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(54) **CONNECTOR AND MACHINING APPARATUS**

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(57) **ABSTRACT**

A connector configured to connect a machining apparatus and a dust collection device includes a through-hole configured to establish communication between the machining apparatus and the dust collection device, and an outer surface made of a static dissipative material.

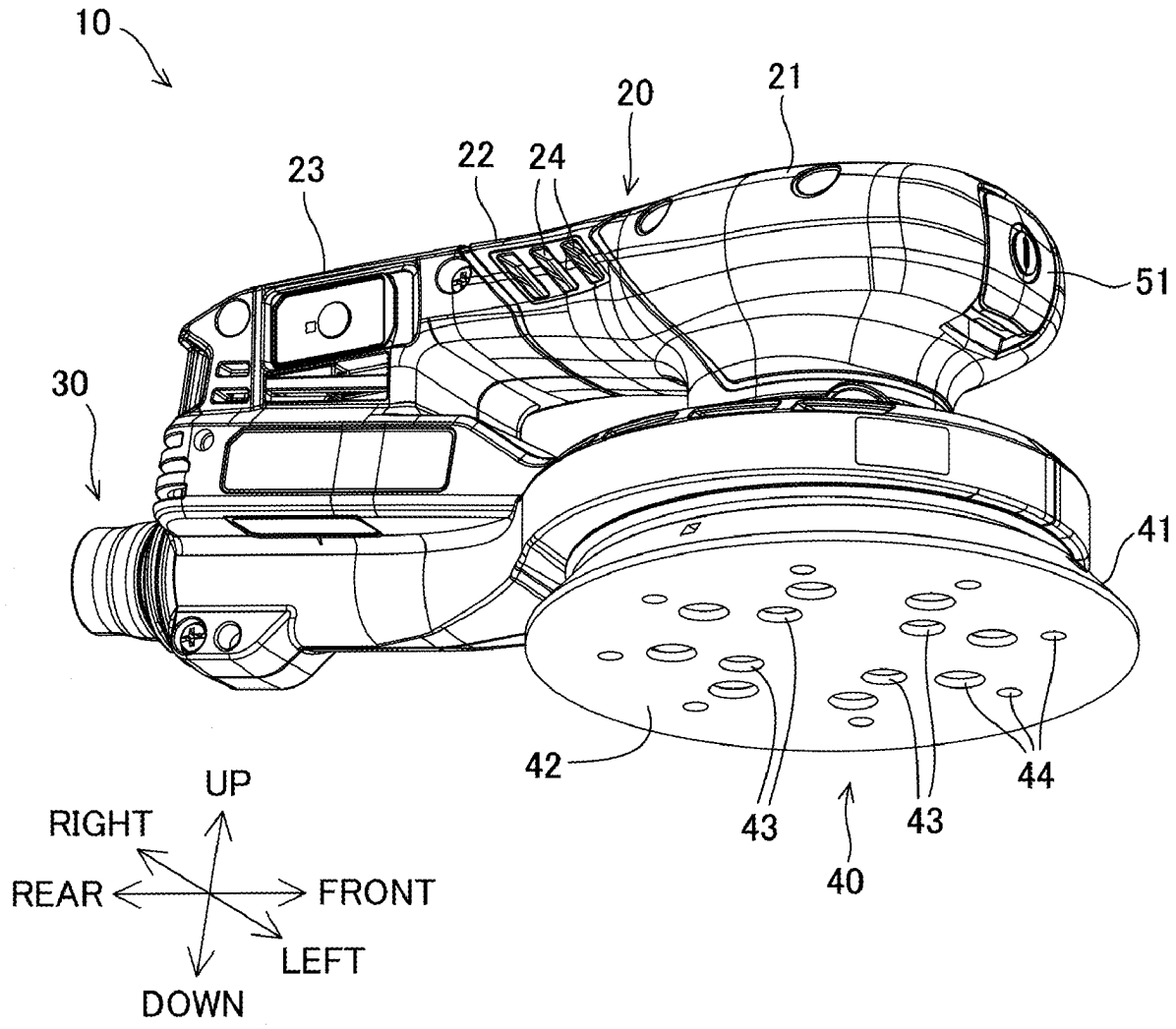


FIG. 1

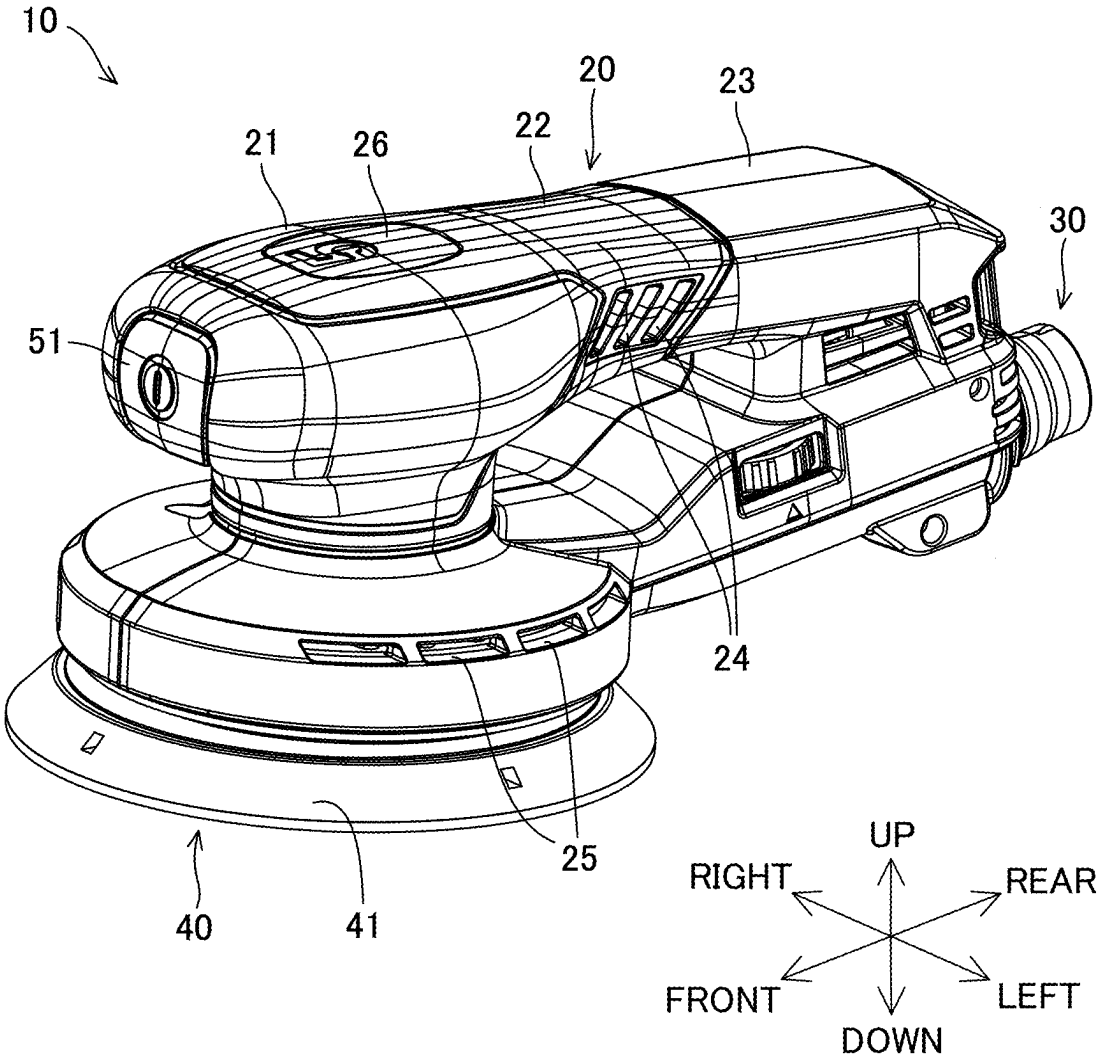


FIG. 2

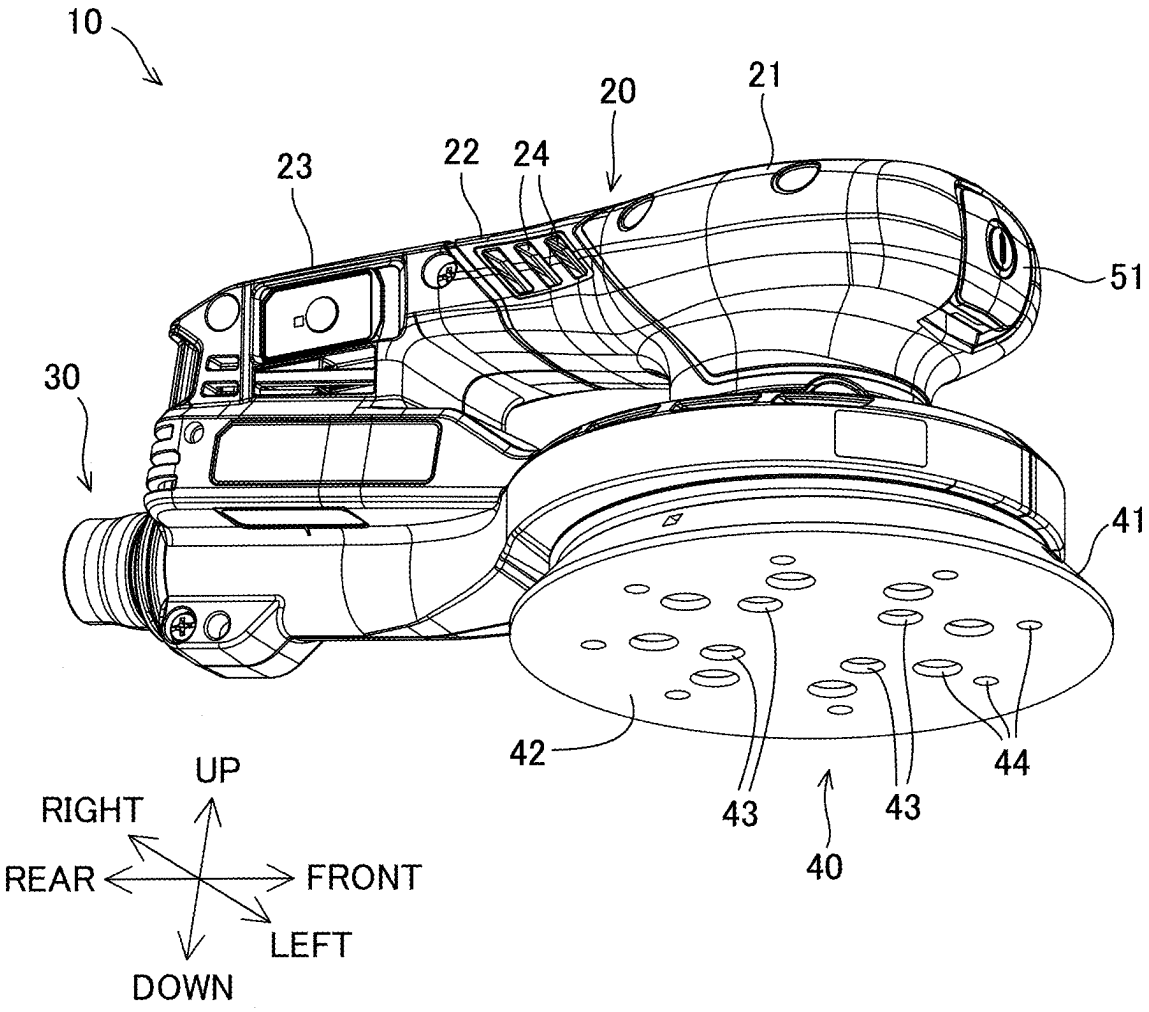

10
20
21
23
22
24
51
30
41
42
43
43
44
40
UP
RIGHT
REAR
FRONT
LEFT
DOWN

FIG. 3

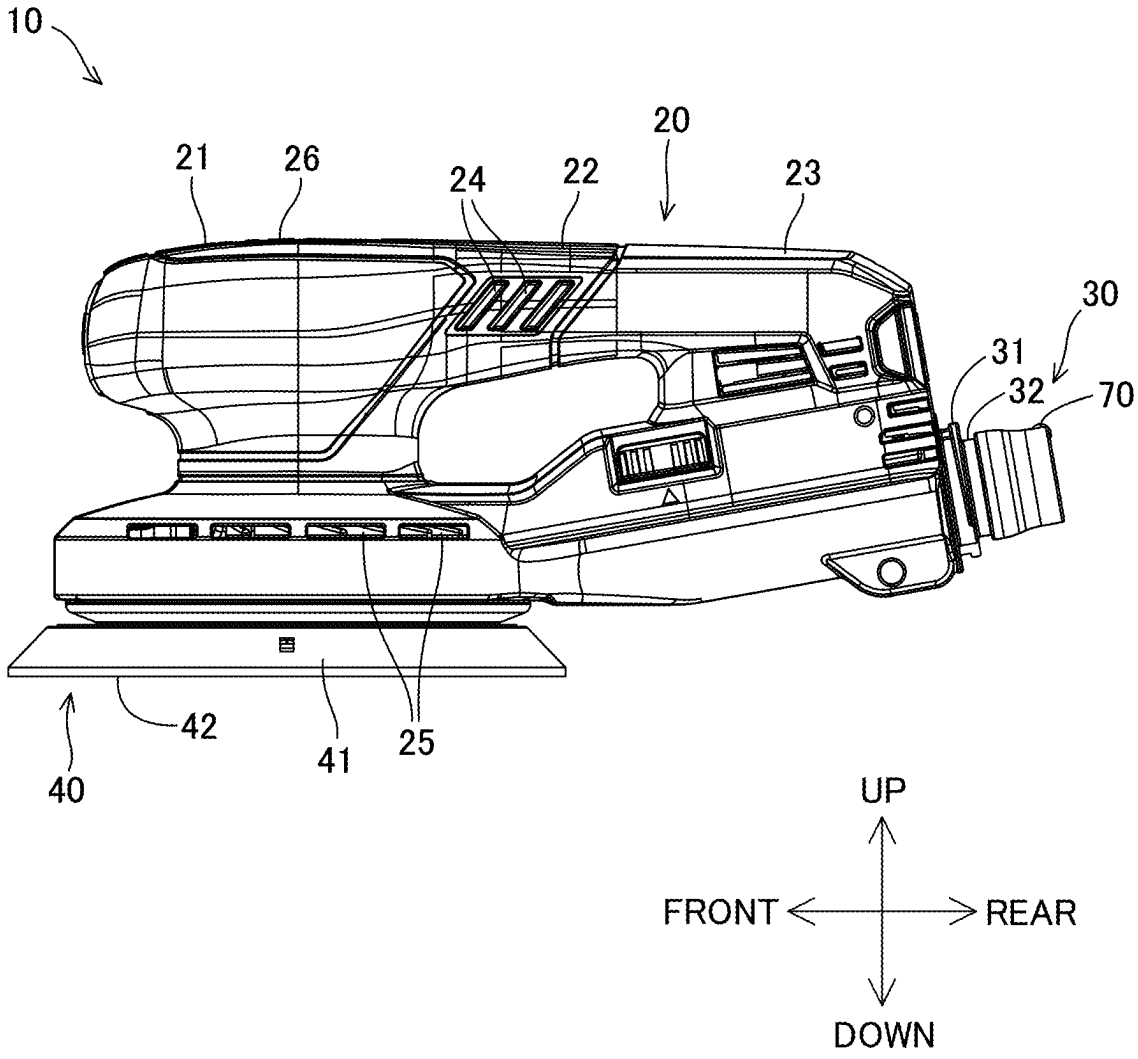
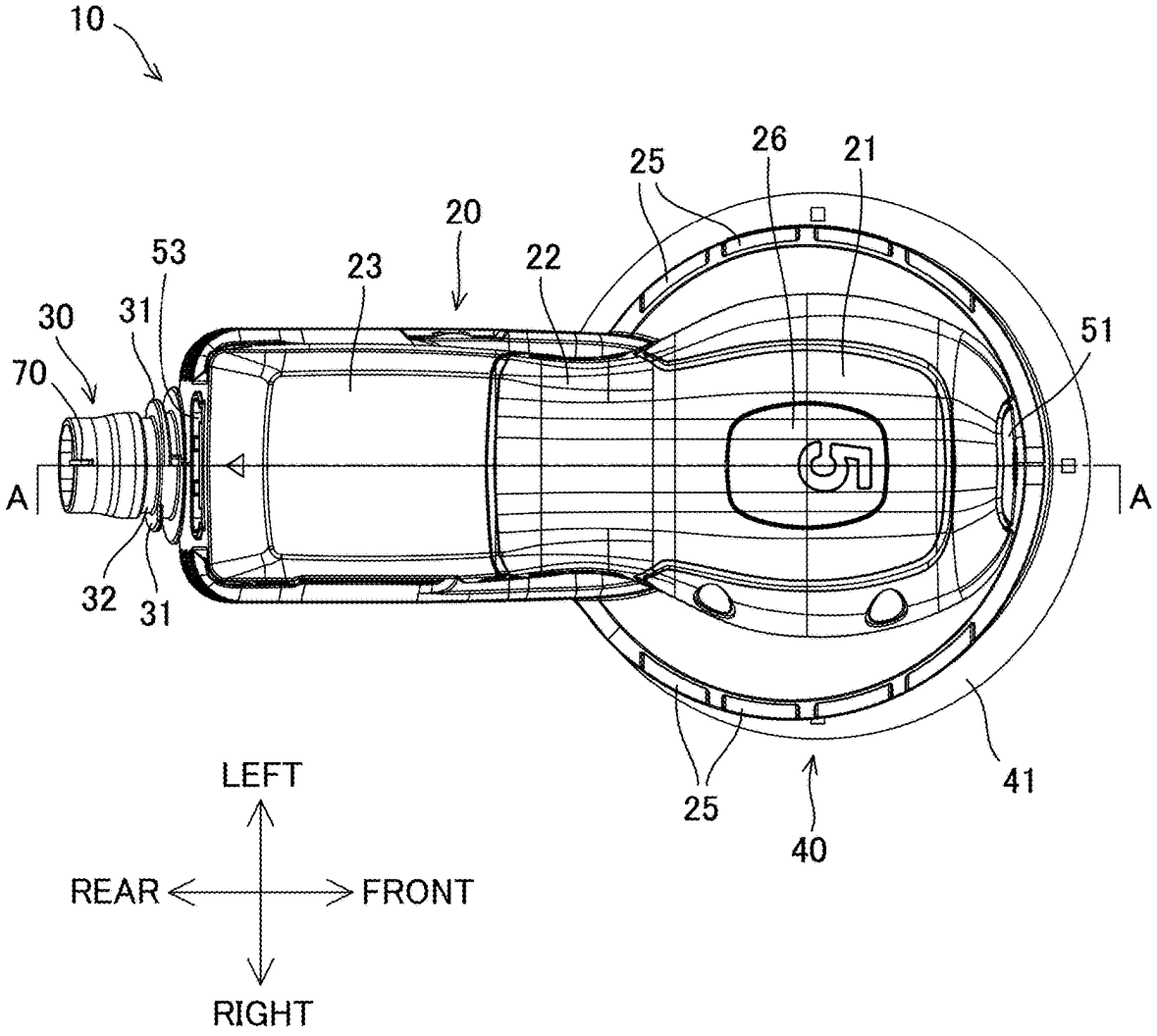


