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Kobayashi et al.

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(54) **MACHINE FOR BLASTING ABRASIVES**

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(30) **Foreign Application Priority Data**

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May 14, 2010 (JP) 2010-112116

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B24C 3/22 (2006.01)

(52) **U.S. Cl.**
CPC ***B24C 9/00*** (2013.01); ***B24C 3/22*** (2013.01)

(58) **Field of Classification Search**
CPC B24C 9/00; B24C 3/22
USPC 451/89, 451, 393, 394, 395, 398, 402
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,584,747 A * 12/1996 Ikeda et al. 451/83
2003/0124955 A1 * 7/2003 Hanson 451/2

FOREIGN PATENT DOCUMENTS

JP 63-66194 2/1988
JP 06-000771 1/1994
JP 10-151566 6/1998
JP 2000-006028 1/2000
JP 2000-042928 2/2000

OTHER PUBLICATIONS

International Search Report from the European Patent Office for International Application No. PCT/JP2010/006833, mailing date Apr. 12, 2011.

* cited by examiner

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(57) **ABSTRACT**

The object of the present invention is to provide a machine for blasting abrasives that has a simple structure and that solves the problem of abrasives falling when the door for the gateway for the work is opened or closed. The machine for blasting abrasives comprises a chamber **11** for processing, a nozzle **13** that is provided within the chamber **11** for shooting the abrasives (shots) S onto the work W, and a jig **15** for holding the work W at a position facing the nozzle **13**. A gateway **17** with a door **19** is formed in the ceiling **11***a* of the chamber **11**. The size of the gateway **17** enables the work W to protrude from the chamber **11** by means of the jig **15** at a position corresponding to the jig **15** that is linearly moving up and down. The door **19** is provided within the chamber **11** so as to seal the gateway by linearly moving up and down and so as to create a vacant plane on the gateway for passing the work by horizontally moving.

5 Claims, 12 Drawing Sheets

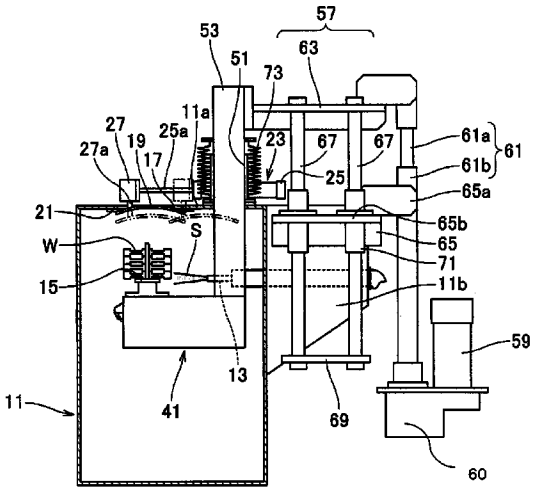
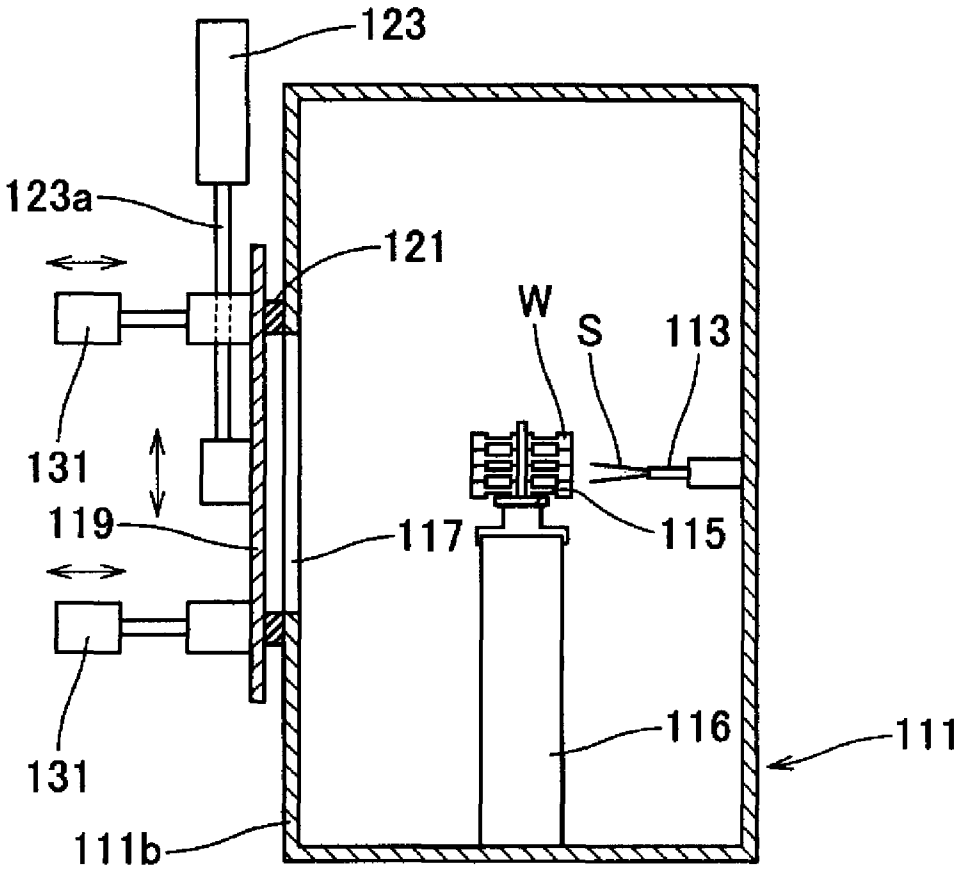
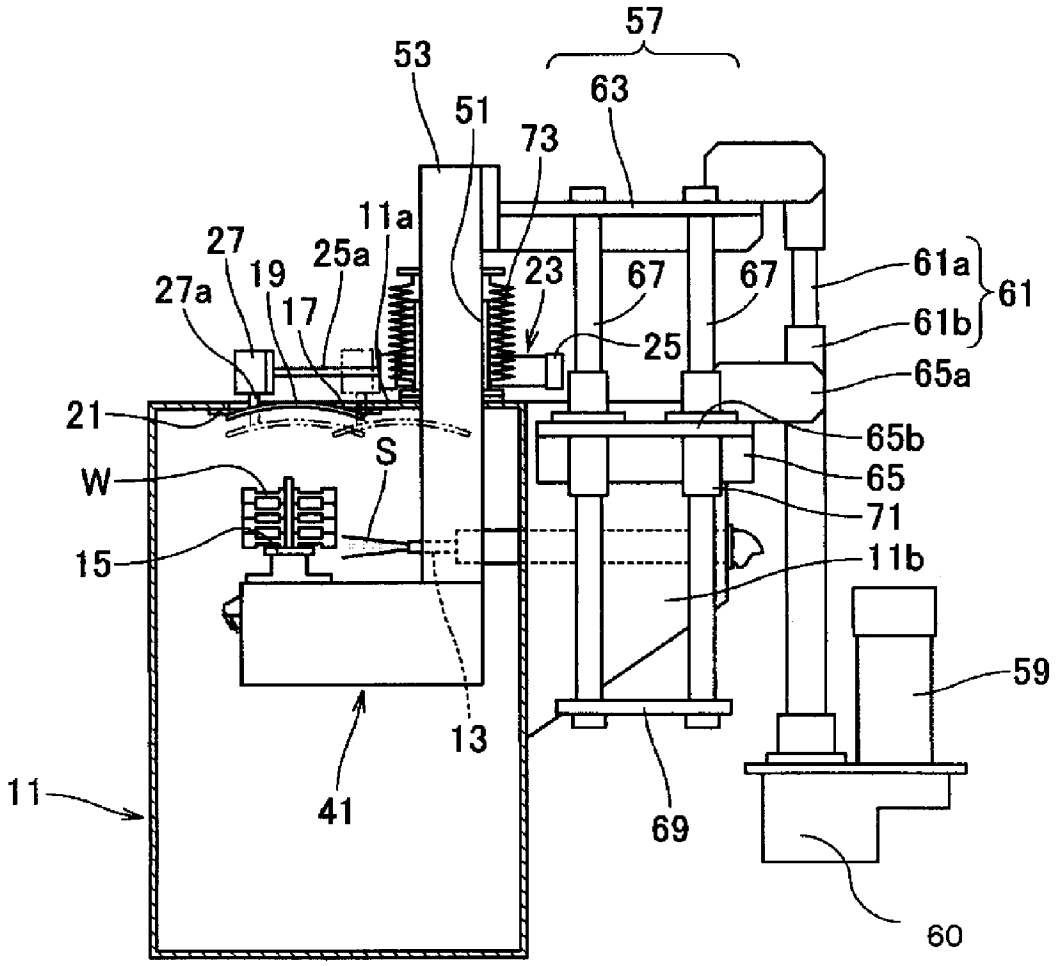


Fig. 1



(Prior Art)

