.

In summary, the present invention has provided a liquid-spraying nozzle which may flatly spray liquid in a very efficient and uniform manner because of the enhanced diffusing-distributing force provided to the liquid and yet which may be manufactured very easily.

Furthermore, according to one preferred embodiment of the present invention, the inner peripheral face is formed as a tapered curved inner peripheral face. This arrangement has the advantages that the liquid may flow more smoothly along the peripheral face whereby the energy loss may be further reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

Accompanying drawings Figs. 1 through 9 show preferred embodiments of the present invention; in

which,

Fig. 1 is a side view in section of a major portion,

Fig. 2 is a side view in section taken along a line II-II of Fig. 1,

Fig. 3 is a section view taken along a line III-III of Fig. 1,

Fig. 4 is a graph showing spraying characteristics,

Figs. 5 through 9 show an alternate embodiment of the invention, with Fig. 5 being a side view in section of a major portion, Fig. 6 being a side view in section taken along a line VI-VI of Fig. 5, Fig. 7 being a graph showing spraying characteristics, Fig. 8 being a side view in section of a major portion, and with Fig. 9 being a side view in section of the major portion taken along a line IX-IX of Fig. 8, respectively, and

Figs. 10(a) and 10(b) show a conventional liquid-spraying nozzle, with Fig. 10(a) being a side view in section of a major portion and Fig. 10(b) being a perspective view taken along a line B - B of Fig. 10(a).

DESCRPITION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the invention will be particularly described hereinafter with reference to the accompanying drawings.

(first embodiment)

Figs. 1 through 3 show a liquid-spraying nozzle A for use in e.g. spraying cooling water onto a continuously casted steel. As shown, this nozzle A includes a bottom-equipped nozzle body 1, a tapered curved inner peripheral face 2 defined at an inner bottom portion of the body 1 and coaxially or substantially coaxially with a nozzle axis P, a laterally-elongated orifice 3 defined at a bottom portion of the nozzle body 1 and normal or substantially normal to the nozzle axis P, a large-diameter peripheral face 4 formed upstream of the inner peripheral face 2 and having a larger inner diameter than the face 2, and a stepped portion 4a formed between the inner peripheral face 2 and the large-diameter peripheral face 4.

Further, at positions opposing to each other across a longitudinal center of the orifice 3 of the inner peripheral face 2, there are formed by cutting a pair of elongated grooves 5 disposed along the nozzle axis P. Each elongated groove 5 has a downstream end

(relative to the liquid-spraying direction) with an arcuate cross section extending to the vicinity of the orifice 3 and an upstream end opened at the stepped portion 4a.

The nozzle body 1 includes at an outer periphery thereof a flange 1a to be fixedly engaged into a screw type pipe coupler 6 which is attached into a discharge pipe 7 of an unillustrated gas-liquid mixer.

With the above-described construction, a liquid portion passing the large-diamter peripheral face 4 flows in the direction of the axis P and reaches the stepped portion 4a, the liquid portion is caused to collide with a further liquid portion flowing closely along the nozzle axis P, through which collision the liquid portion is provided with a diffusing-distributing force. Then, a portion of the converged liquid flows along the curved inner peripheral face 2 thereby acquiring an acceleration while another portion of the liquid smoothly flows as being guided by the elongated grooves 5.

Thereafter, the liquid portions opposing to each other and smoothly and constrictedly quided along the curved inner peripheral face 2 collide with each other when running into the orifice 3 thereby acquiring a diffusing-distributing force along the longitudinal direction of the orifce.

Further, at the longitudinal center of the orifice 3, the liquid portions guided along the pair of elongated grooves 5 also collide with each other across the orifice 3. Then, the above-mentioned diffusing-distributing force provided by the collision between the liquid portions guided along the face 2 is further increased by the collision between the liquid portions guided along the grooves 5. Consequently, the nozzle may spray the liquid very efficiently and uniformly.

In Fig. 4, a line d1 shows measurement results of sprayed liquid distribution in the width direction of the spraying achieved by the the liquid-spraying nozzle of this embodiment used in combination with a conventional gas-liquid mixer disclosed e.g. in a Japanese laid-open patent No. 61-161162.