FIG. 4


10
25
26
21
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53
23
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30
31
51
70
A
A
32
31
25
40
41
LEFT
REAR
FRONT
RIGHT

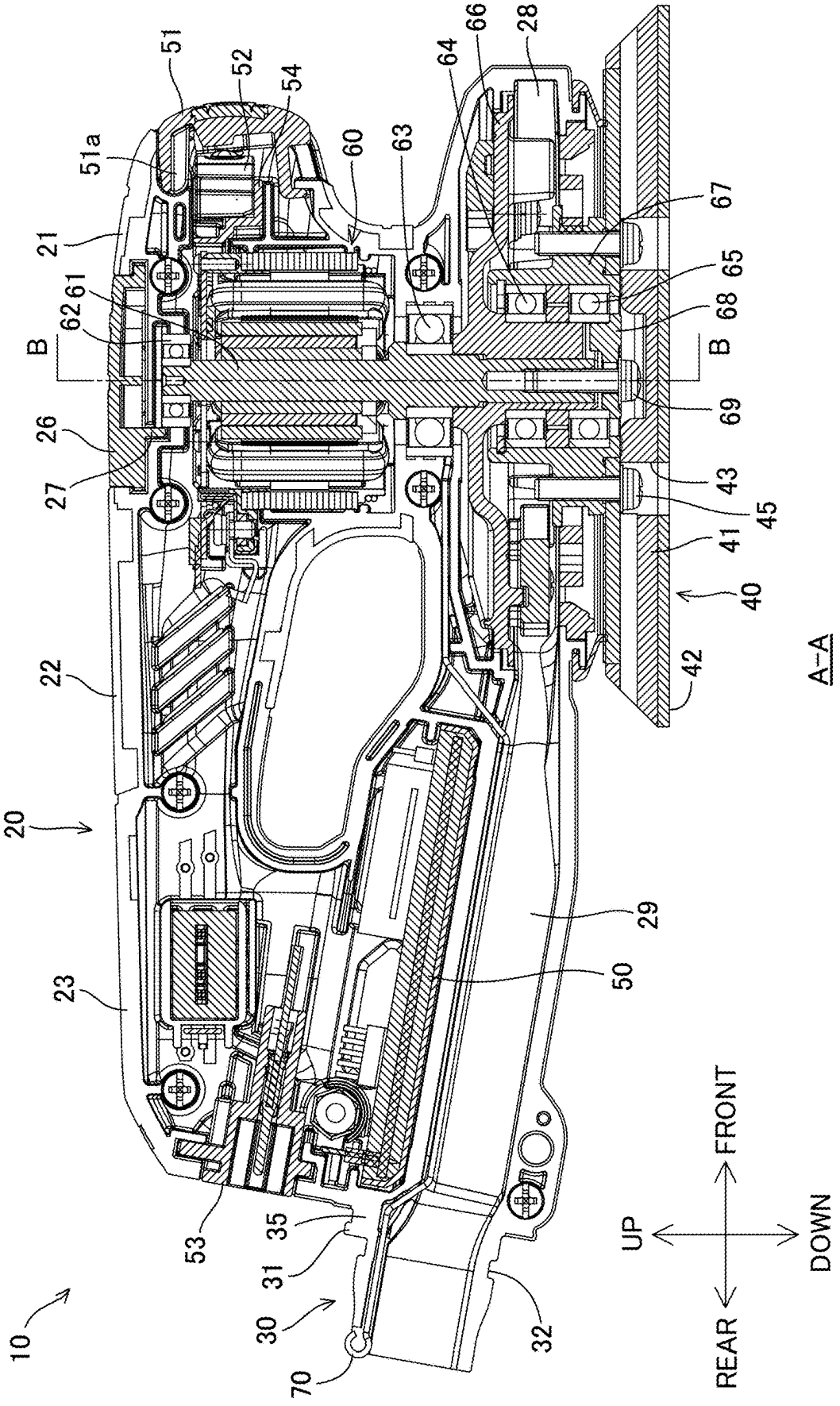
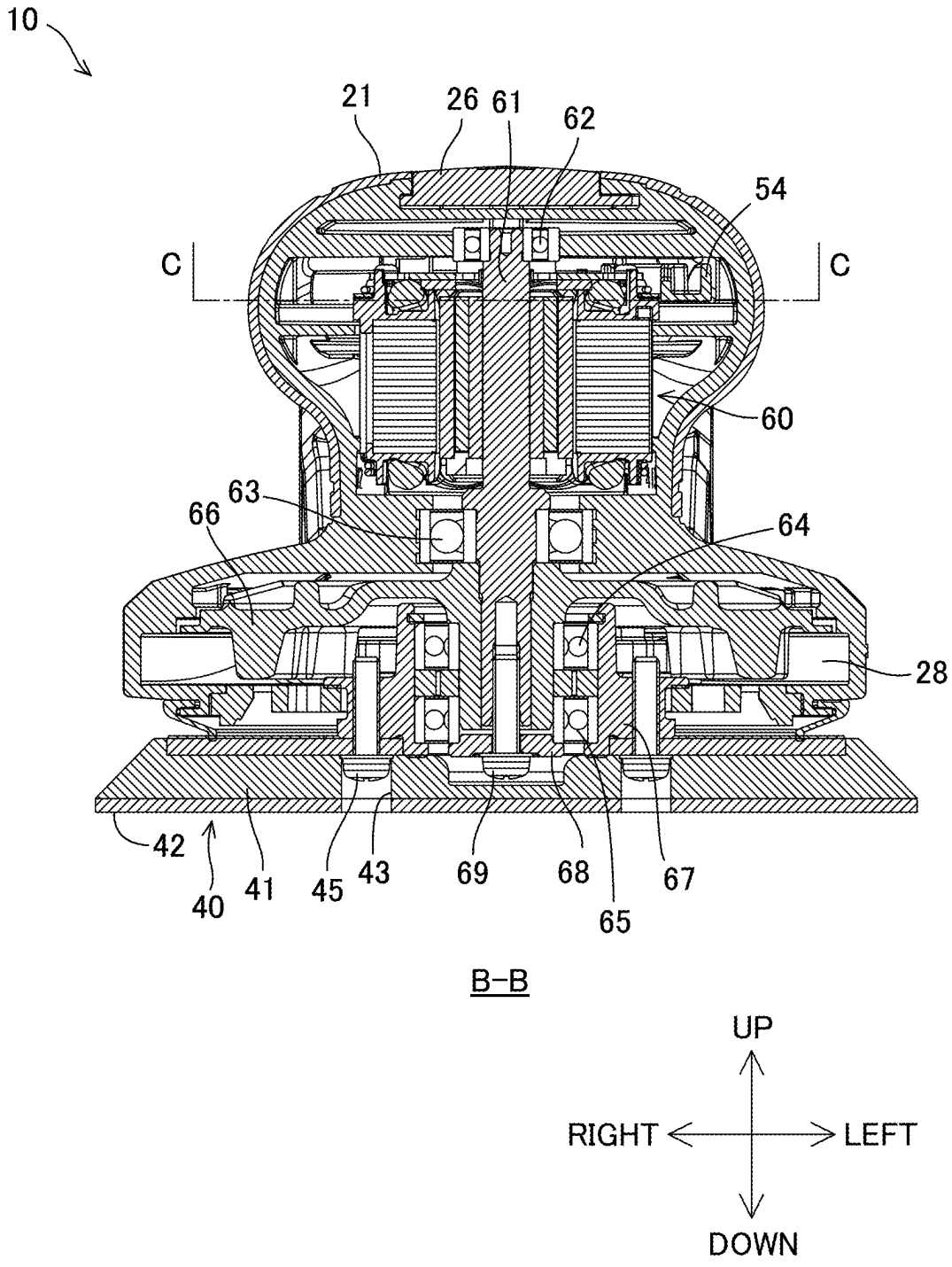