Fig. 2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53
51
63
73
11a
27
19
25a
27a
17
23
67
67
61a
61
61b
25
65a
21
S
65b
W
65
71
15
11b
59
13
41
69
11
60

Fig. 3

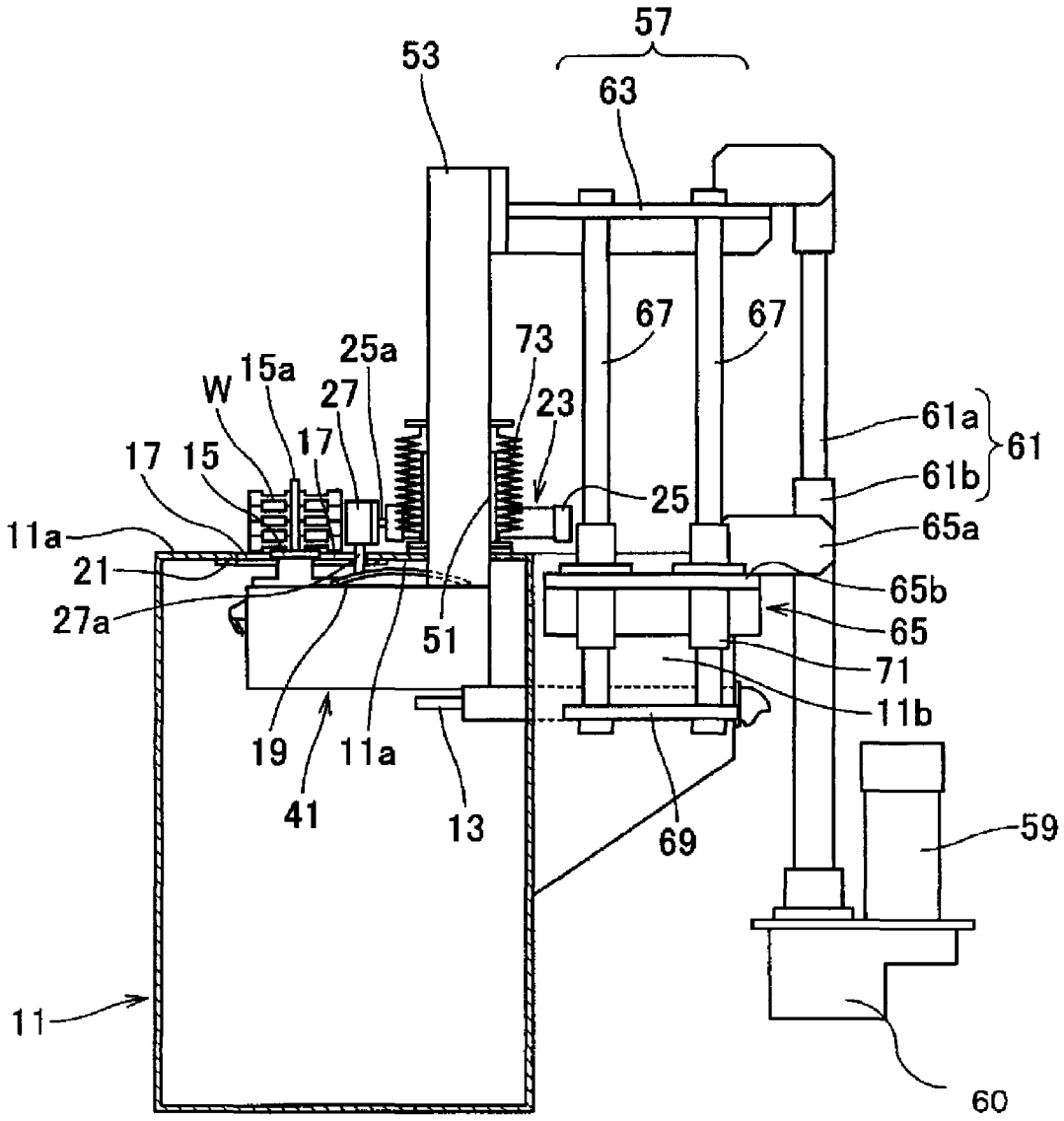

57
53
63
67
67
73
25a
15a
W
27
23
61a
61
17
15
17
61b
25
11a
65a
21
65b
27a
51
65
71
11b
19
11a
41
13
69
59
11
60

Fig. 4

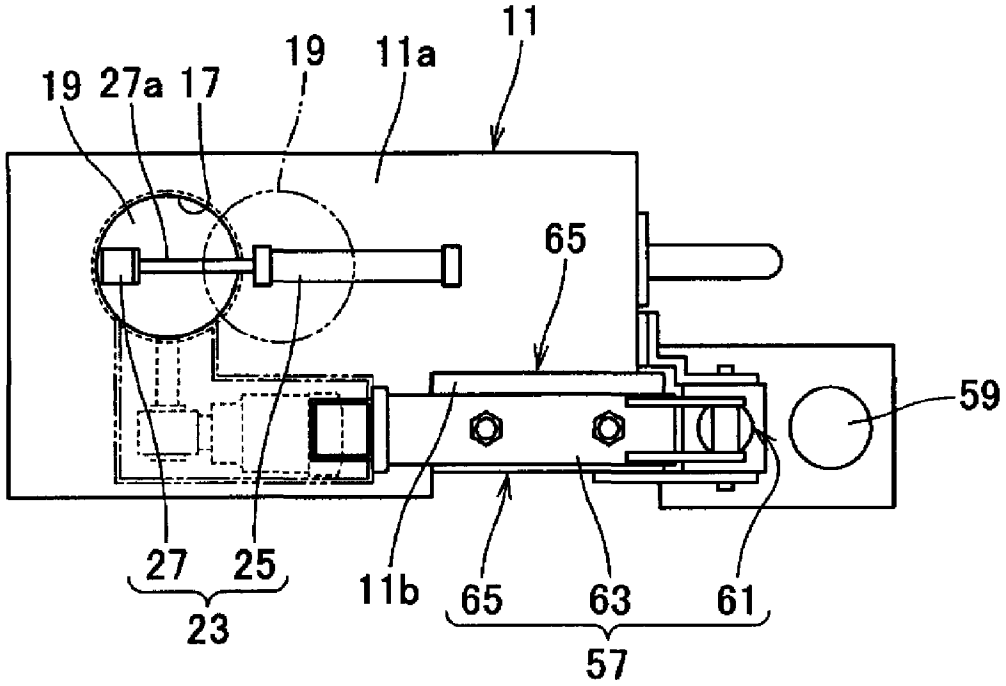
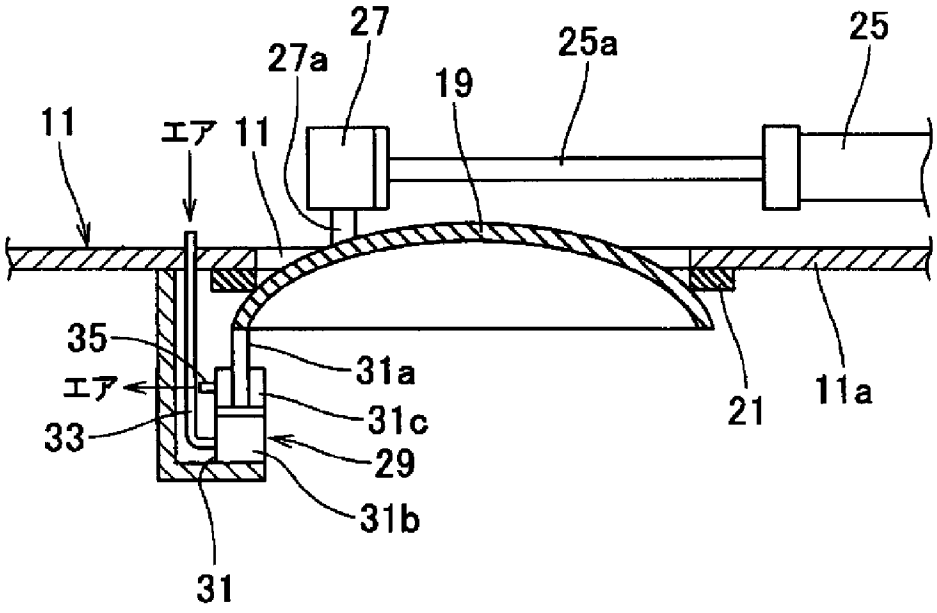


Fig. 5

(A)


27
27a
25a
25
19
11
エア
11
35
エア
33
31a
31c
29
31b
31
21
11a

(B)

