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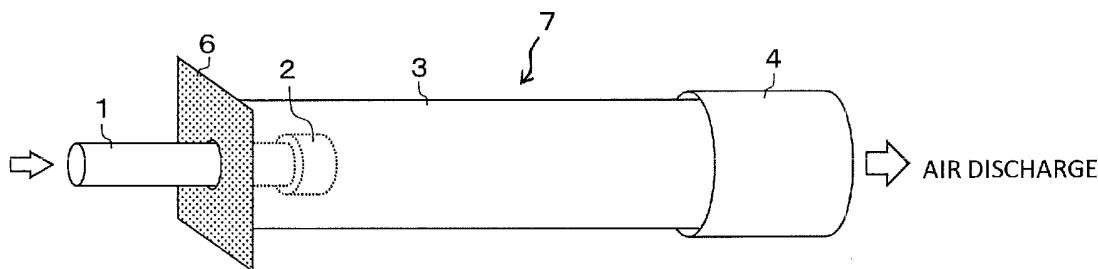
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(54) **SCALE REMOVING METHOD AND SCALE REMOVING DEVICE**

(57) A scale removing apparatus 7 in accordance with the present invention subjects the internal surface of the steel pipe 3 to a blasting process wherein abrasive particles (not shown) are ejected through a high-pressure jet nozzle 2 and collide with the internal surface of the steel pipe 3. The scale removing apparatus 7 has the high-pressure jet nozzle 2 for ejecting the abrasive par-

ticle, a dust collector 4 for collecting dust particles after blasting, and restraining means 6 for restraining air from flowing into the steel pipe 3 from an end part of the steel pipe 3 due to the flow of abrasive particle ejected through the high-pressure jet nozzle 2. Therefore, the scale can be removed without scattering of dust particles into the atmosphere even with a low-capacity dust collector.

FIG.1



Description

Technical Field

[0001] The present invention relates to a scale removing method and scale removing apparatus wherein the internal surface of a steel pipe is subjected to blasting process where abrasive particles are ejected through a high-pressure jet nozzle and hit the internal surface of the steel pipe.

Background Art

[0002] Steel pipes are often subjected to heat treatment depending on the usage purpose thereof. For improving the quality of steel pipe, it is important to remove scale (descaling) formed on the inner and outer surfaces of steel pipe at the time of heat treatment. A blasting has been known as the method for removing scale from the internal surface of steel pipe. In the blasting, scale formed on the inner surfaces of steel pipe is removed by impacts of an abrasive particle such as iron, stainless steel, alumina, or quartz sand. The blasting involves, for example, sand blasting, shot blasting, and grit blasting. A high-pressure jet system, a negative-pressure suction system, or a combination of these two systems is adopted as the abrasive particle ejecting method.

[0003] In the blasting apparatus of high-pressure jet system, for example, a steel pipe is placed on turnable rollers, and while the steel pipe is rotated, a high-pressure jet nozzle is inserted from an end part of the steel pipe and is moved in the longitudinal direction with an abrasive particle blown onto the internal surface of steel pipe through the high-pressure jet nozzle, whereby scale is removed by impacts of the abrasive particle to the internal surface of steel pipe. Dust particles after blasting are usually collected by a dust collector provided in an end part on the opposite side to the end part of steel pipe from which the high-pressure jet nozzle is inserted.

[0004] In the blasting apparatus of negative-pressure suction system, for example, a suction machine is installed at one end of a steel pipe, and while the interior of steel pipe is maintained at a negative pressure by the suction machine, abrasive particles are charged from the other end in the state, whereby scale is removed by the impacts of the abrasive particle, moving in the steel pipe, to the internal surface of the steel pipe.

[0005] The blasting apparatus of high-pressure jet type has a disadvantage that a large equipment space is required because a pipe for transporting the abrasive particles to the nozzle (transportation pipe) has a long length. The blasting apparatus of negative-pressure suction type has a disadvantage that the scale removing capability is low because the impact angle of abrasive particles is low.

[0006] In order to compensate for these disadvantages of the blasting apparatuses, in Patent Document 1, the present applicant disclosed an invention relating to scale removing equipment wherein: a first high-pressure jet

blasting section for subjecting the internal surface of one pipe end part of a steel pipe to blasting; a second high-pressure jet blasting section for subjecting the internal surface of the other pipe end part of the steel pipe to blasting; and a negative-pressure suction blasting section for subjecting the internal surface of the overall length of steel pipe to blasting are arranged in juxtaposition, and steel pipe transfer devices are provided between these blasting sections. In this invention, scale formed near the end part of steel pipe, which is less liable to be removed by the negative-pressure suction blasting, is removed by the high-pressure jet blasting.