51
52
54
64
66
28
51a
60
63
67
21
61
62
65
68
B
B
26
69
27
43
45
41
40
22
42
A-A
20
29
50
23
53
35
31
30
70
32
10
UP
FRONT
DOWN
REAR

FIG. 5

FIG. 6


10
21
26
61
62
54
C
C
60
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B-B
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DOWN

FIG. 7

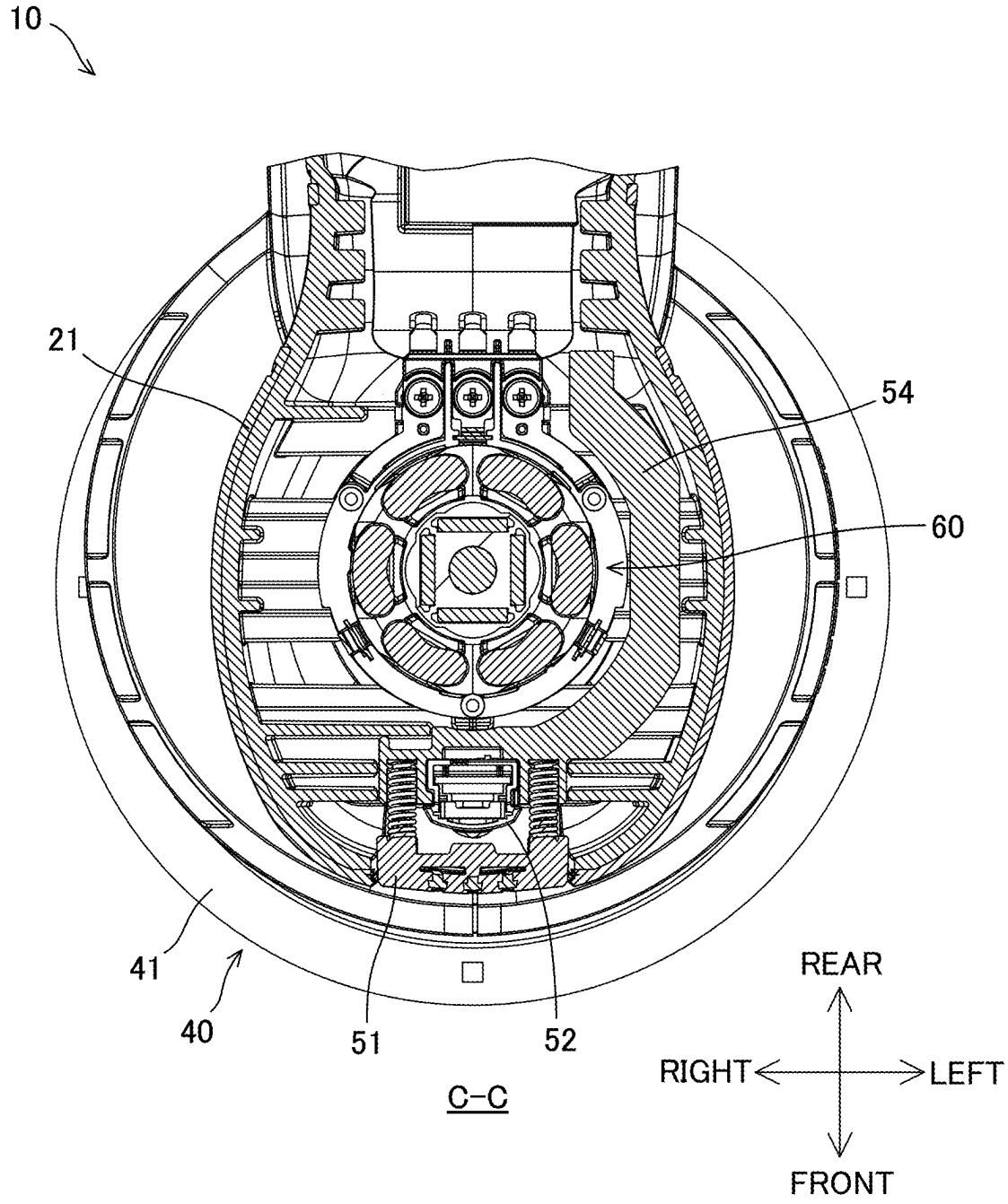


FIG. 8

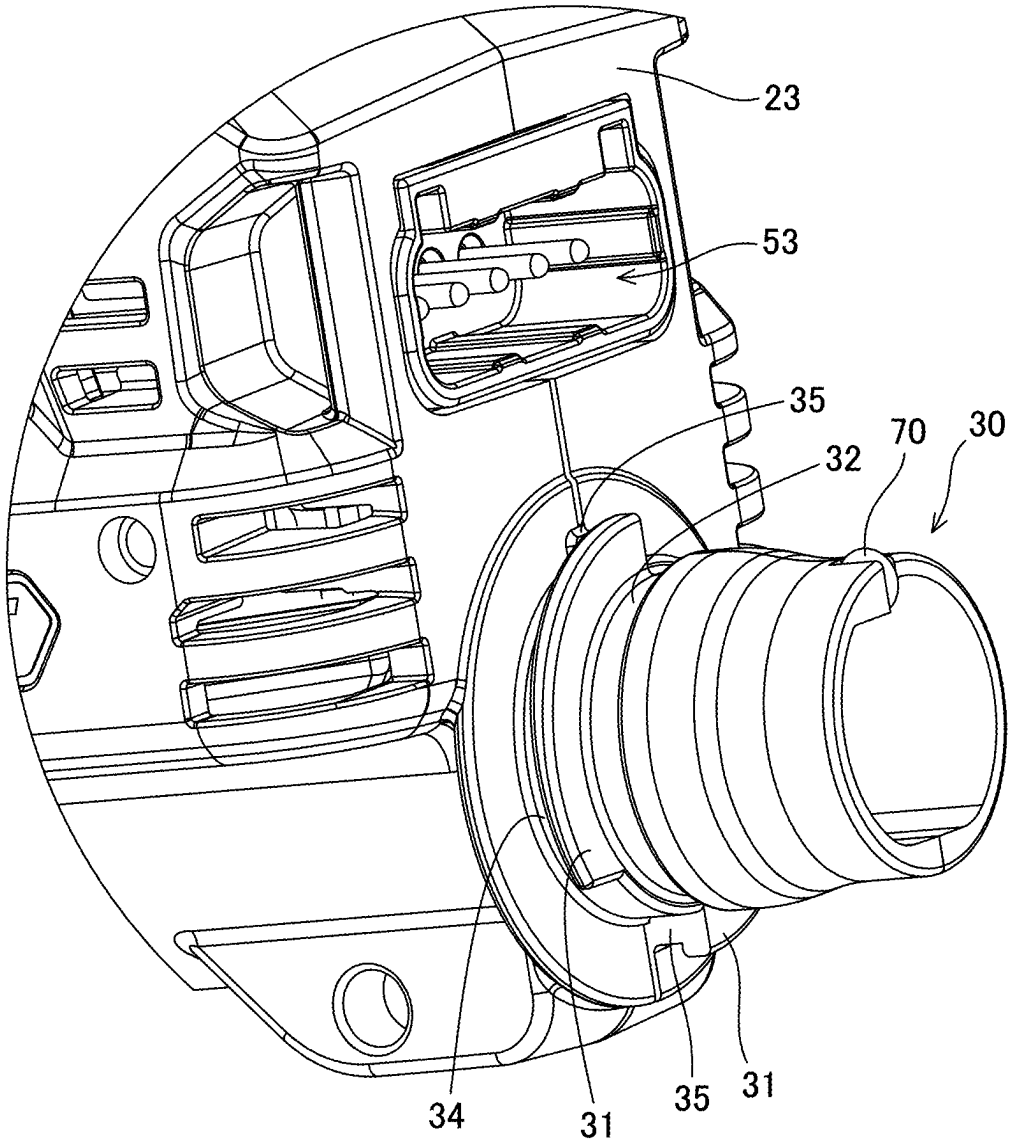


FIG. 9

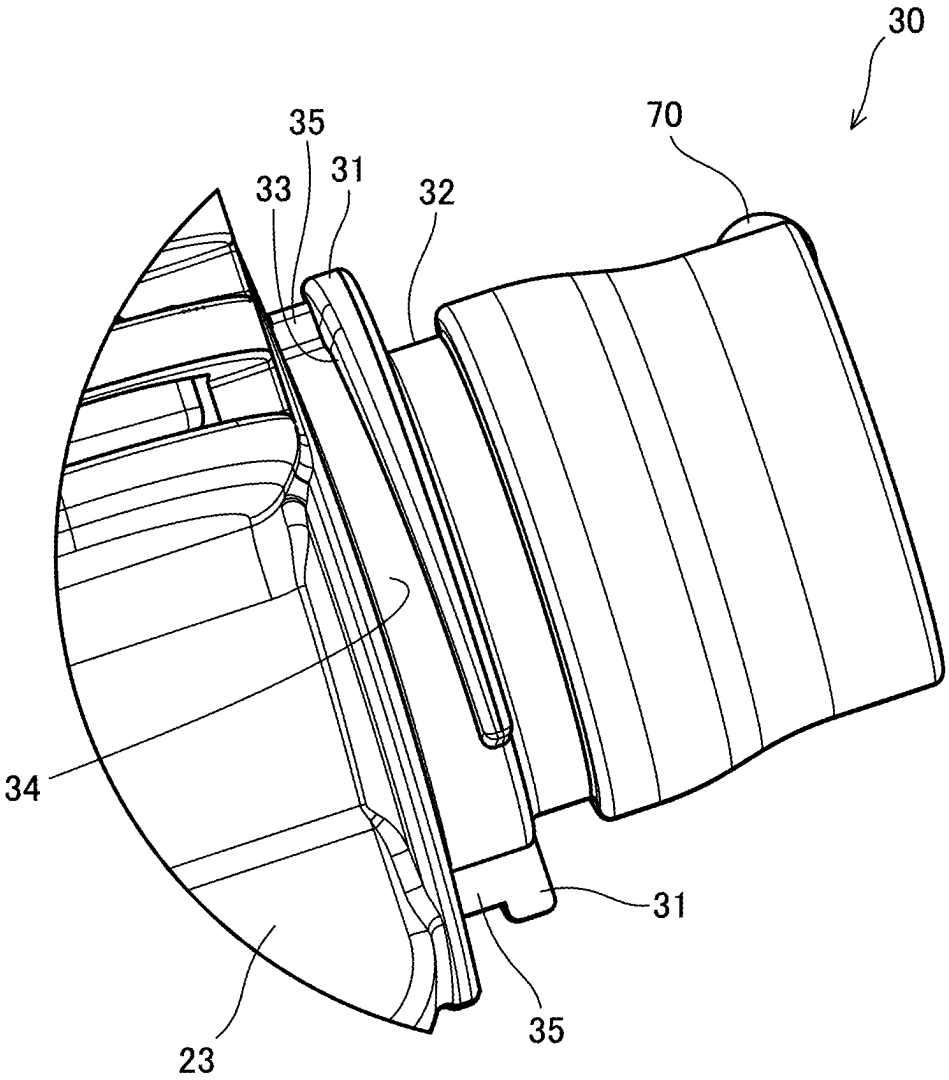
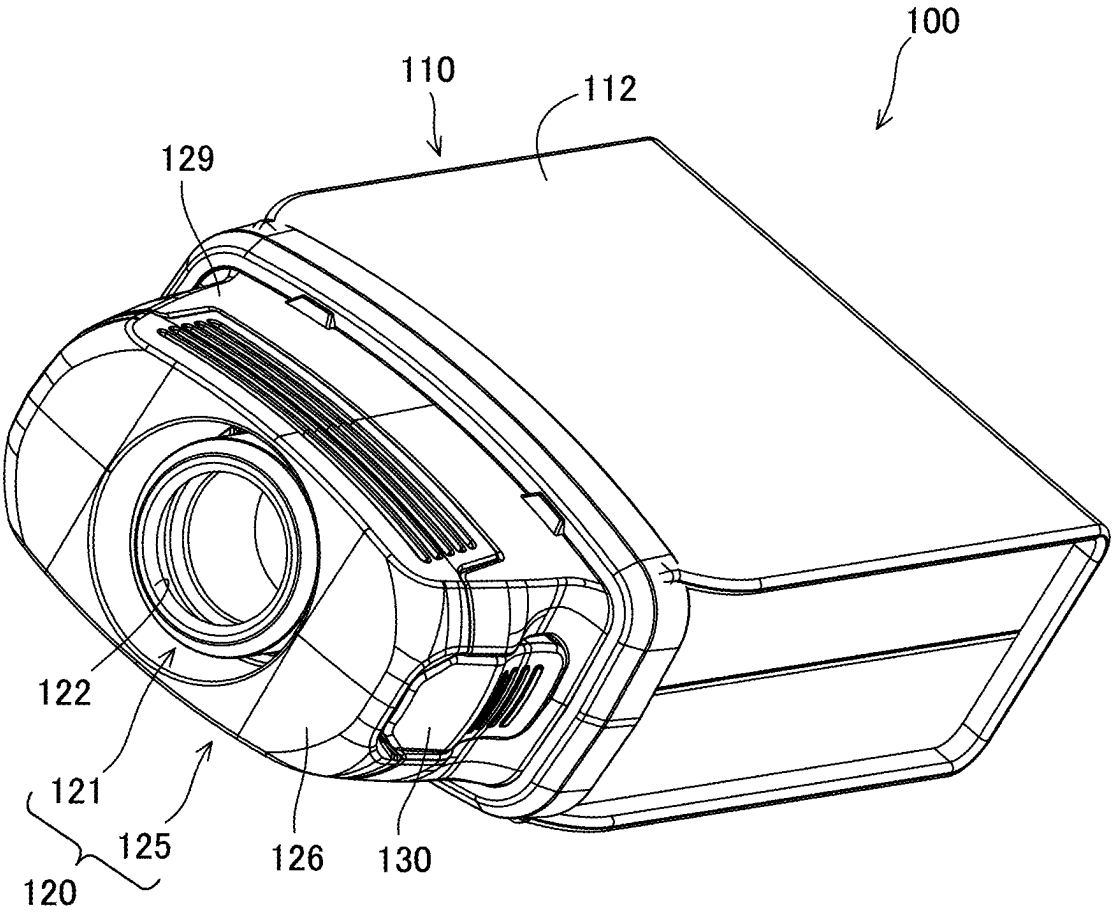
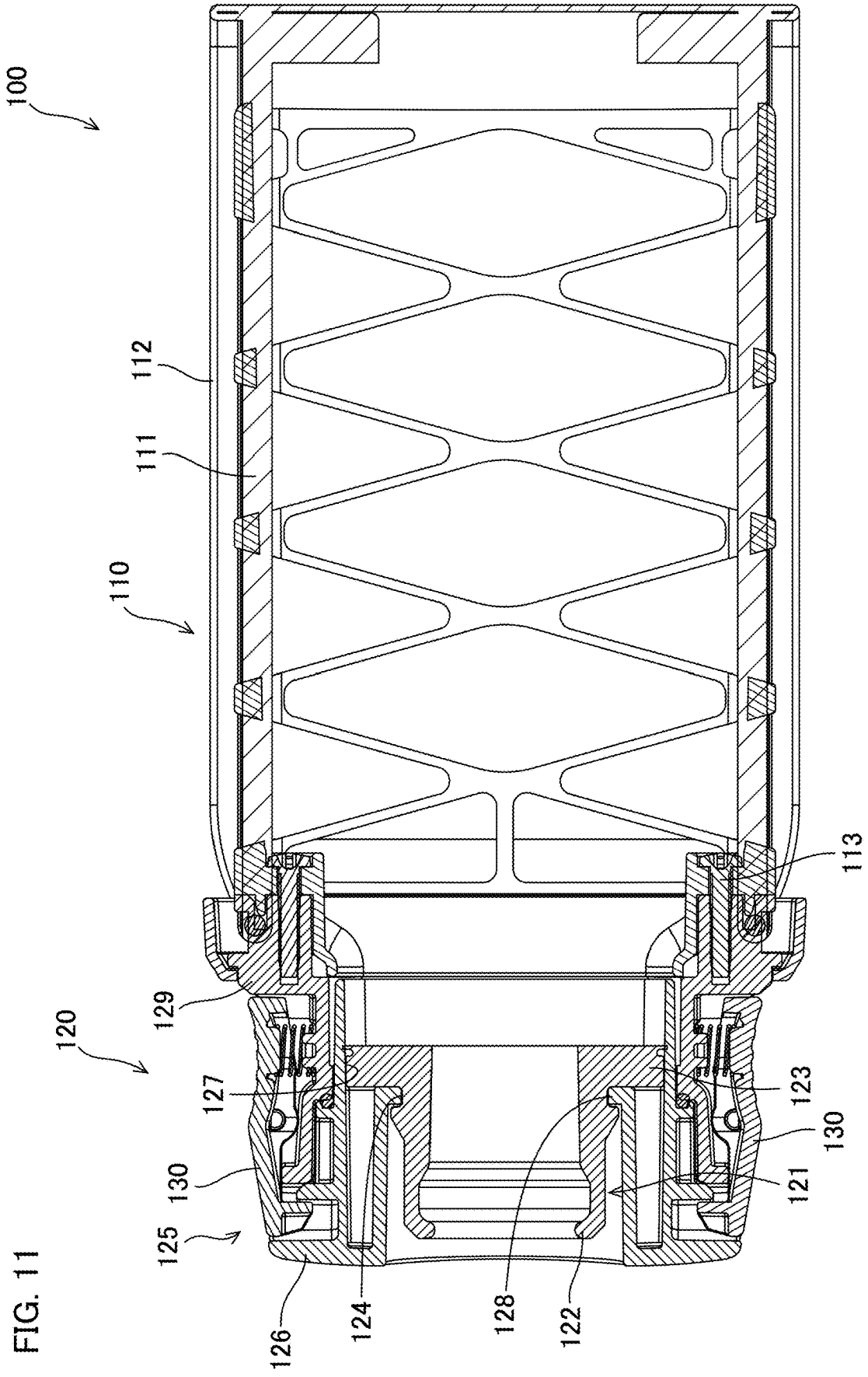