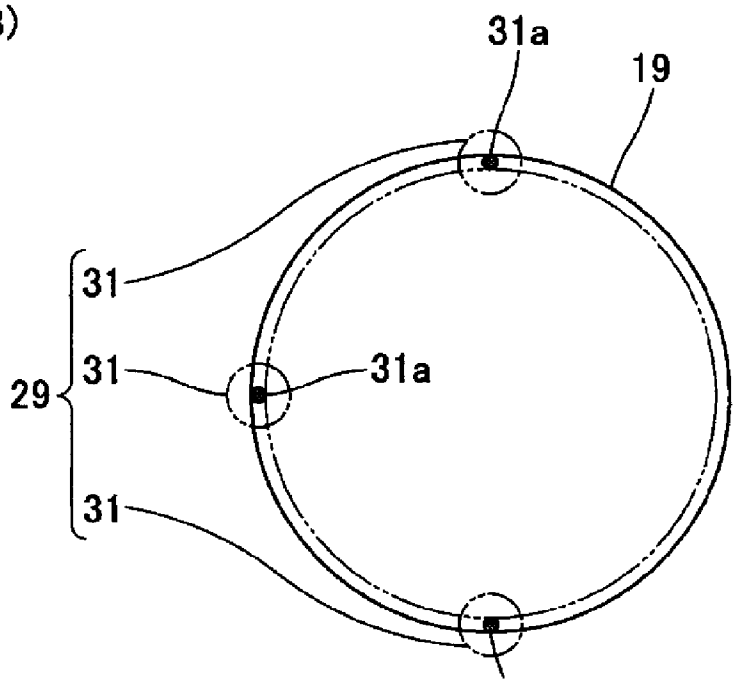

31a
19
31
29
31
31a
31

Fig. 6

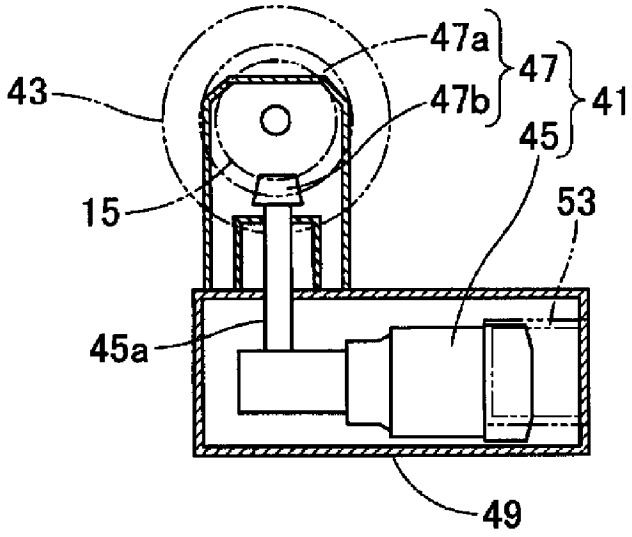


Fig. 7

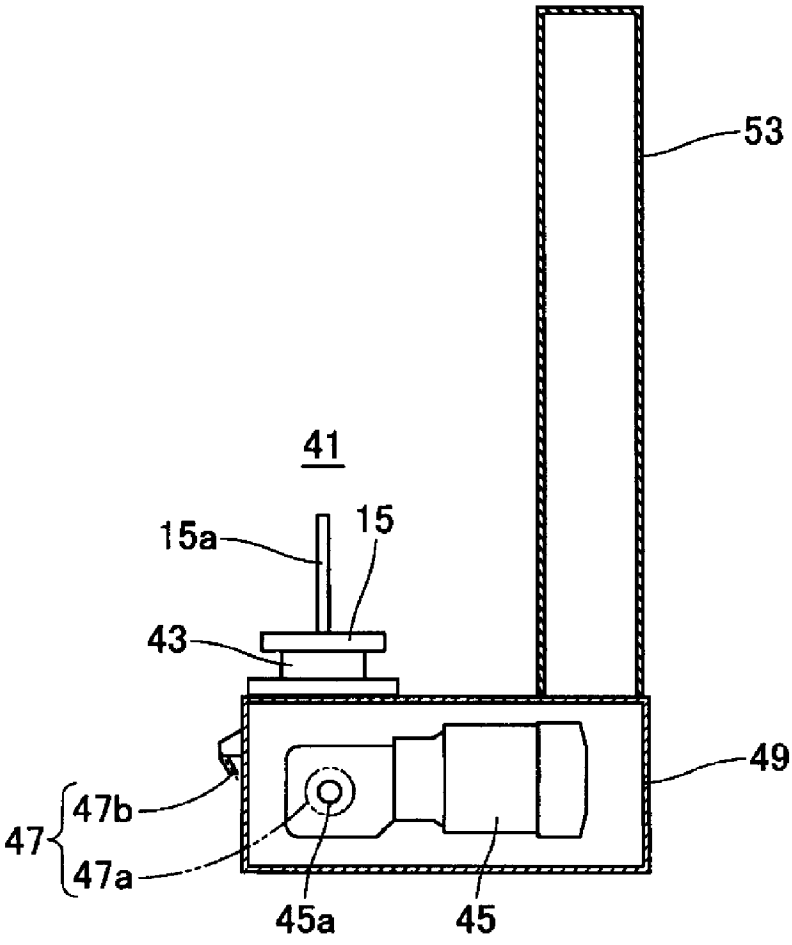


Fig. 8

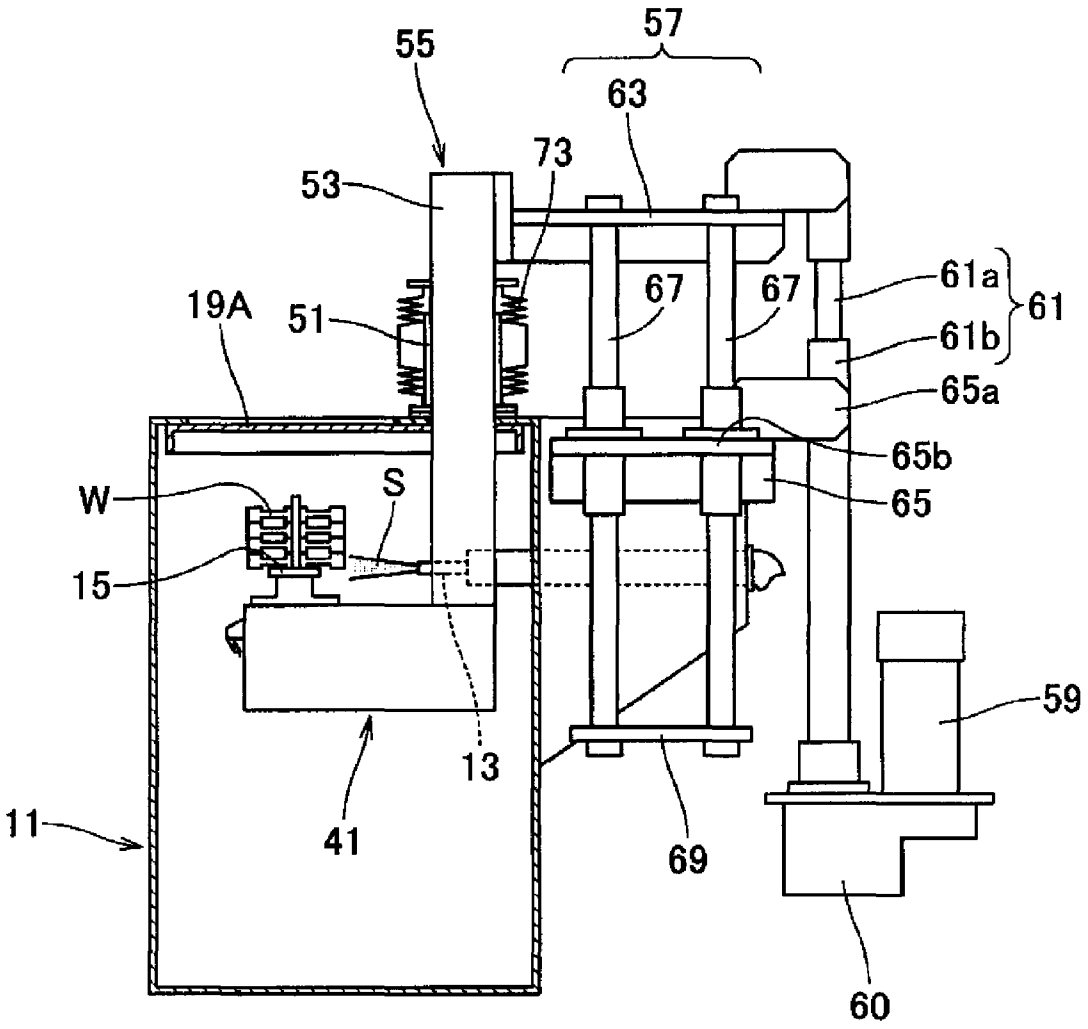

55
57
63
73
53
19A
51
67
67
61a
61
61b
65a
65b
65
W
S
15
59
13
41
11
69
60

Fig. 9

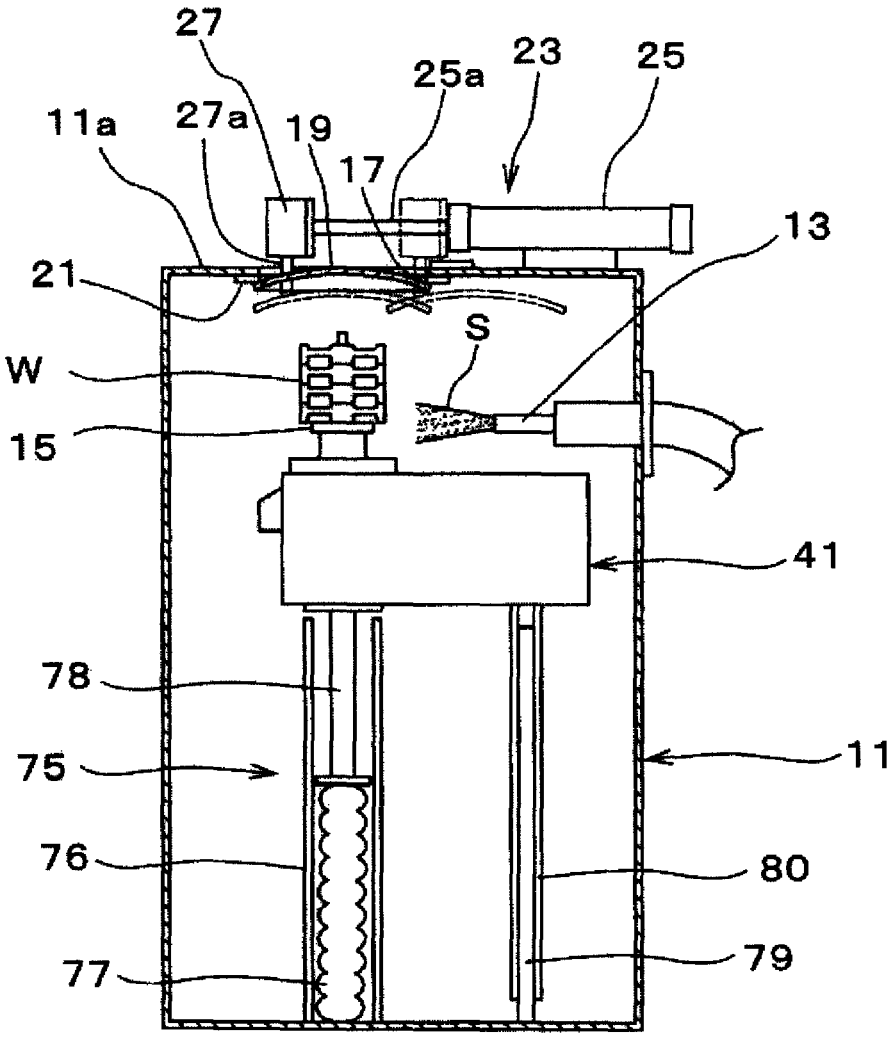


Fig. 10

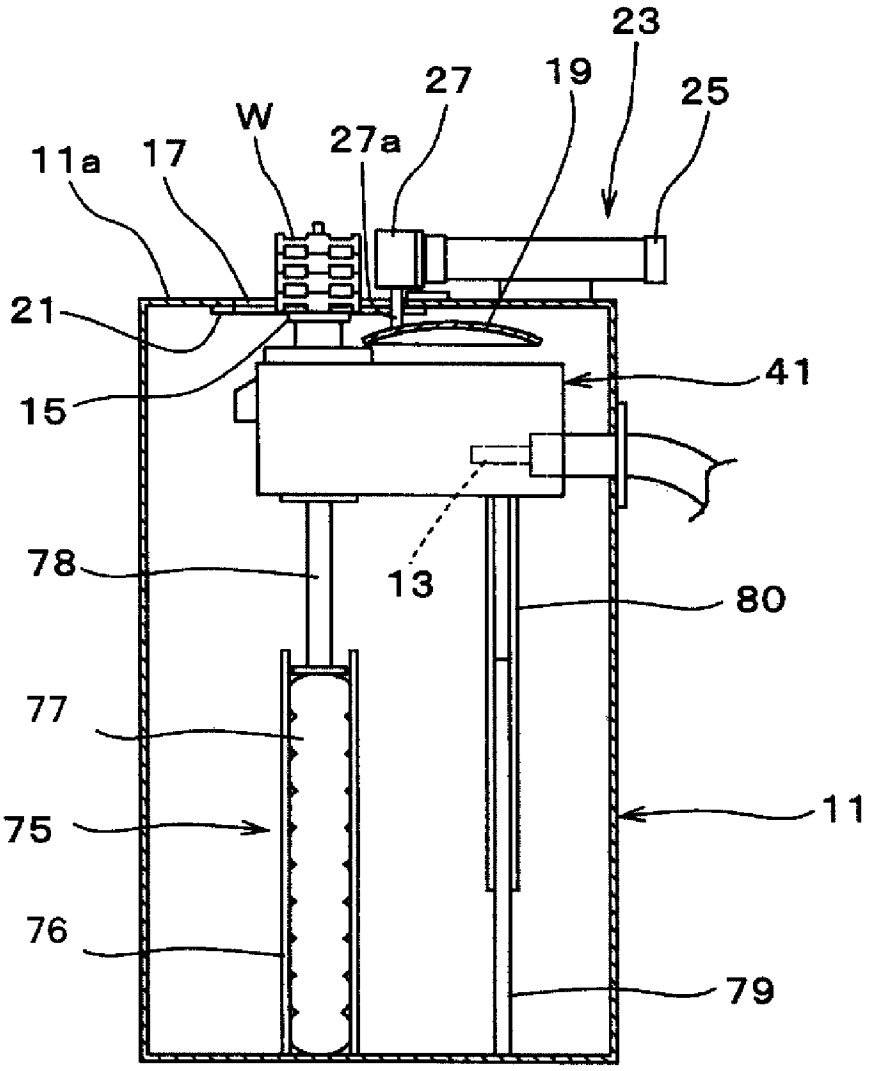


Fig. 11

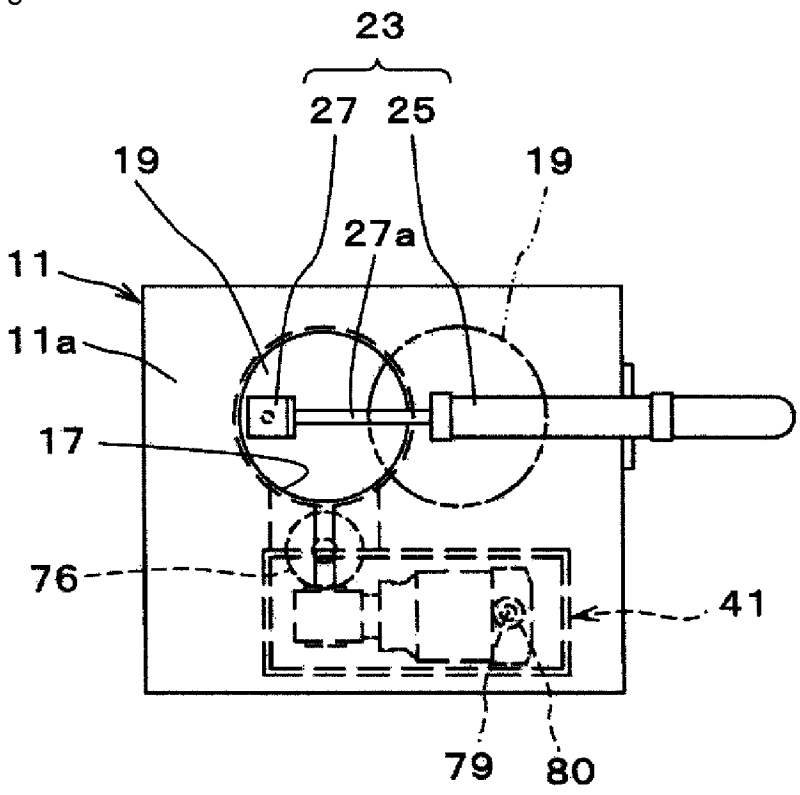


Fig. 12

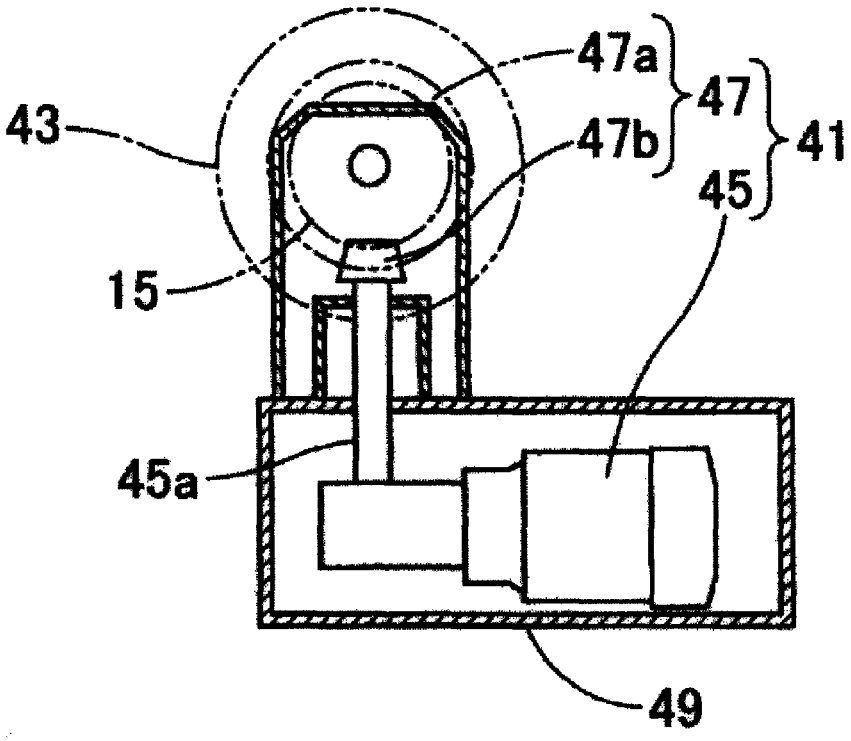
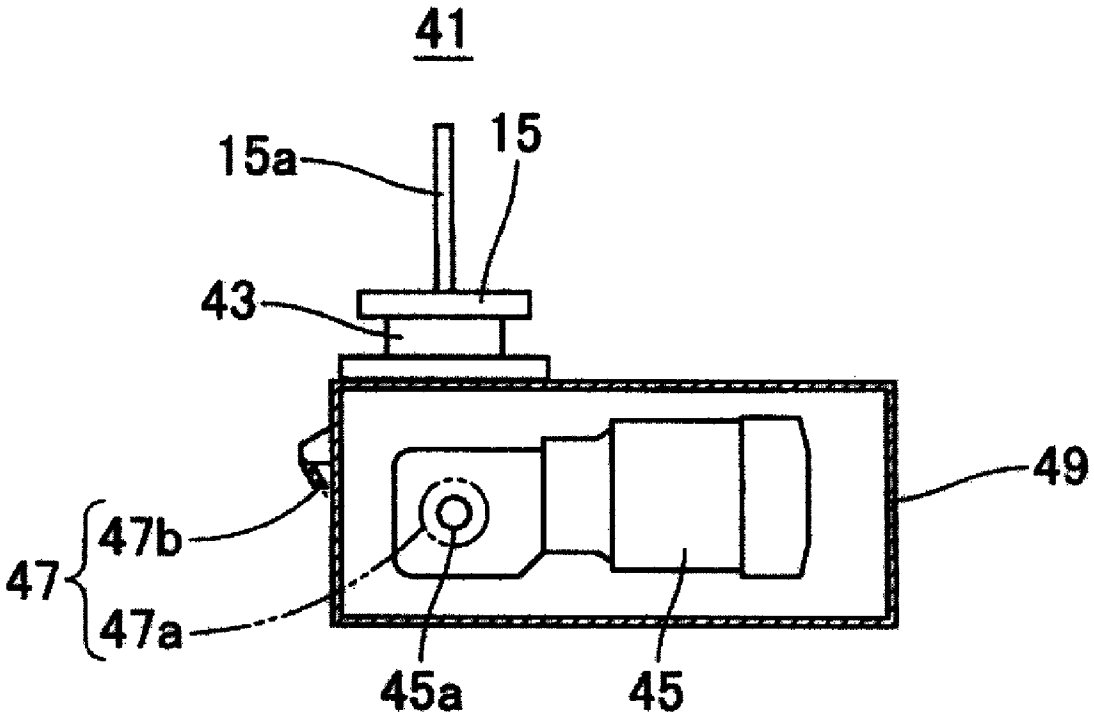


Fig. 13



MACHINE FOR BLASTING ABRASIVES

TECHNICAL FIELD

The present invention relates to a machine for blasting abrasives that is used for processing a surface of a work (an object to be processed), such as by surface modification, grinding, and burring. The machine shoots shots (abrasives) onto a work just as a machine for shot-peening or shot-blasting does.

The term "abrasives" means any materials to be shot by energy that is provided by an airflow, a fluid flow (such as a water flow), or centrifugal forces. The materials are used for processing a surface of a work such as shot blasting and shot peening. Thus, the abrasives include any materials to be shot, such as fine grains, grits, and cut wires, as well as shots (small particles).

BACKGROUND ART

FIG. **1** illustrates a schematic diagram of a prior-art machine for blasting abrasives that is used for shot blasting.

The machine for blasting abrasives comprises a nozzle (a nozzle for shooting) **113** for shooting abrasives onto a work, a jig **115** for holding the work, and a door **119** for opening and closing a gateway **117** to bring the work to be processed in and take the processed work out. The height of the jig **115** is adjustable so as to keep the work W in a position to face the nozzle **113**. The jig **115** is attached to a vertically-moving pivoting table **116**. Auxiliary cylinders **131** for clamping, which are disposed at the respective four corners of the door **119**, enable the door **119** to tightly contact, and separate from, a surrounding sealing material **121**, which is disposed along the outer rim of the gateway **117**. This structure is designed to withstand a vacuum or an unexpected high pressure in a chamber for processing.