[0007]

Patent Document 1: JP11-320413A

Disclosure of the Invention

Problems to be Solved by the Invention

[0008] As a blower used for the dust collector for high-pressure jet blasting, a blower having a low capacity (usually, about 40 kW or lower) is used as compared with the blower used for the suction machine for negative-pressure suction blasting (90 kW or higher). The reason for this is as described below. The suction machine for negative-pressure suction blasting must create a negative pressure in the steel pipe to produce an air flow sufficient to transport the abrasive particles, whereas in the high-pressure jet blasting, the abrasive particles are transported by the high-pressure jet nozzle, so that the purpose of the dust collector therefor is merely to collect dust particles (abrasive particles and chips thereof, removed scales, etc.).

[0009] Figure 4 shows a problem with a conventional high-pressure jet blasting method. As shown in Figure 4, in the high-pressure jet blasting, for example, compressed air is sent from a compressor (not shown), and abrasive particles are supplied from an abrasive particles tank (not shown) to an abrasive particles transfer pipe 1, whereby high-pressure abrasive particles (not shown) is ejected through a nozzle 2. In the case where the gap between the outside diameter of the abrasive particles transfer pipe 1 and the inside diameter of a steel pipe 3, a blasted material, is small or sufficiently large, a blower having a capacity corresponding to the flow rate at the nozzle 2 can be used. However, in the case where the above-described gap is in a fixed range, the amount of air flowing into the steel pipe 3 increases beyond expectation, exceeding the suction capability of the dust collector 4, and dust particles 5 may scatter into the atmosphere.

[0010] The reason for this is that during the blasting, the flow of abrasive particles and air are produced in the steel pipe 3 by the abrasive particles ejected through the high-pressure jet nozzle 2, and due to the ejector effect thereof, air of about several times the flow rate of the high-pressure jet nozzle 2 flows into the steel pipe 3 from

a portion near an end part of steel pipe (the left end part in the figure).

[0011] It can be thought that the capacity of the dust collector is increased to solve the above-described problem. However, since the ejector effect is increased or decreased depending on the inside diameter of the steel pipe, it is not preferable from the viewpoint of energy saving that the suction capability of dust collector be designed so as to match the case where the ejector effect is great.

[0012] The present invention has been made to solve the above problems, and accordingly an object thereof is to provide a scale removing method and scale removing apparatus wherein the ejector effect is reduced, and dust particles do not scatter into the atmosphere even with a low-capacity dust collector in high-pressure jet blasting.

Means of Solving the Problems

[0013] The present invention has been made to solve the above problems, and the gist thereof is a scale removing method shown in item (1) and a scale removing apparatus shown in item (2).

[0014]

(1) A method for removing a scale formed on an internal surface of a steel pipe by subjecting the internal surface of the steel pipe to a blasting process wherein abrasive particles are ejected through a high-pressure jet nozzle and collide with the internal surface of the steel pipe, wherein the blasting process is performed while air is restrained from flowing into the steel pipe from an end part of the steel pipe due to the flow (motion) of the abrasive particle.

[0015]

(2) An apparatus for removing a scale formed on an internal surface of a steel pipe by subjecting the internal surface of the steel pipe to a blasting process wherein abrasive particles are ejected through a high-pressure jet nozzle and collide with the internal surface of the steel pipe, wherein the apparatus has: the high-pressure jet nozzle for ejecting the abrasive particles; a dust collector for collecting dust particles after blasting; and restraining means for restraining air from flowing into the steel pipe from an end part of the steel pipe due to the flow of the abrasive particles.

[0016] As the scale removing apparatus shown in the above item (2), for example, any mode of items (a) to (c) described below is preferably adopted.

[0017]

(a) The dust collector is installed so as to be capable of collecting dust particles from a pipe end on the

opposite side to a nozzle insertion end of the steel pipe, and the restraining means is formed of a plate material having a size capable of covering the nozzle insertion end of the steel pipe and has a through hole where the high-pressure jet nozzle can be slid.

[0018]

(b) The dust collector is installed so as to be capable of collecting dust particles from a pipe end on the opposite side to a nozzle insertion end of the steel pipe, and the restraining means is attached to the outer periphery of the high-pressure jet nozzle and is formed of a disc-shaped plate material having an outside diameter equivalent to an inside diameter of the steel pipe so as to be capable of sliding in the steel pipe.