FIG. 10

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122

FIG. 11

FIG. 12

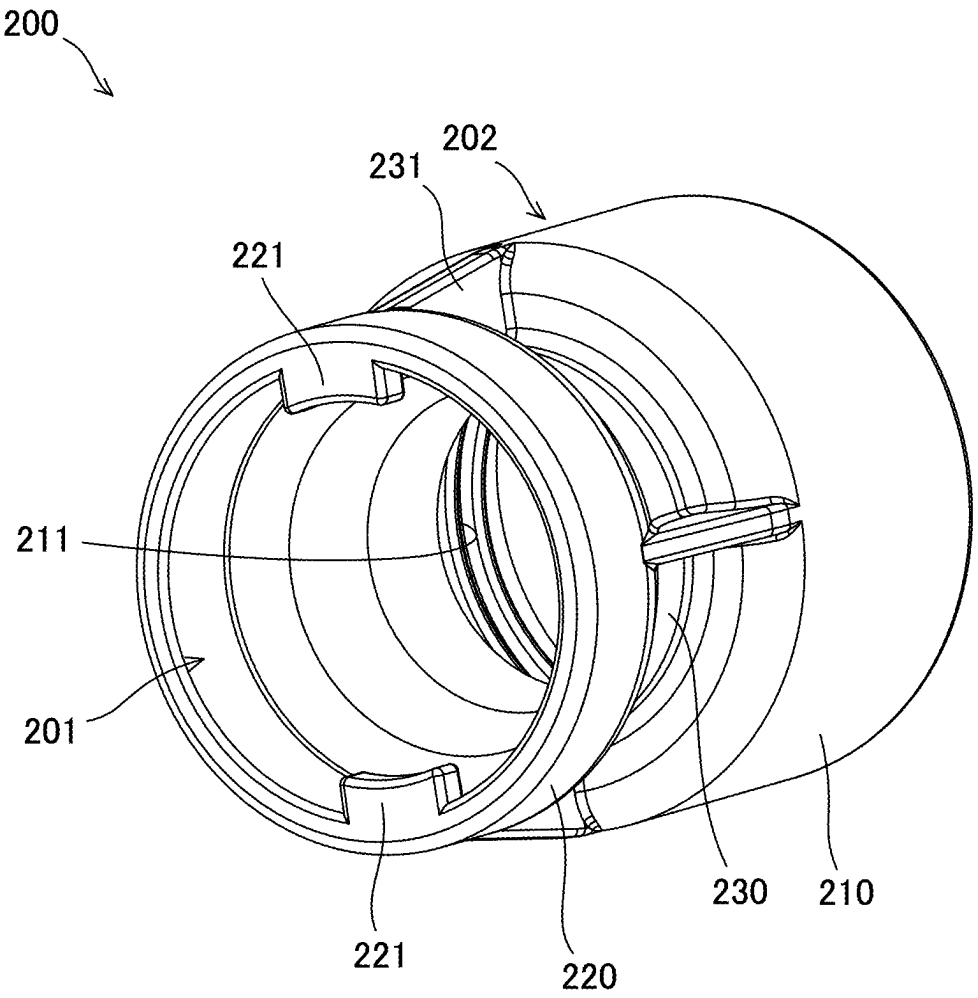
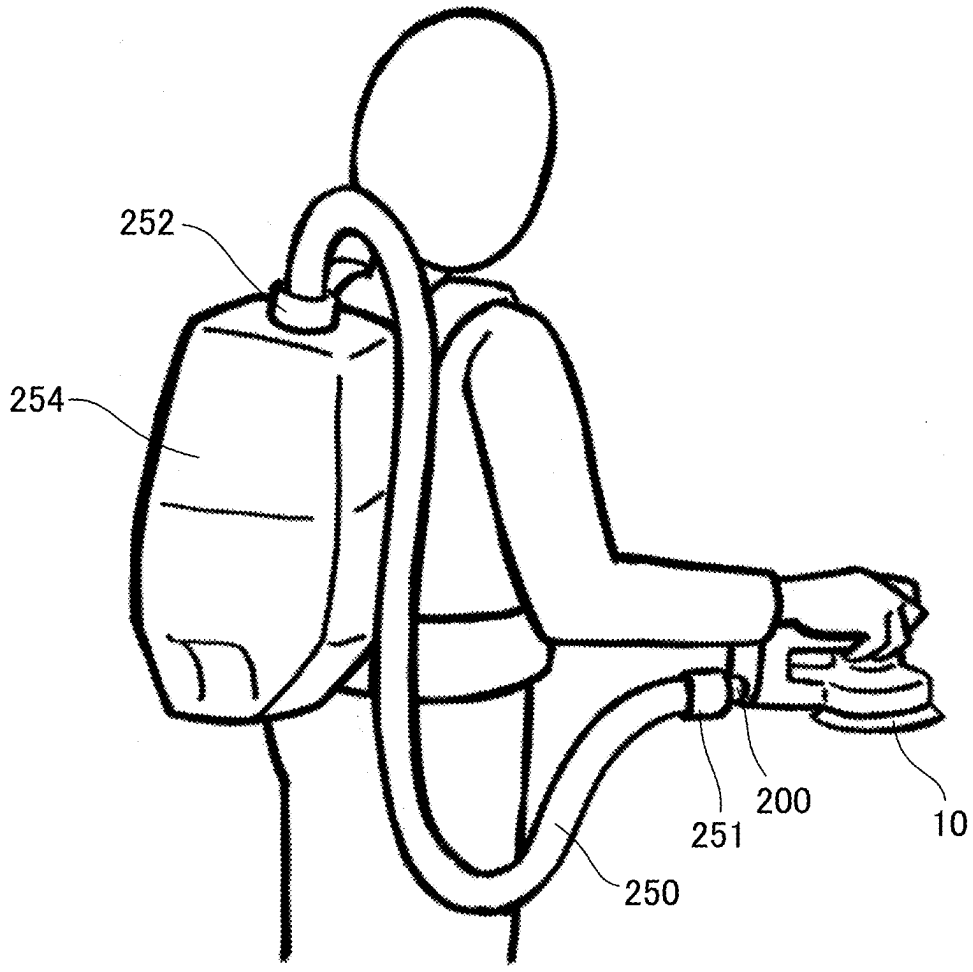


FIG. 13



CONNECTOR AND MACHINING APPARATUS

TECHNICAL FIELD

[0001] The present invention relates to a connector and a machining apparatus.

BACKGROUND

[0002] As one type of machining apparatus, sanders have been known conventionally. For example, orbital sanders as one type of sander cause a pad coupled to one end of an output shaft (for example, a motor shaft) to perform an eccentric circular motion (an orbital motion). Sanding paper is attached to the pad. Sanding work can be performed by pressing the sanding paper against a workpiece.

[0003] Many types of sanders include a dust collection nozzle for guiding dust generated due to the sanding to a dust collector. A dust collection device (for example, a dust collector or a dust bag) for collecting the dust is connected to the dust collection nozzle via a connector and/or a hose.

[0004] The dust is collected into the dust collection device in a state of being positively or negatively charged due to friction, and this leads to a accumulation of charges in a range from the connector and/or the hose to the dust collection device. The charges accumulated in this manner bring about static electricity of a high potential unless a route for discharging these charges is sufficiently secured. Therefore, when a user's hand contacts or approaches a portion having a high potential during the sanding work, an electric discharge to the user's hand occurs and invokes an unpleasant feeling in the user. For such a reason, a floor standing-type dust collector connected to the dust collection nozzle via the hose is configured to release the static electricity using an earth wire.

[0005] On the other hand, the earth connection cannot be secured for a dust collection device that is not installed on a floor surface or the ground surface when in use. In consideration thereof, Japanese Patent Application Laid-Open No. H11-291170 discloses a technique for connecting a sander and a dust bag via a cuff made of conductive resin. According to this technique, when dust contacts the cuff in the course of being guided from a dust collection nozzle to a dust box, charges of the dust are guided into the sander via an earth plate in contact with the cuff. This makes it difficult for an unpleasant electric discharge to the user's hand to occur

[0006] Further, Japanese Patent Application Laid-Open No. H11-138435 discloses a technique for connecting a dust collection nozzle and a dust bag. More specifically, a connector (an attachment portion) of the dust bag includes flexible claw portions, and the claw portions are engaged with stepped portions of the dust collection nozzle. This makes it difficult for the connection to be disengaged compared with a configuration in which two tapered tubular bodies are simply fitted to each other.