The door **119** is disposed outside a sidewall **111***b* of the chamber **111**. The door **119** slides vertically or laterally (vertically in FIG. **1**) along the outside of the wall by means of a cylinder **123** for opening and closing the door. See Paragraph 0002 of Japanese Patent Laid-open Publication No. 2000-6028 and FIG. 1 of Japanese Patent Laid-open Publication No. H6-771.

However, the above door has the following problems. Reference is now made to Paragraph 0002 of Japanese Patent Laid-open Publication No. 2000-6028.

"The scattered blasting materials or dust generated by processing easily adhere to the surface of the door facing the machine for shot blasting. Thus the blasting materials on the surface of the door may slide into the sealing surface to deteriorate the seal. They may fall out of the machine, to contaminate the area near the machine. These have been problems. Further, the machine for shot blasting is normally kept in a vacuum during the process to prevent the shot-blasting materials from flowing out. Thus if the door is opened during the process, a differential pressure is applied to the door. That causes a problem in the operability of the door."

To solve the problems, a device for a door for a work in a chamber for shot blasting is proposed by the prior-art publication Japanese Patent Laid-open Publication No. 2000-6028 (see claim 1).

Claim 1 says the following:

"A device for a door for a work in a chamber for shot blasting, wherein an opening for passing the work is formed in a surrounding wall of a machine for shot blasting, the machine processing the work by shooting blasting materials from a nozzle for blasting by means of a high-velocity airflow, the door being provided so that the door closes the opening by contacting the rim of the opening from the inner side of the chamber."

The door disclosed in the publication is attached to the sidewall. It swings to open and shut. Thus, when the door is opened, blasting materials (abrasives) that have adhered near the door may fall outside the chamber. Thus the following component is proposed to effectively prevent the blasting materials from adhering to the door (see claim 3 and Paragraph 0004).

"A protecting cover is provided above the opening. Auxiliary covers are provided between the side section of the protecting cover and the periphery of the machine for shot blasting. A means for supplying air under the protecting cover is provided."