[0019]

(c) The restraining means, which is formed of a plate material having a size capable of covering the end part of the steel pipe, is installed at a pipe end on the opposite side to a nozzle insertion end of the steel pipe, and the dust collector is installed so that dust particles can be collected from the same pipe end as the nozzle insertion end of the steel pipe.

Effects of the Invention

[0020] According to the present invention, dust particles do not scatter into the atmosphere even with a low-capacity dust collector in high-pressure jet blasting, so that energy can be saved, and at the same time, the work environment can be improved.

Brief Description of the Drawings

[0021]

Figure 1 is a perspective view showing one example of a scale removing apparatus in accordance with the present invention;

Figure 2 is a perspective view showing another example of a scale removing apparatus in accordance with the present invention;

Figure 3 is a perspective view showing still another example of a scale removing apparatus in accordance with the present invention;

Figure 4 is a perspective view of a conventional scale removing apparatus;

Figure 5 is a graph showing the relationship between pipe inside diameter and in-pipe air flow rate in an experiment conducted while changing the pipe inside diameter and a nozzle pressure variously;

Figure 6 is a graph showing the relationship between pipe inside diameter and in-pipe air flow rate in example embodiment of the present invention and

comparative example;

Figure 7 is a perspective view showing experimental conditions;

Figure 8 is a sectional view showing measurement positions of in-pipe flow rate; and

Figure 9 is a graph showing the relationship between position index X and flow rate index Y.

Best Mode for Carrying Out the Invention

[0022] An embodiment of the present invention will now be described with reference to Figures 1 to 3. As shown in Figure 1, a scale removing apparatus 7 in accordance with the present invention is a scale removing apparatus that performs blasting on the internal surface of a steel pipe 3 by causing abrasive particles (not shown) ejected through a high-pressure jet nozzle 2 to collide with the internal surface of the steel pipe 3. The scale removing apparatus 7 has the high-pressure jet nozzle 2 for ejecting the abrasive particles, a dust collector 4 for collecting dust particles after blasting, and restraining means 6 for restraining air from flowing into the steel pipe 3 from an end part thereof due to the flow of abrasive particles ejected through the high-pressure jet nozzle 2.

[0023] Thereby, during blasting, air can be restrained from flowing into the steel pipe 3 from the end part (the left end part in the figure) of the steel pipe 3. Therefore, dust particles produced by blasting can be collected even if the capacity of the dust collector is not increased.

[0024] An example of a scale removing apparatus 7 in accordance with the present invention is shown in Figure 1. In the apparatus, for example, the dust collector 4 is installed so that dust particles can be collected from a pipe end (the right end part of the steel pipe 3 in Figure 1) on the opposite side to a nozzle insertion end (the left end part of the steel pipe 3 in Figure 1) of the high-pressure jet nozzle 2 of the steel pipe 3, and the restraining means 6 is formed of a plate material having a size capable of covering the nozzle insertion end (the left end part of the steel pipe 3 in Figure 1) of the high-pressure jet nozzle 2 of the steel pipe 3 and has a through hole where the high-pressure jet nozzle 2 can be slid.

[0025] The other example of a scale removing apparatus 7 in accordance with the present invention is shown in Figure 2. The apparatus is the same as that shown in Figure 1 in that a dust collector 4 is installed so that dust particles can be collected from a pipe end (the right end part of a steel pipe 3 in Figure 2) on the opposite side to a nozzle insertion end (the left end part of the steel pipe 3 in Figure 2) of a high-pressure jet nozzle 2 of the steel pipe 3. In the apparatus, however, restraining means 6 is attached to the outer periphery of the high-pressure jet nozzle 2, and is formed of a disc-shaped plate material having an outside diameter equivalent to the inside diameter of the steel pipe 3 so as to be capable of sliding in the steel pipe 3.

[0026] The other example of a scale removing apparatus 7 in accordance with the present invention is shown

in Figure 3. In the apparatus, for example, restraining means 6 is installed at a pipe end (the right end part of a steel pipe 3 in Figure 3) on the opposite side to a nozzle insertion end (the left end part of the steel pipe 3 in Figure 3) of a high-pressure jet nozzle 2 of the steel pipe 3, a dust collector (not shown) is installed so that dust particles can be collected from the same pipe end as the nozzle insertion end (the left end part of the steel pipe 3 in Figure 3) of the high-pressure jet nozzle 2 of the steel pipe 3, and the restraining means 6 is formed of a plate material having a size capable of covering the end part of the steel pipe 3.