SUMMARY

[0007] The present specification discloses a connector configured to directly or indirectly connect a machining apparatus and a dust collection device. This connector may include a through-hole configured to establish communication between the machining apparatus and the dust collection device, and an outer surface made of a static dissipative material.

[0008] The above-described connector can be used as a part of the dust collection device. In this case, the connector can be detachably attached to a dust collection nozzle of the machining apparatus. Alternatively, the above-described connector can be undetachably or detachably attached to a dust conveyance means (typically, a hose) connected to the dust collection device, and, further, can be detachably attached to the dust collection nozzle of the machining apparatus. According to this connector, the outer surface of the connector is made of the static dissipative material, and this makes it difficult for an unpleasant electric discharge from the connector to a user's hand to occur even when the user brings his/her hand close to the connector in a state that a range from the connector to the dust collection device is charged with static electricity of a high potential when the user connects the machining apparatus and the dust collection device via the connector to conduct machining, compared with a connector made of a conductive material. Further, the outer surface of the connector is made of the static dissipative material, and therefore static electricity accumulated at a portion closer to the dust collection device than the connector can be released to the machining apparatus via the connector compared with a connector made of an insulating material. This makes it difficult for the range between the connector and the dust collection device to be charged with static electricity of a high potential.

[0009] The present specification further discloses a connector configured to directly or indirectly connect a machining apparatus and a dust collection device. The connector may include a rubber sleeve made of a conductive material and including an inner circumferential surface with a circumferentially extending recessed portion and/or protrusion portion defined thereon, and a cover made of an insulating material and disposed outside the rubber sleeve so as to surround the rubber sleeve.

[0010] The above-described connector can be detachably attached by press-fitting a dust collection nozzle of the machining apparatus into the connector. In this case, the dust collection nozzle may include a protrusion portion and/or recessed portion engageable with the recessed portion and/or the protrusion portion of the rubber sleeve. According to this connector, the dust collection nozzle of the machining apparatus and the dust collection device can be easily connected and disconnected via the rubber sleeve. Further, since the cover surrounding the rubber sleeve made of the conductive material is made of the insulating material, an unpleasant electric discharge from the connector to the user's hand does not occur. In addition, since the rubber sleeve is made of the conductive material, static electricity of the connector (or the dust collection device) can be released to the machining apparatus.

[0011] The present specification further discloses a machining apparatus. This machining apparatus may include a dust collection nozzle for discharging dust generated due to machining out of the machining apparatus. The dust collection nozzle may include a first engagement portion for a twist lock and a second engagement portion for press-fit engagement.

[0012] According to the above-described machining apparatus, a connector having the twist lock structure and a connector having the press-fit engagement structure can be

selectively attached to the dust collection nozzle. This leads to an increase in the number of types of connectors attachable to the dust collection nozzle, thereby improving the versatility of the dust collection nozzle. Therefore, the machining apparatus and the dust collection device can be connected with improved convenience.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. **1** is a perspective view of a sander according to a first embodiment.

[0014] FIG. **2** is a perspective view of the sander.

[0015] FIG. **3** is a left side view of the sander.

[0016] FIG. **4** is a plan view of the sander.

[0017] FIG. **5** is a longitudinal sectional view of the sander taken along a line A-A illustrated in FIG. **4**.

[0018] FIG. **6** is a longitudinal sectional view of the sander taken along a line B-B illustrated in FIG. **5**.

[0019] FIG. **7** is a transverse sectional view of the sander taken along a line C-C illustrated in FIG. **6**.

[0020] FIG. **8** is a partial enlarged perspective view around a dust collection nozzle.

[0021] FIG. **9** is a partial enlarged perspective view around the dust collection nozzle.

[0022] FIG. **10** is a perspective view of a dust bag according to the first embodiment.

[0023] FIG. **11** is a cross-sectional view of the dust bag.

[0024] FIG. **12** is a perspective view of a connector according to the first embodiment.

[0025] FIG. **13** illustrates one example of the sander in use.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0026] Representative and non-limiting specific examples of the present invention will be described in detail below with reference to the drawings. This detailed description is merely intended to teach a person of skill in the art details for practicing preferred examples of the present invention and is not intended to limit the scope of the present invention. Furthermore, each of additional features and inventions disclosed below can be utilized separately from or together with the other features and inventions to provide further improved apparatuses and methods for manufacturing and using the same.

[0027] Moreover, combinations of features and steps disclosed in the following detailed description are not necessary to practice the present invention in the broadest sense, and are instead taught merely to particularly describe a representative specific example of the present invention. Furthermore, various features of the above-described and the following representative examples, as well as various features recited in the independent and dependent claims below, do not necessarily have to be combined in herein specifically exemplified manners or enumerated orders to provide additional and useful embodiments of the present invention.

[0028] All features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original written disclosure, as well as for the purpose of restricting the claimed subject matter, independent of the compositions of the features in the embodiments and/or the claims. In addition, all value ranges and indications of groups or aggregations are intended to disclose every possible intermediate individual forming them for the purpose of original written disclosure, as well as for the purpose of restricting the claimed subject matter.

[0029] In one or more embodiments, surface resistivity of the outer surface may be equal to or higher than 1×10^{5} (Ω/sq.) and equal to or lower than 1×10^{13} (Ω/sq.). This configuration makes it difficult for an unpleasant electric discharge from the connector to the user's hand to occur. In one or more embodiments, the surface resistivity of the outer surface may be equal to or higher than 1×10^{7} (Ω/sq.) and equal to or lower than 1×10^{12} (Ω/sq.).

[0030] In one or more embodiments, the connector may include a claw portion for a twist lock usable for the connection to the machining apparatus. This connector can be attached to the dust collection nozzle in such a manner that, for example, the claw portion for the twist lock is engaged with a flange portion defined on an outer circumferential surface of the dust collection nozzle. According to this configuration, the connection force between the connector and the dust collection nozzle of the machining apparatus is enhanced and makes it difficult for the connector to be disengaged from the dust collection nozzle.

[0031] In one or more embodiments, the connector may include a rubber sleeve including an inner circumferential surface with a circumferentially extending recessed portion and/or protrusion portion defined thereon. This connector can be attached to the dust collection nozzle in such a manner that, for example, the recessed portion and/or the protrusion portion of the rubber sleeve is fitted to a protrusion portion and/or a recessed portion extending circumferentially on the outer circumferential surface of the dust collection nozzle. According to this configuration, the connector and the dust collection nozzle of the machining apparatus can be easily attached and detached. Further, the connection force between the connector and the dust collection nozzle of the machining apparatus can be enhanced compared to a structure in which tapered tubular bodies not having a recess and a protrusion are fitted to each other.

[0032] In one or more embodiments, a machining apparatus may be provided. This machining apparatus may include any of the above-described connectors, and a dust collection nozzle connectable to the connector. According to this machining apparatus, advantageous effects similarly to any of the above-described connectors can be acquired.

[0033] In one or more embodiments, the machining apparatus may include a metallic earth member disposed in contact with the connector with the connector attached to the dust collection nozzle. According to this configuration, the static electricity charged between the connector and the dust collection nozzle can be efficiently released via the metallic earth member.

[0034] In one or more embodiments, the machining apparatus may include a metallic power transmission member, and may be configured to release static electricity from the connector to the power transmission member. According to this configuration, the static electricity charged between the connector and the dust collection nozzle can be efficiently released via the metallic power transmission member. Further, the power transmission member originally existing in the machining apparatus is used as the route for releasing the static electricity, and this reduces the necessity of additional

members and specifications for releasing the static electricity and contributes to the simplification of the apparatus configuration.

[0035] In one or more embodiments, the machining apparatus may include a grip portion configured to be held by a user with his/her hand during machining, and may be configured to release the static electricity from the connector to the grip portion. According to this configuration, the connector and the grip portion (and thus the user gripping the grip portion) are constantly kept at equal potentials during the machining work, and this makes it further difficult for an electric discharge considerable to the degree that the user feels unpleasant to occur.

[0036] In one or more embodiments, the grip portion may include an outer surface at least partially made of conductive resin or a static dissipative material. According to this configuration, the static electricity can be efficiently released from the connector to the grip portion (and thus the user gripping the grip portion).

[0037] In one or more embodiments, the outer surface of the grip portion may be at least partially made of conductive elastomer. According to this configuration, the static electricity can be efficiently released from the connector to the grip portion (and thus the user gripping the grip portion). In addition, the user can feel an excellent fit when gripping the grip portion.