The prior-art publication Japanese Patent Laid-open Publication No. H10-151566 discloses a machine for burring by shot blasting to solve the problem wherein shot materials fall outside the machine (see Paragraph 0010). In the machine a gateway for a work is formed in the ceiling of the machine. One swinging door is attached by a hinge to the rim of the gateway to open and close it. The door has tapered edges (see the abstract, claim 1, and FIGS. 1 and 3).

However, in the publication, the direction to bring the work into the machine is offset from the center of a jig **15** for holding a work (a means for mounting a basket) when the work is processed. Thus a mechanism to rotate the jig **15** is needed. Further, a first cylinder for opening and closing the door is needed on the upper surface of the door. A second cylinder that is mounted on the pivot of the door is also needed. The piston rod of the second cylinder is illustrated as penetrating the door. Therefore its structure is unclear. Thus no detailed description is given that is sufficient and clear so as to enable one having ordinary skill in the art to work the invention.

It is not denied that in Japanese Patent Laid-open Publication No. H6-771 there is "a door for bringing a work in and taking it out is provided on an upper wall in a chamber for grinding" (see the abstract and claim 1). However, it is not intended nor suggested to dispose a gateway for a work with a door on the upper wall to prevent abrasives from dropping outside the machine when opening or closing the door. Actually, in the embodiment, which should be preferable, a sliding door for the gateway is provided at the sidewall.

All of the prior-art publications described above relate to a machine for shot blasting, not to a machine for shot peening.

The object of shot peening is for the surface modification of a work. That of shot blasting is for burring, grinding, making a matte finish, polishing, or making a pearskin-finish or a leather-texture finish, of the surface of a work. Thus they are different processes.

For shot peening, shots with a diameter

(e.g., 20 to 100 μm)

that is smaller than that of the blasting materials have increasingly been used to enhance the effect of shot peening. The sizes of the shots for blasting are generally in the range of

50 to 2500 μm.