[0027] An expandable material such as rubber is desirably used as the restraining means. The restraining means is not subject to any special restriction if it is configured so as to be capable of restraining air from flowing into the steel pipe from the end part of the steel pipe. For example, in the example shown in Figure 2, in the case where the size of the steel pipe differs greatly, the size of the restraining means must be changed. Therefore, in the case where the size of steel pipe subjected to blasting changes frequently, it is desirable to use a plate material having a size far larger than the outside diameter of steel pipe as in the examples shown in Figures 1 and 3. Also, in the examples shown in Figures 1 and 2, two dust collectors must be provided at the pipe end on the opposite side to the nozzle insertion end to collect dust particles. However, in the example shown in Figure 3, only one dust collector may be provided to collect dust particles from the same pipe end as the nozzle insertion end. Therefore, the example shown in Figure 3 is desirable, because the configuration of apparatus is simple and the number of consumable parts can be reduced and a repair cost can be decrease.

[0028] In the case where scale is removed throughout the overall length of steel pipe by using the high-pressure jet nozzle, the length of the transportation pipe must inevitably be increased, and also the amount of abrasive particles to be ejected must be increased. Therefore, the abrasive particles remain easily in the pipe. If the remaining amount of abrasive particles increases, the work for moving the transportation pipe is sometimes difficult to do. For this reason, the scale removing apparatus of the present invention is especially effective in removing scale at the pipe end of steel pipe by using the high-pressure jet nozzle.

Embodiment 1

[0029] In order to verify the effects of the present invention, an experiment was conducted where pipes having different inside diameter is prepared the high-pressure jet nozzle was first inserted from one end of each pipe, and then air was ejected while the nozzle jet pressure (nozzle pressure) was changed variously, whereby the flow rate of air at the pipe end on the opposite side to the nozzle insertion side was examined. In this experiment, the inside diameter of the abrasive particles trans-

fer pipe was set at 5.27 mm, and the amount of air discharged from the pipe end part when air is blown into the steel pipes having different inside diameters by using the high-pressure jet nozzle (nozzle pressure: 4.9 to 39.2 N/cm²) was measured. The measurement results are shown in Figure 5.

[0030] If the in-pipe air flow rate is 2 Nm³/min or lower, all dust particles produced at the time of blasting can be removed even with a low-capacity blower of 14.0 kW (diameter: 100 mm, 1750 rpm, -5000 mmAq). However, if the in-pipe air flow rate exceeds 5 Nm³/min, the above-described low-capacity blower is insufficient to collect dust, and dust particles are liable to scatter into the atmosphere. Therefore, the in-pipe air flow rate must be controlled so as to be 5 Nm³/min or lower, preferably 2 Nm³/min or lower.

[0031] As shown in Figure 5, with an increase in the nozzle pressure, the in-pipe air flow rate increases. For example, as is apparent from the example where the pipe inside diameter is 55 mm, in the examples where the nozzle pressure is 4.9 N/cm² and 9.8 N/cm², the in-pipe air flow rate can be kept at 5 Nm³/min or lower. However, in the example where the nozzle pressure is 19.6 N/cm² or higher, the in-pipe air flow rate exceeds 5 Nm³/min. On the other hand, in the case where the pipe inside diameter is large, the in-pipe air flow rate increases. For example, as is apparent from the example where the nozzle pressure is 29.4 N/cm², in the examples where the pipe inside diameter is 31 mm and 44 mm, the in-pipe air flow rate can be kept at 5 Nm³/min or lower. However, in the example where the pipe inside diameter is 55 mm or larger, the in-pipe air flow rate exceeds 5 Nm³/min.

Embodiment 2

[0032] Next, an experiment was conducted where pipes having different inside diameter is prepared, the restraining means of the present invention shown in Figure 1 was used, the high-pressure jet nozzle was inserted into one end of each pipe, and air having a nozzle pressure of 39.2 N/cm² was ejected in the state where the pipe end on the nozzle insertion side was closed, whereby the flow rate of air at the pipe end on the opposite side to the nozzle insertion side was examined as in the embodiment 1. The experimental results are shown in Figure 6. A comparative example in Figure 6 is the example where the nozzle pressure is 39.2 N/cm² in the embodiment 1.

[0033] As shown in Figure 6, in the example embodiment of the present invention, even when air having a pressure as high as 39.2 N/cm² was ejected, the in-pipe air flow rate did not increase so much, and in any examples, the in-pipe air flow rate could be kept at 5 Nm³/min or lower.

[0034] Successively, the same experiment as the above-described one was conducted by using the restraining means shown in Figures 2 and 3. In this experiment, the in-pipe air flow rate could be kept at 5 Nm³/min

or lower as in the example embodiment of the present invention shown in Figure 6.