The vertical axis of the graph represents the liquid amount density with its maximum value 100 whereas the horizontal axis represents the position in the width direction of the spraying. The measurements were conducted under the conditions specified as follows:

air pressure (PA) 3.00 Kg f/ cm^2 G

water pressure (PW) 3.00 Kg f/cm^2

air pressure (QA) 58.8 Nm^2 /h

water amount (QW) 17.5 l/min

air/water volume ratio (QA/QW) 56.00

In Fig. 4, a line d2 shows measurement results of sprayed liquid distribution in the width direction of the spraying achieved by a liquid-spraying nozzle which construction is the same as the above nozzle A of this embodiment except that the former does not have the elongated grooves 5. As these spraying amount distribution performances are compared, it may be readily seen that the elongated grooves 5 contribute significantly to the uniformity and efficiency of the spraying amount distribution.

(second embodiment)

Figs. 5 and 6 show a liquid-spraying nozzle according to a further embodiment of the present invention. In the spraying nozzle of this embodiment, the inner peripheral face 2 is formed by continuation of a peripheral face 8 having a constant diameter along the nozzle axis P and a tapered curved

peripheral face 2a. The upstream end of the face 2, i.e. of the face 8 is formed continuous with the large-diameter portion 4 via the stepped portion 4a. Further, the elongated grooves 5 have their upstream ends opened at the stepped portion 4a such that the grooves 5 are formed continuous with the large-diameter portion 4.

The rest of the construction are the same as those of the previous embodiment.

In Fig. 7, a line d3 shows measurement results of sprayed liquid distribution in the width direction of the spraying achieved by the the liquid-spraying nozzle A of this embodiment. Whereas, a line d4 in the same drawing shows the results of a nozzle having the same construction as that of this embodiment except that the former does not have the elongated grooves 5.

The measurements were conducted under the conditions specified as follows:

air pressure (PA)	3.00 Kg f/ cm^2 G
water pressure (PW)	3.00 Kg f/cm^2
air pressure (QA)	58.8 Nm^2 /h
water amount (QW)	17.5 l/min
air/water volume ratio (QA/QW)	56.00

As these spraying amount distribution performances are compared, it may be readily seen again that the elongated grooves 5 contribute significantly to the uniformity and efficiency of the spraying amount distribution.

(third embodiment)

Figs. 8 and 9 show a liquid-spraying nozzle according a still further embodiment of the present invention. The spraying nozzle of this embodiment includes at an inner bottom portion thereof the inner peripheral face 2 formed by a peripheral face 2a having a constant diameter along the nozzle axis P and a flat bottom face 2b. The upstream end of the face 2, i.e. of the face 2a is formed continuous with the large-diameter portion 4 via the stepped portion 4a. Further, the pair of elongated grooves 5 are formed across the peripheral face 2a and the bottom face 2b and opposed at the downstream ends thereof to each other across the orifice 3.

(other embodiments)

The elongate groove may have an angular cross section.

The downstream end of the elongated groove may be formed as a tapered face inclined relative to the nozzle axis.

CLAIMS

1. A liquid spraying nozzle comprising a bottom-equipped nozzle body having an inner peripheral face formed at an inner bottom portion of the body substantially coaxial with a nozzle axis, a laterally-elongated orifice defined substantially normal to the nozzle axis when viewed from the direction of the nozzle axis, a large-diameter peripheral face being formed upstream of the inner face and having a larger inner diameter than the inner face, a stepped portion being formed between the inner face and the large-diameter peripheral face and a pair of elongated grooves being disposed along the nozzle axis and at positions opposing each other across a longitudinal center of the orifice of the inner face, each elongated groove having a downstream end relative to the spraying direction with an arcuate cross-section extending to the vicinity of the orifice and an upstream end opened at the stepped portion.

2. A liquid spraying nozzle as claimed in claim 1, in which the inner face includes a tapered inner peripheral face.

3. A liquid spraying nozzle as claimed in claim 1, in which the inner face is formed by continuation of a peripheral face having a constant diameter along the nozzle axis and a tapered curved peripheral face.

4. A liquid spraying nozzle as claimed in claim 1, in which the inner face is formed by a peripheral face having a constant diameter along the nozzle axis and a flat bottom face.

5. A liquid spraying nozzle constructed and arranged to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

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