Hence, the structure for sealing disclosed in Japanese Patent Laid-open Publication No. H10-151566 may not cause problems when shot blasting is carried out. However, when shot peening is carried out where fine abrasives (shots) are used, the shots may penetrate the gap between the inner surface of the gateway and the opposing outer surface of the door. Thus a problem such as a bite by the abrasives may occur there. The structure for sealing is formed as follows:

"A sealing member 47 includes an elastic portion 47*a* that is formed with silicone covered with glass wool and an attach-

ing member 47*b* that is a portion extending from the glass wool. The attaching member 47*b* is fixed to the sidewall of a door 40 by a fixing member, such as a screw. The elastic portion 47*a* is positioned at the lower edge of the sidewall of the door 40" (see Paragraph 0035 and FIG. 5).

Furthermore, the structure for sealing the door that is disclosed in Japanese Patent Laid-open Publication No. 2000-6028 and in No. H10-151566 is complicated.

In the structure for sealing disclosed in Japanese Patent Laid-open Publication No. 2000-6028 a means for supplying air is needed as described above. In the structure for sealing disclosed in Japanese Patent Laid-open Publication No. H10-151566 it comprises a link mechanism with two pin joints. To withstand a negative pressure during a process, a robust link mechanism must be used.

DISCLOSURE OF INVENTION

The present invention has been conceived to solve the above problems. It is, therefore, an object to provide a machine for blasting abrasives with a novel and simple structure that can solve the problem wherein abrasives fall when opening and closing the door for a gateway for a work.

As a result of the inventors' intense efforts for solving these problems, the structure that is, for example, illustrated in FIGS. **2** and **3**, has been conceived as the present invention. In the structure a gateway for a work is formed in the ceiling of a chamber for processing. The door for the gateway is provided on the inner side of the gateway. The door moves back and forth in a direction perpendicular to the ceiling to contact, and separate from, the ceiling. While the door separates from the ceiling it moves horizontally so as to be offset from the gateway.

A machine for blasting abrasives comprises a chamber **11** for processing, a nozzle **13** for shooting abrasives (shots) S onto a work, and a jig **15** for holding the work in the position facing the nozzle **13**. The nozzle **13** is located within the chamber **11**. A gateway **17** for the work that is formed in the chamber **11** is opened and closed by a door **19**. The machine is characterized in that the gateway **17** is formed in the ceiling **11***a* of the chamber **11**. It is also characterized in that the door **19** is provided within the chamber **11** so as to linearly move up and down to tightly contact, and separate from, the gateway **17**. While the door **19** is separating from the gateway **17**, it horizontally moves to create a vacant plane on the gateway **17** for passing a work.

In the above structure, it is preferable that the jig **15** linearly move up and down so as to be able to adjust the height. The gateway **17** is formed at the location corresponding to the jig **15** that is linearly moving up and down. It has such a size so as to enable the work W to protrude by means of the jig **15** from the chamber **11**. Since one driving source can be used for bringing the work in and taking it out and for adjusting the height of it during the process, the structure of the machine for blasting abrasives can be simplified. Further, energy can be saved.

In the above structure, it is preferable that the door **19** be shaped as a dome (hemisphere). By doing so, any error in the size of the door **19** or the opening that is manufactured may be compensated for. A misalignment of the motion of the door **19** in relation to the gateway **17** may be also compensated for. Thus sealing by the door can be reliable and stable.

Furthermore, in the above structure, it is preferable that an auxiliary mechanism **29** for shutting the door that functions under a vacuum be provided on the chamber **11**, as, for example, shown in FIG. **5**. The auxiliary mechanism **29** has a plurality of cylinders **31** that are located under the periphery of the door **19**. The tips of piston rods **31***a* press the periphery of the door. In the cylinder **31** a communication tube **33** that communicates with the outside of the chamber **11** is connected to the compressing chamber **31***b* that pushes out the piston rod **31***a*. A vent **35** that communicates with the inside of the chamber **11** is formed in a back-pressure chamber **31***c*. Since the pressure in the chamber **11** becomes negative during the process because of the operation of a dust collector, etc., sealing may be more reliable and stable (i.e., an increase of the pressure for sealing).

In the above structure the driving means for linearly moving the jig up and down can be combined with the driving means for linearly moving the door up and down.

In the above structure, as shown, for example, in FIGS. **9** and **10**, the jig **15** is connected to a driving unit **41** for rotating the jig **15**, which driving unit **41** can be vertically moved by a vertically-moving unit. The vertically-moving unit comprises a cylindrical supporting member **76** that stands under the driving unit **41** for rotating the jig on the floor of the chamber **11**. It is located near one of the ends of the driving unit **41** for rotating the jig. The vertically-moving unit also comprises an extending and contracting member **77** that is disposed within the supporting member **76**. It is shaped like a bellows to extend or contract by having fluid supplied to or discharged from it. The vertically-moving unit also comprises a circular disk that is suspended from the underside of the driving unit **41** for rotating the jig. The circular disk is slidably attached to the supporting member **76**. It contacts the upper end of the extending and contracting member **77**.

The basic Japanese patent applications, No. 2009-269551, filed Nov. 27, 2009, and No. 2010-112116, filed May 14, 2010, are hereby incorporated by reference in their entireties in the present application.

The present invention will become more fully understood from the detailed description given below. However, the detailed description and the specific embodiment are only illustrations of desired embodiments of the present invention, and so are given only for an explanation. Various possible changes and modifications will be apparent to those of ordinary skill in the art on the basis of the detailed description.

The applicant has no intention to dedicate to the public any disclosed embodiment. Among the disclosed changes and modifications, those which may not literally fall within the scope of the present claims constitute, therefore, a part of the present invention in the sense of the doctrine of equivalents.

The use of the articles "a," "an," and "the" and similar referents in the specification and claims are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by the context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illuminate the invention, and so does not limit the scope of the invention, unless otherwise claimed.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** shows a schematic sectional drawing of a prior-art machine for blasting abrasives (a machine for shot blasting).

FIG. **2** illustrates a schematic sectional front view of an embodiment (a machine for shot peening) of a machine for blasting abrasives according to the present invention, when a work is processed.

FIG. **3** illustrates the schematic sectional view of the machine for blasting the abrasives of FIG. **2**, when a work is taken out.

FIG. **4** shows a schematic plane view of the machine for blasting the abrasives of FIG. **2**.

FIG. **5**(A) illustrates a sectional view of the main section of the auxiliary mechanism for shutting the door that is used in the present invention.

FIG. **5**(B) illustrates a positional relationship between the cylinder and the door that are used in the mechanism of FIG. **5** (A).

FIG. **6** illustrates a sectional plane view of a driving mechanism for rotating a jig for holding a work.

FIG. **7** illustrates a sectional elevation view of the driving mechanism for rotating the jig for holding the work of FIG. **6**.

FIG. **8** shows a schematic sectional front view of a variation of the machine for blasting abrasives (a machine for shot peening) according to the present invention.

FIG. **9** shows a schematic sectional front view of another embodiment of the machine for abrasive processing (a machine for shot peening) according to the present invention, when a work is processed.

FIG. **10** shows a schematic sectional front view of the machine for blasting abrasives of FIG. **9**, when a work is taken out.

FIG. **11** shows a schematic plane view of the machine for blasting abrasives of FIG. **10**.

FIG. **12** illustrates a sectional plane view of a driving mechanism for rotating a jig for holding a work.

FIG. **13** illustrates a sectional elevation view of the driving mechanism for rotating the jig for holding a work of FIG. **12**.

BEST MODE FOR CARRYING OUT THE INVENTION

An embodiment of the machine for blasting abrasives (a machine for shot peening) of the present invention is illustrated in FIGS. **2** and **3**.

The machine for blasting abrasives basically comprises a chamber **11** for processing, a nozzle **13** for shooting abrasives (shots) S onto a work W, and a jig **15** for holding the work W. The nozzle **13** is located within the chamber **11**. The height of the jig **15** is adjustable so as to keep the work W in the position to face the nozzle **13**. A gateway **17** for the work is formed in the chamber **11**. It is opened and closed by a door **19**. This machine for blasting abrasives has the same structure as a prior-art machine for blasting abrasives.

The gateway **17** is formed in the ceiling **11***a* of the chamber **11**. The gateway **17** is located at a position corresponding to the jig **15** that is linearly moving up and down. Its size enables the work W to protrude from the chamber **11** by means of the jig **15**. The door **19** is provided within the chamber **11**, specifically at a height just under the ceiling **11***a*, so as to linearly move up and down to seal the gateway **17** and to horizontally (laterally) move to create a vacant plane on the gateway **17** for passing the work through it. A sealing material **21** is provided on the rim of the gateway **17**. The sealing material **21** is typically made of wear-resistant rubber or a closed-cell porous sponge.