Embodiment 3

[0035] Next, to study the conditions where dust particles are not produced, steel pipes each having an outside diameter of 88.9 mm, 114.3 mm, and 177.8 mm were prepared, the high-pressure jet nozzle (nozzle diameter: 10.0 mm) was inserted into the steel pipe from one end of steel pipe, and the abrasive particles were blown (jet flow rate: 5.9 Nm³/min) and was sucked by the dust collector connected to the other end of steel pipe (suction flow rate: 11.9 Nm³/min), whereby the production state of dust particles and the in-pipe flow rate at this time were examined. The ratio of suction flow rate to jet flow rate (hereinafter, referred to as "Yc") was 2. As shown in Figure 7, the experiment was conducted by providing a restraining plate, serving as the restraining means, having a size larger than the inside diameter of steel pipe at a position near the pipe end on the nozzle insertion side and by variously changing a distance "a" between the pipe end and the restraining plate. The in-pipe flow rate is an average value of flow rates at one point at the circle central portion at the pipe end on the dust collector connection side and at four points in the circumferential portion, that is, at five points indicated by black dots in Figure 8.

[0036] Figure 9 shows the relationship between the ratio of distance "a" to nozzle diameter (hereinafter, referred to as a "position index X") and the ratio of in-pipe flow rate to jet flow rate (hereinafter, referred to as a "flow rate index Y"). As shown in Figure 9, for any of the steel pipes, with an increase in the value of position index X, the value of flow rate index Y increases. This tendency becomes remarkable with an increase in steel pipe size. On the other hand, for any of the steel pipes, if the flow rate index Y exceeded 2, that is, exceeded Yc, dust particles were produced. Therefore, in order to prevent dust particles, it is important that the flow rate index Y do not exceed Yc. In order for the in-pipe flow rate not to exceed the suction flow rate of dust collector, the distance X must be set in a proper range in relation to the nozzle diameter.

Industrial Applicability

[0037] According to the present invention, dust particles do not scatter into the atmosphere even with a low-capacity dust collector in high-pressure jet blasting, so that energy can be saved and the work environment can be improved.

Description of Symbols

[0038]

1. abrasive particles transfer pipe
2. high-pressure jet nozzle

- 3. steel pipe
- 4. dust collector
- 5. dust particles
- 6. restraining means
- 7. scale removing apparatus

Claims

1. A method for removing a scale formed on an internal surface of a steel pipe by subjecting the internal surface of the steel pipe to a blasting process wherein abrasive particles are ejected through a high-pressure jet nozzle and collide with the internal surface of the steel pipe, wherein the blasting process is performed while air is restrained from flowing into the steel pipe from an end part of the steel pipe due to the flow of the abrasive particles.

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2. An apparatus for removing a scale formed on an internal surface of a steel pipe by subjecting the internal surface of the steel pipe to a blasting process wherein abrasive particles are ejected through a high-pressure jet nozzle and collide with the internal surface of the steel pipe, wherein the apparatus has:

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 - the high-pressure jet nozzle for ejecting the abrasive particles;

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 - a dust collector for collecting dust particles after blasting; and
 - restraining means for restraining air from flowing into the steel pipe from an end part of the steel pipe due to the flow of the abrasive particles.

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3. The apparatus for removing scale according to claim 2, wherein the dust collector is installed so as to be capable of collecting dust particles from a pipe end on the opposite side to a nozzle insertion end of the steel pipe, and the restraining means is formed of a plate material having a size capable of covering the nozzle insertion end of the steel pipe and has a through hole where the high-pressure jet nozzle can be slid.

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4. The scale removing apparatus according to claim 2, wherein the dust collector is installed so as to be capable of collecting dust particles from a pipe end on the opposite side to a nozzle insertion end of the steel pipe, and the restraining means is attached to the outer periphery of the high-pressure jet nozzle and is formed of a disc-shaped plate material having an outside diameter equivalent to an inside diameter of the steel pipe so as to be capable of sliding in the steel pipe.

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5. The scale removing apparatus according to claim 2, wherein the restraining means, which is formed of a plate material having a size capable of covering the end part of the steel pipe, is installed at a pipe end on the opposite side to a nozzle insertion end of the steel pipe, and the dust collector is installed so that dust particles can be collected from the same pipe end as the nozzle insertion end of the steel pipe.