The gateway **17** has a circular shape with its center line being aligned with that of the jig **15**. If the work W protrudes from the chamber **11**, the center line of the gateway **17** may deviate from the center line of the jig **15**.

An actuator **23** for opening and closing the door is provided adjacent the gateway **17** on the ceiling **11***a*. The actuator **23** comprises a lateral cylinder **25** for horizontal motion and a vertical cylinder **27** for vertical motion. The vertical cylinder **27** is fixed to the tip of the piston rod **25***a* of the lateral cylinder **25**.

The tip of the piston rod **27***a* of the vertical cylinder **27** is connected to the door **19** that has a shape of a dome. The position for the connection deviates from the center of the dome and toward the direction that the piston rod **25***a* of the lateral cylinder **25** extends.

The lateral cylinder **25** is configured to have the front dead point of the piston rod **25***a* located at the position where it can close the door and the back dead point at the position where it can open it.

The vertical cylinder **27** is configured to have the back dead point (upper dead point) of the piston rod **27***a* located at the position to have the door press the surrounding sealing material **21** at the rim of the gateway **17** and the front dead point (lower dead point) located at the position to have the door separate from the surrounding sealing material **21** so as to be able to slide under the ceiling **11***a*.

The machine in this embodiment preferably comprises an auxiliary unit **29** for shutting the door, as shown in FIG. **5**. The auxiliary unit **29** for shutting the door comprises a plurality (three in FIG. **5**) of auxiliary cylinders **31** for pressing the lower surface of the periphery of the door **19**. The auxiliary cylinders **31** press the lower surface of the periphery of the door **19** by means of the tips of the piston rods **31***a*. A flexible communication tube **33** to communicate with the outside of the chamber **11** (the ambient side) is connected to each chamber at the side of the piston rod, i.e., a compressing chamber **31***b* that pushes out the piston rod **31***a*. A vent **35** to communicate with the inside of the chamber **11** is formed at the chamber at the reverse side, i.e., the back-pressure chamber **31***c*. By so constructing the machine for blasting the abrasives, when the pressure in the chamber **11** is as that in a vacuum (below the atmospheric pressure), each piston rod **31***a* functions as an aid to press the door **19**, to close it.

Though the door **19** may be shaped as a flat plate as shown in FIG. **8** (the door **19**A in FIG. **8**), it is preferably shaped as a dome (hemisphere) as illustrated in FIG. **5**, because a door with such a shape can easily and uniformly contact the surface of the sealing material and ensure a high sealing (contacting) ability. Thus dust can be reliably prevented from leaking from the chamber **11** for processing even if the pressure in the chamber **11** reaches the atmospheric pressure or higher.

The jig **15** for holding the work that comprises a rod **15***a* for placing the work on the rod **15***a* is attached to a driving unit **41** for rotating the jig, as shown in FIGS. **6** and **7**. The driving unit **41** for rotating the jig comprises a rotating table **43** on which the jig **15** is set, a rotating motor **45** that is a driving source for the rotating table **43**, and a bevel-gear system **47** to transfer the output from the rotating motor **45** to the rotating table **43** by changing the axes of rotation. The bevel-gear system **47** comprises a bevel spur-gear **47***a* that is formed under the rotating table **43** and a bevel pinion **47***b* that is fixed at the tip of the output shaft **45***a* of the rotating motor **45**.

The driving unit **41** is held within, and is covered by, a holding arm **49** that functions to prevent dust from entering the arm **49**. The arm **49** is a square tube with an L shape in a horizontal plane.

The root of the holding arm **49** is connected to the lower end of a vertically-moving column (square pipe) **53** that is supported by a sleeve **51** on the ceiling **11***a* of the machine.

In this embodiment, one driving source, i.e., an actuator for moving the work up and down (called a "vertically-moving actuator" below) **57** can drive both a mechanism for adjusting the height of the work and a mechanism for causing the work to protrude.

The vertically-moving actuator **57** comprises the vertically-moving column **53**, to the lower end of which the driving actuator **41** for rotating the jig is attached, a vertically-moving cylinder **61**, which is a driving source, and a

connecting arm **63**, which connects the piston rod **61***a* of the vertically-moving cylinder **61** to the upper end of the vertically-moving column **53**.

The vertically-moving cylinder **61** is an electric cylinder that is driven by a servomotor (electric motor) **59** via gears. The number **60** in the drawings denotes a gear case. The source to drive the vertically-moving actuator **57** is not limited to an electric cylinder, but may be a hydraulic cylinder, a pneumatic cylinder, or a scissor lift driven by a chain.

The piston rod **61***a*, which is the moving part of the vertically-moving cylinder **61**, and the upper end of the vertically-moving column **53**, are connected by the connecting arm **63**. Thus they move up and down in an integrated manner.

The vertically-moving actuator **57** is supported by a frame (mounting) **65** that is fixed to the sidewall **11***b* of the chamber **11** as follows:

The cylinder portion **61***b* of the vertically-moving cylinder **61** is clamped by brackets **65***a*, **65***a* at the front side of the frame **65**. The brackets **65***a*, **65***a* are formed on the sidewall of the chamber **11**.

The connecting arm **63** is equipped with a pair of guide rods **67**, **67** that extend downward. The lower ends of the guide rods **67**, **67** are connected by a connecting plate **69**. They are guided by a pair of fixed guiding tubes **71**, **71** that are attached to a horizontal supporting plate **65***b* of the frame **65** to enable the vertically-moving column **53** to smoothly move up and down.

A portion of the vertically-moving column **53** corresponding to the sleeve **51** is covered with a bellows-type dust boot **73**. It is used for preventing dust that is generated in the chamber **11** or fine shots from leaking out of the chamber **11**.

Each cylinder may be a pneumatic cylinder, a hydraulic cylinder, or an electric cylinder. An electric cylinder is preferable because no piping that is generally used for a pneumatic cylinder or a hydraulic cylinder is required.

Next, the usage of the machine for blasting abrasives (machine for shot peening) of the present invention will be described.

The machine for blasting abrasives may be used not only for shot peening, but also for shot blasting. Works that can be processed by shot peening include a variety of gears, a variety of shafts, springs, parts of engines, turbine engines for aircraft, and machine tools. Works that can be processed by shot blasting with a nozzle as described in the above embodiment are the same as those for shot peening. For shot blasting that is energized by centrifugal forces (impellers), the works to be processed include cast products that are subject to sand stripping and wrought products and products made by performing work on a plate that are subject to scaling or burring.

First, the gateway **17** for the work is opened by activating the actuator **23** for opening and closing the door. That is, the door **19** is lowered by activating the vertical cylinder **27**. Then, by activating the lateral cylinder **25**, the door **19** is moved to the position under the ceiling **11***a* that is adjacent to the gateway **17**. Thus the door **19** is opened. By doing so the gateway **17** is then in a condition that a work can pass through it.

The jig **15** is elevated by activating the vertically-moving actuator **57** to cause it to protrude from the ceiling **11***a* of the machine for blasting abrasives. In this condition the work W is placed on the jig **15**. Then the vertically-moving actuator is again activated to lower and adjust the work W to the height that is predetermined for the process.

Then the door **19** is closed by activating the actuator **23** for opening and closing the door. That is, the door is laterally moved by the lateral cylinder **25** to the position corresponding to the gateway **17**. Then the door **19** is elevated by the vertical cylinder **27** to the position where it presses the sealing material **21** at the rim of the gateway **17**.

In that condition, the abrasives S are blasted from the nozzle **13** onto the work W. If required, the work W is rotated by activating the rotating motor **45**.

When blasting the abrasives, a dust collector (not shown) that is connected to the chamber **11** is generally used to retrieve the abrasives or collect dust. Thus the pressure in the chamber **11** becomes that of a vacuum.

In this embodiment, the lower surface of the periphery of the door **19** is pressed by the piston rod **31***a* of the auxiliary cylinder **31** for pressing when the piston rod **31***a* is elevated. This is caused by air that is introduced from the outside of the chamber **11** into the compressing chamber **31***b* of the auxiliary cylinder **31** and air that escapes from the back-pressure chamber **31***c*, since the pressure in the chamber **11** is that of a vacuum because of the operation of the dust collector as described above (see FIG. **5**).

If a plurality of portions or a wide area in the vertical direction is to be processed, the work W (the jig **15** for holding the work) is moved up and down in a discontinuous or a continuous manner by the vertically-moving actuator **57**.

While the work W is processed, the gateway **17** is located in the ceiling **11***a* of the chamber **11**. Thus, the abrasives that fly in all directions during the process fall due to their own weight. Therefore the leakage of the abrasives out of the chamber is greatly reduced in compared to if the gateway **17** were to be located in the sidewall.

Further, if the gateway for the work were to be provided in the sidewall, the gateway would have to be enlarged so that a tall work could be passed through it. However, in the present invention, when the gateway **17** is provided in the ceiling **11***a*, the gateway **17** is formed as a circle by considering only the diameter of the work. Thus the perimeter of the gateway **17**, i.e., the length to be sealed, can be greatly shortened. Because of this, the leakage of the abrasives during the process can be reduced.

After processing the work W in the way described above, the dust collector is stopped, and the door **19** is opened by activating the actuator **23** for opening and closing the door as described above.

At this time, the vertically-moving actuator **57** is activated to move the work out of the chamber **11** and through the ceiling **11***a* (gateway **17**). Thus the work (product) is taken out of the jig **15**.

When taking out the work W, the abrasives that have adhered to the work W may fall off it. Since the abrasives fall due to their own weight, they seldom fall outside of the gateway **17**.

A variation from the above-described embodiment is illustrated in FIG. **8**. In the variation, the door **19**A is shaped as a rectangular plate, not as a dome. The function and effects of the variation are the same as those of the above-described embodiment except for those caused by the door **19**A. Thus the elements other than the door **19**A are denoted by the same numbers. So the descriptions of those elements are omitted.

In the above-described embodiment, the driving source for moving the jig **15** up and down to protrude the work from the chamber **11** and the driving source for adjusting the height of the work during the process are the same source. However, they may be separate sources. Further, the work W may be placed on, or taken out of, the jig **15** within the chamber **11**.

In the present invention, the height of the nozzle **13** relative to that of the work W may be adjusted by just moving the nozzle **13** up and down while the height of the jig **15** is fixed.

Next, another embodiment of the machine for blasting abrasives (machine for shot peening) of the present invention is described with reference to FIGS. **9** and **10**. In the machine for blasting abrasives in FIGS. **9** and **10**, the way for moving the driving unit **41** up and down to which the jig **15** is attached differs from that of the machine for blasting abrasives in FIGS. **2** and **3**.

The jig **15** for holding the work that comprises a rod **15***a* for placing the work on the rod **15***a* is attached to a driving unit **41** for rotating the jig, as shown in FIGS. **11** and **12**. The driving unit **41** for rotating the jig comprises a rotating table **43** on which the jig **15** is set, a rotating motor **45** that is a driving source for the rotating table **43**, and a bevel-gear system **47** to transfer the output from the rotating motor **45** to the rotating table **43** by changing the axes of rotation. The bevel-gear system **47** comprises a bevel spur-gear **47***a* that is formed under the rotating table **43** and a bevel pinion **47***b* that is fixed at the tip of the output shaft **45***a* of the rotating motor **45**.

The driving unit **41** is held within, and is covered by, a holding arm **49** that functions to prevent dust from entering the arm **49**. The arm **49** is a square tube with an L shape in a horizontal plane.

The height and position of the driving unit **41** to which the jig **15** is attached can be adjusted by a vertically-moving unit **75**. The vertically-moving unit **75** comprises a cylindrical supporting member **76** that stands on the floor of the chamber **11** at a position below the left side in FIGS. **9** and **10** of the driving unit **41** for rotating the jig. It also comprises an extending and contracting member **77** that is inserted into the supporting member **76** and is constructed like a bellows so as to extend or contract in the vertical direction by having compressed air supplied to or discharged from it like a balloon. It also comprises a vertically-moving member **78** that is suspended from the underside of the driving unit **41** for rotating the jig and loosely and slidably held by the supporting member **76**. The vertically-moving member **78** has a circular disk that contacts the upper end of the extending and contracting member **77**. The vertically-moving unit **75** also comprises a guiding rod **79** that stands on the floor of the chamber **11** at a position below the right side in FIGS. **9** and **10** of the driving unit **41** for rotating the jig. It also comprises a guiding sheath **80** that is suspended from the underside of the driving unit **41** for rotating the jig and slidably attached around the guiding rod **79**. The height of the vertically-moving unit **75** is adjusted by supplying and discharging compressed air to and from the extending and contracting member **77**. The guiding rod **79** and the guiding sheath **80** function as a guide to stabilize the up and down motion of the driving unit **41** for rotating the jig. Thus the guiding rod **79** and the guiding sheath **80** are preferably disposed, on the underside of the driving unit **41** for rotating the jig, at a position symmetrical to the position of the supporting member **76**, the extending and contracting member **77**, and the vertically-moving member **78**. The guiding rod **79** and the guiding sheath **80** are not necessarily provided. The guiding rod **79** may be suspended from the underside of the driving unit **41** for rotating the jig and the guiding sheath **80** may stand on the floor of the chamber **11**. Further, the supporting member **76**, the extending and contracting member **77**, and the vertically-moving member **78**, or the guiding rod **79** and the guiding sheath **80**, are not limited to one set. Though in this embodiment compressed air is supplied to, and discharged from, the extending and contracting member **77**, the fluid that is supplied to, and discharged from, the extending and contracting member **77** may be a liquid.

The door **19** is opened to enable the work W to pass through the gateway **17**. The door **19** is opened and closed in the same way as that shown in FIGS. **2** and **3**.

After opening the door **19**, compressed air is supplied to the extending and contracting member **77** of the vertically-moving unit **75**. The jig **15** is elevated to protrude out of the ceiling **11***a* of the machine for blasting abrasives. In such a condition the work W is set on the jig **15**. Then the compressed air is discharged from the extending and contracting member **77** of the vertically-moving unit **75** to lower and adjust the work W to the position that is predetermined for the process.

Then the door **19** is closed. The abrasives S are blasted from the nozzle **13** onto the work W. The way to blast the abrasives S is the same as that shown in FIGS. **2** and **3**.

If a plurality of portions or a wide area in the vertical direction is to be processed, the work W (the jig **15**) is moved up and down by the vertically-moving unit **75** in a discontinuous or a continuous manner.

When the process (peening or blasting) of the work W is completed, the dust collector is stopped. Then the door **19** is opened by activating the unit for opening and closing the door in the same way as described above.

At this time, compressed air is supplied to the extending and contracting member **77** of the vertically-moving unit **75** to move the work out of the chamber **11** and through the ceiling **11***a* (gateway **17**). Thus the work (product) is taken out of the jig **15**.

When taking out the work W, the abrasives that have adhered to the work W may fall off it. Since the abrasives fall due to their own weight, they seldom fall outside the gateway **17**.

In the above-described embodiments, the driving source for vertically-moving the jig for placing a work on it and taking it out and the driving source for adjusting the height of the work during the process, are the same source. However, they may be different sources. Further, the work W may be placed on, or taken out of, the jig **15** within the chamber **11**.

The invention claimed is:

1. A machine for blasting abrasives comprising:
a chamber for processing;
a nozzle for shooting the abrasives onto a work, the nozzle being located within the chamber; and
a jig for holding the work in a position facing the nozzle;
wherein a gateway for the work being formed in the chamber is opened and closed by a door;
characterized in that the gateway is formed in the ceiling of the chamber; and
in that the door is provided within the chamber so as to be able to linearly move up and down to contact, and separate from, the gateway from inside the chamber, and,
in that, while the door is separating from the gateway, the door horizontally moves to create a vacant plane on the gateway for passing the work.

2. A machine for blasting abrasives comprising:
a chamber for processing;
a nozzle for shooting the abrasives onto a work, the nozzle being located within the chamber; and
a jig for holding the work in a position facing the nozzle, the jig being moved up and down to adjust a height;
wherein a gateway for the work that is formed in the chamber is opened and closed by a door;
characterized in that the gateway is formed in a ceiling of the chamber at a position corresponding to the jig that is linearly moving up and down, a size of the gateway enabling the jig to cause the work to protrude from the chamber; and
in that the door is provided within the chamber so as to be able to linearly move up and down to contact, and separate from, the gateway from inside the chamber, and,

while the door is separating from the gateway, the door horizontally moves to create a vacant plane on the gateway for passing the work.

3. The machine for blasting abrasives of claim **1** or **2**, wherein the door is shaped as a dome.

4. The machine for blasting abrasives of claim **3**, further comprising:

an auxiliary mechanism for shutting the door being operated when a pressure in the chamber is that of a vacuum;

wherein the auxiliary mechanism for shutting the door is configured so that a plurality of cylinders are provided at positions corresponding to a lower surface of a periphery of the door, so that tips of piston rods of the cylinders press the lower surface of the periphery of the door, so that communication tubes that connect respective compressing chambers of the cylinders to outside the chamber so that the compressing chambers push out the piston rods, and so that vents are formed in back-pressure chambers of the cylinders to communicate with the chamber.

5. The machine for blasting abrasives of claim **1** or **2**,

wherein the jig is attached to a driving unit for rotating the jig, and

wherein the driving unit for rotating the jig is vertically moved by a vertically-moving unit, the vertically-moving unit comprising:

a cylindrical supporting member standing on a floor of the chamber under a side of the driving unit for rotating the jig;

an extending and contracting member being provided within the supporting member, the extending and contracting member being shaped like a bellows to vertically extend or contract by having fluid supplied to or discharged from the supporting member; and

a circular disk being suspended from an underside of the driving unit for rotating the jig and slidably attached to the supporting member, the circular disk contacting an upper end of the extending and contracting member.

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