FIG.1

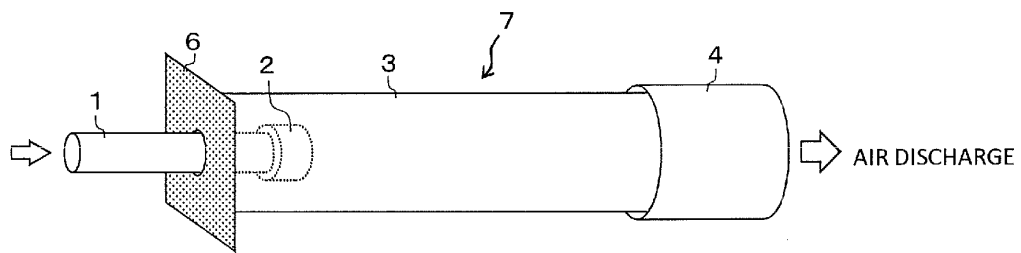


FIG.2

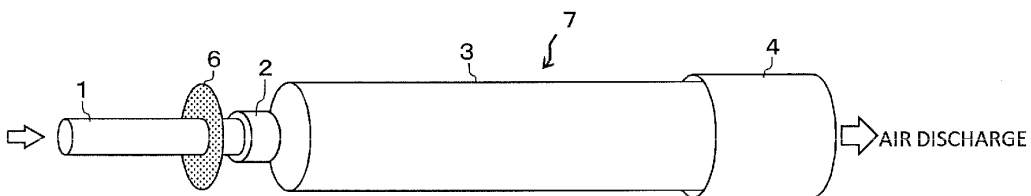


FIG.3

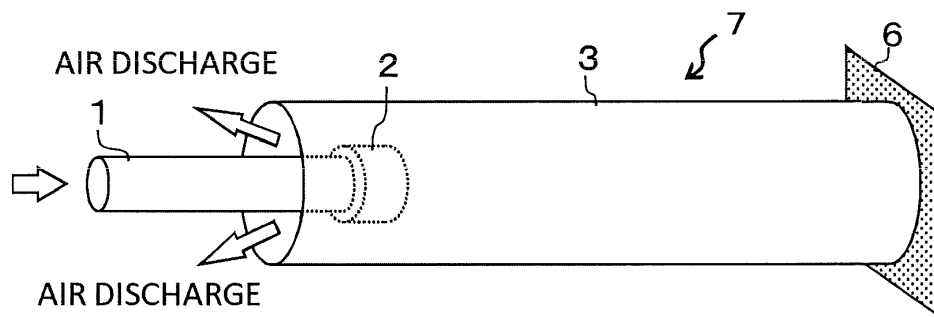


FIG.4

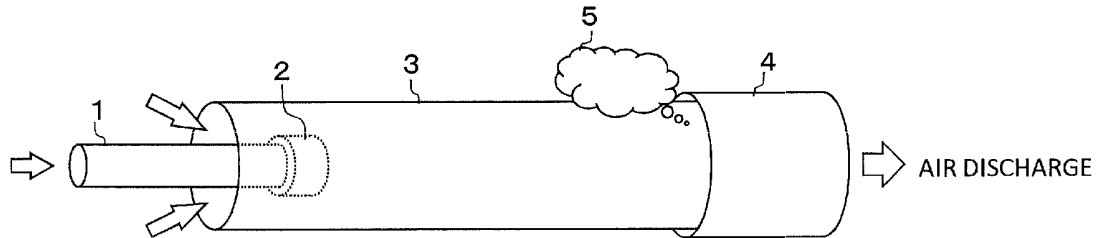


FIG.5

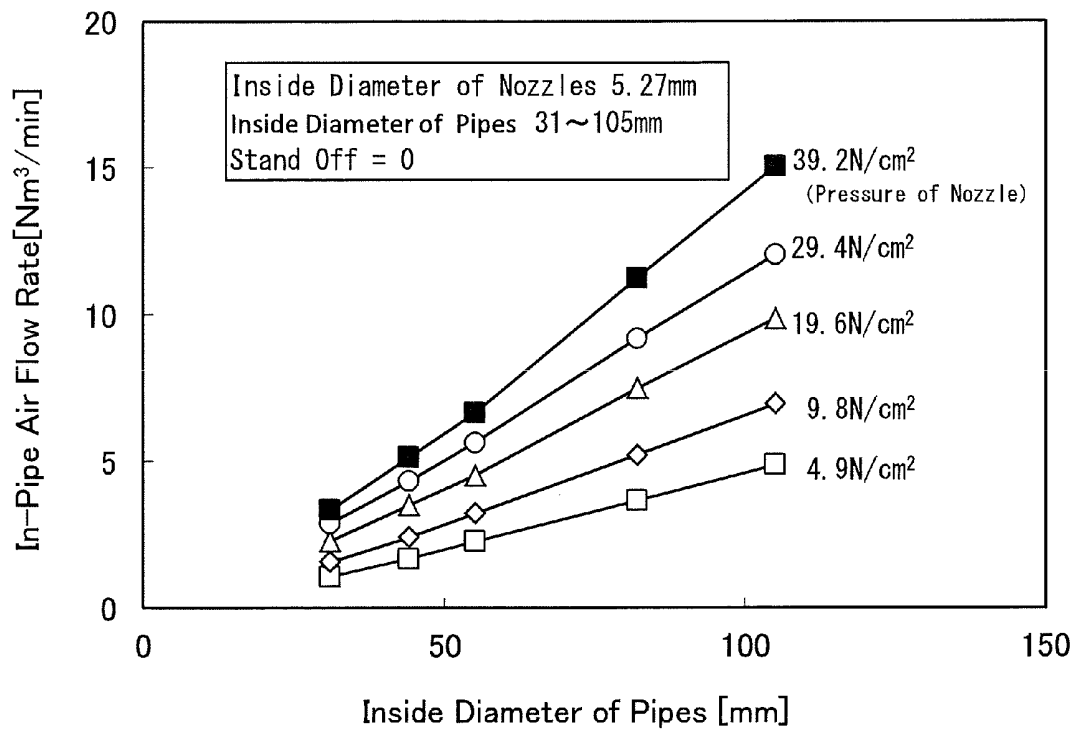


FIG.6

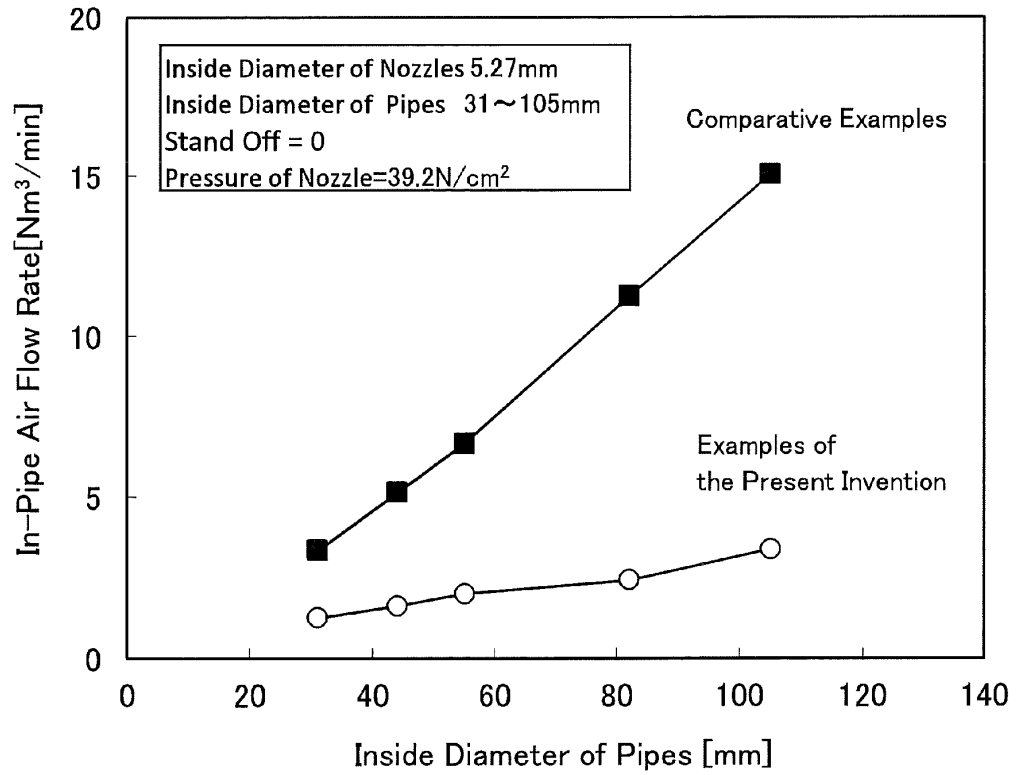


FIG.7

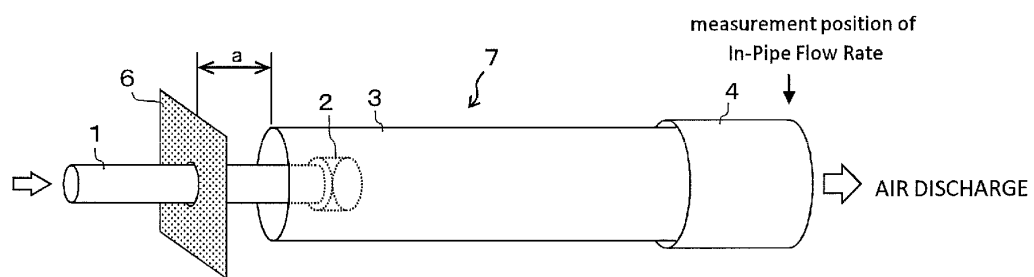


FIG.8

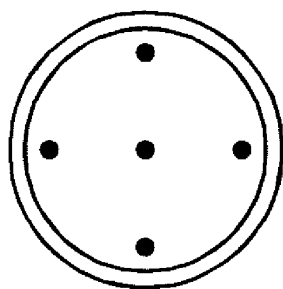
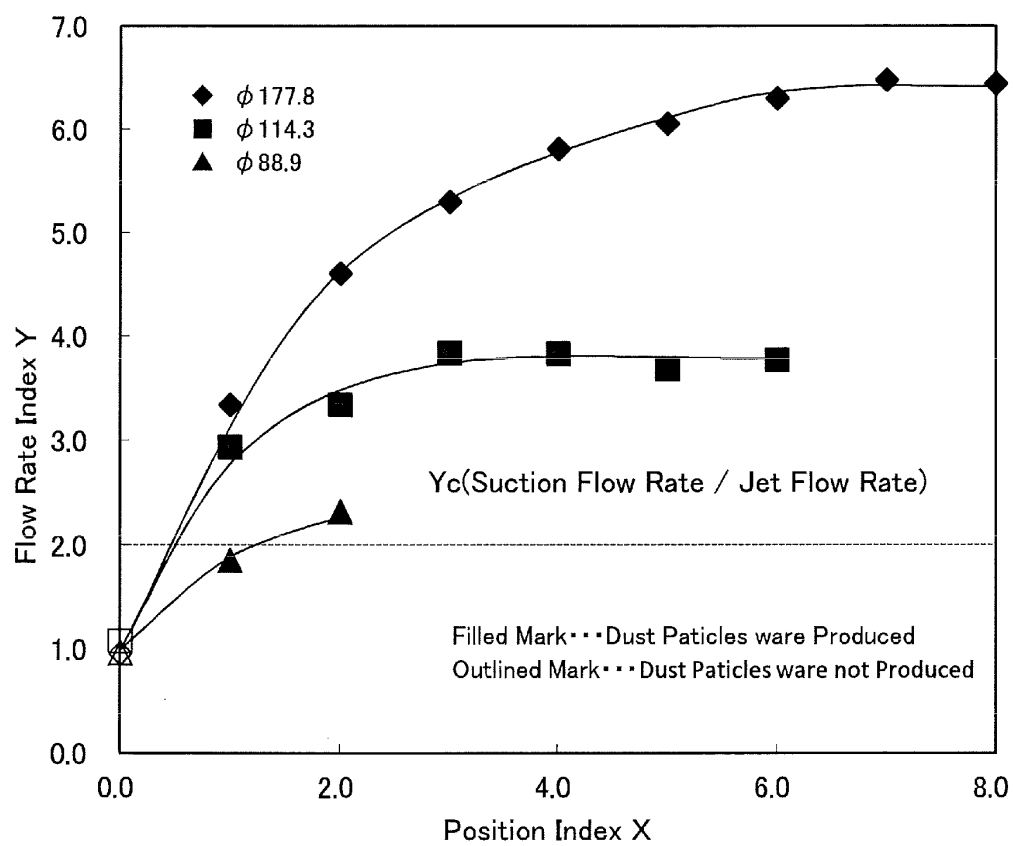


FIG.9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/055744

A. CLASSIFICATION OF SUBJECT MATTER

B24C3/32 (2006.01) i, B24C3/16 (2006.01) i, B24C9/00 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B24C3/32, B24C3/16, B24C9/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2009

Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2003-80460 A (Mitsubishi Heavy Industries, Ltd.), 18 March, 2003 (18.03.03), All pages; all drawings & US 2004/0074632 A1 & EP 1415763 A1 & WO 2003/013790 A1 & CA 2434733 A & CN 1471451 A	1-5
A	JP 5-228841 A (Mitsubishi Materials Corp.), 07 September, 1993 (07.09.93), Fig. 2 (Family: none)	1-5
A	JP 6-270065 A (Kawasaki Steel Corp.), 27 September, 1994 (27.09.94), All drawings (Family: none)	1-5

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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Date of the actual completion of the international search
25 May, 2009 (25.05.09)Date of mailing of the international search report
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Patent documents cited in the description

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