[0038] In one or more embodiments, the machining apparatus may include a direct-current motor disposed right below the grip portion. According to this configuration, the required insulation distance between the grip portion and the electric motor is shortened, and the first grip portion and the electric motor can be disposed at positions closer to each other, compared to when an alternating-current motor is employed. Therefore, the machining apparatus can have a compact size. Especially, using the motor shaft as the route for releasing the static electricity allows the static electricity to be released from the connector to the grip portion via a shorter route, thereby contributing to the simplification of the apparatus configuration.

[0039] In one or more embodiments, the dust collection nozzle may have a generally circular cylindrical shape. The first engagement portion may include a flange portion defined on an outer circumferential surface of the dust collection nozzle engageably with a claw portion of a connector configured to directly or indirectly connect the dust collection nozzle to a dust collection device. According to this configuration, the dust collection nozzle of the machining apparatus and the connector can be reliably connected with the aid of the engagement between the flange portion of the dust collection nozzle and the claw portion of the connector.

[0040] In one or more embodiments, the flange portion may include a helical lead surface. According to this configuration, an axial force is applied at the time of the engagement between the flange portion of the dust collection nozzle and the claw portion of the connector, and therefore the dust collection nozzle of the machining apparatus and the connector can be further robustly connected.

[0041] In one or more embodiments, the second engagement portion may include a protrusion portion and/or a recessed portion circumferentially extending on the outer circumferential surface of the dust collection nozzle engageably with a recessed portion and/or a protrusion portion extending circumferentially on an inner circumferential surface of a rubber sleeve of the connector. The protrusion portion and/or the recessed portion of the second engagement portion may be located between a distal end and the flange portion of the dust collection nozzle. According to this configuration, the connector and the dust collection nozzle of the machining apparatus can be easily attached and detached, and the connection force can be enhanced using the engagement based on the recessed/protrusion shape.

[0042] In the following description, a sander **10** as an exemplary first embodiment will be described in further detail with reference to the drawings. The sander **10** is also referred to as a random orbit sander.

[0043] As illustrated in FIG. **5**, the sander **10** includes an electric motor **60**, a motor shaft **61**, and a tool accessory **40**. One end of the motor shaft **61** is coupled with the tool accessory **40** via another member. As will be described in detail below, the sander **10** is configured in such a manner that the tool accessory **40** performs a sanding motion with the aid of a rotation of the electric motor **60** (the motor shaft **61**).

[0044] As will be used in the following description, an up-down direction of the sander **10** is defined to be a direction in which the motor shaft **61** extends. A lower side and an upper side are defined to be one side in the up-down direction on which the tool accessory **40** is located, and the opposite side therefrom, respectively. Further, a front-rear direction of the sander **10** is defined to be the longitudinal direction of the sander **10** orthogonal to the up-down direction. A front side and a rear side are defined to be one side in the front-rear direction on which the tool accessory **40** is located, and the opposite side therefrom, respectively. Further, a left-right direction of the sander **10** is defined to be a direction orthogonal to the front-rear direction and the up-down direction. A right side and a left side of the sander **10** are defined to be a right side in the left-right direction when the front side is viewed from the rear side, and the opposite side therefrom, respectively.

[0045] As illustrated in FIGS. **1** to **4**, the sander **10** includes a housing **20**. The housing **20** includes a front housing portion **21**, a connection portion **22**, and a rear housing portion **23**. The front housing portion **21** and the rear housing portion **23** are connected in the front-rear direction via the connection portion **22** having a forked form spaced apart in the up-down direction. A top portion of the front housing portion **21** functions as a first grip portion. The first grip portion is a portion intended to be gripped by a user when the user performs sanding work. An upper portion of the forked form of the connection portion **22** functions as a second grip portion. The second grip portion is a portion intended to be gripped by the user when the user carries the saner **10**.

[0046] A power connector jack **53** (illustrated in detail in FIG. **8**) having electric connection terminals is disposed on the rear surface of the rear housing portion **23**. A power connector plug (not illustrated) is detachably connected to the power connector jack **53**. A power cord (not illustrated) extending out of the power connector plug is connected to a battery holster (not illustrated) on which a battery (not illustrated) is mountable. The power connector jack **53** receives a direct-current power source of the sander **10** from the battery mounted on the battery holster. The sander **10** may include a battery attachment portion on which the battery is detachably mountable instead of the power connector jack **53**. Alternatively, a power cord or a power cable

for supplying a commercial AC power source may extend out of the rear housing portion **23** instead of the power connector jack **53**.

[0047] As illustrated in FIG. **5**, a controller **50** is contained in the lower portions of the connection portion **22** and the rear housing portion **23**. The controller **50** is electrically connected to the power connector jack **53** and the electric motor **60**, and controls the operation of the electric motor **60** by controlling electricity supplied to the electric motor **60**. The electric motor **60** is a DC brushless motor, and the controller **50** performs PWM control of the electric motor **60**. As illustrated in FIG. **1**, a switch button **51** is located at the front portion of the front housing portion **21**. The switch button **51** is used to perform an operation of starting up and stopping the electric motor **60**. As illustrated in FIG. **5**, a switch unit **52** is disposed in the rear of the switch button **51**. The switch unit **52** is electrically connected to the controller **50**, and detects an ON/OFF operation of the switch button **51** to input an ON/OFF signal to the controller **50**. The switch button **51** includes a hinge shaft **51***a* on the upper portion thereof. The hinge shaft **51***a* extends in the left-right direction. The switch button **51** swings rearward around the hinge shaft **51***a* when being operated by being pushed rearward. The switch button **51** is swung rearward and pushes the front portion (a plunger) of the switch unit **52** disposed in the rear of the switch button **51**.

[0048] As illustrated in FIG. **5**, the electric motor **60** is contained in the front housing portion **21**. In the present embodiment, the electric motor **60** is a direct-current motor. The electric motor **60** is disposed right below the first grip portion (i.e., the top portion of the front housing portion **21**). Employing the direct-current motor as the electric motor **60** leads to a reduction in the required insulation distance between the first grip portion and the electric motor **60**, thereby allowing the first grip portion and the electric motor **60** to be disposed at positions closer to each other, compared to when employing an alternating-current motor. Therefore, the sander **10** can have a compact size. However, an alternating-current motor may be employed as the electric motor **60**. The motor shaft **61** of the electric motor **60** extends in the up-down direction, and is rotatably supported by bearings **62** and **63** fixed to the front housing portion **21**. The bearing **62** supports the upper end of the motor shaft **61**, and the bearing **63** supports near the center of the motor shaft **61**.

[0049] As illustrated in FIGS. **5** to **7**, a switch holder **54** is disposed between the bearing **62** and the bearing **63**. The switch holder **54** has a shape extending in the front-rear direction. As illustrated in FIG. **5**, the front edge of the switch holder **54** has a box-like shape opened on the top and the front thereof, and contains the switch unit **52** therein. The switch holder **54** has a generally U-like shape opened on the top thereof in the rear of the front edge of the switch holder **54** (refer to FIG. **6**), and extends in the front-rear direction on the left side of the electric motor **60** so as to avoid the electric motor **60**. A lead wire for connecting the switch unit **52** and the controller **50** is contained in a groove defined due to this generally U-like shape. The lead wire can be prevented from contacting the electric motor **60** by placing this lead wire in the switch holder **54**. Further, arranging the switch holder **54** between the bearing **62** and the bearing **63** allows the height (the dimension in the up-down direction) of the sander **10** to be shortened by an amount corresponding to the space required for laying the lead wire, compared with a conventional technique in which the lead wire is disposed so as to pass through above the bearing **62**.

[0050] A fan **66** is disposed below the bearing **63**. The fan **66** is fixed to the motor shaft **61** so as to surround the motor shaft **61** circumferentially. In the present embodiment, the fan **66** has a function as a motor cooling fan and a function as a dust collection fan. More specifically, the upper portion of the fan **66** functions as a motor cooling fan, and the lower portion of the fan **66** functions as a dust collection fan.

[0051] When the fan **66** is rotated according to the rotation of the motor shaft **61**, air flows into the housing **20** from outside via intake ports **24** (refer to FIG. **1**) defined on the connection portion **22**. This air flows axially (in the direction in which the motor shaft **61** extends) through the electric motor **60** and is directed radially outward by the fan **66**, and is exhausted out of the housing **20** via exhaust ports **25** (refer to FIG. **1**) defined on the front housing portion **21**. The electric motor **60** is cooled with the aid of such a flow of air.

[0052] As illustrated in FIG. **5**, a containing space **28** of the fan **66** in the front housing portion **21** is in communication with a dust collection passage **29** extending in the front-rear direction in the lower portion of the rear housing portion **23**. As illustrated in FIG. **5**, the dust collection passage **29** is in communication with a dust collection nozzle **30**. The dust collection nozzle **30** extends rearward from the lower and rear edge portion of the rear housing portion **23**. A dust collection device is directly or indirectly connected to the dust collection nozzle **30** (as will be described in detail below).

[0053] As illustrated in FIGS. **1** to **3**, the tool accessory **40** is located at the lowermost portion of the sander **10**, and includes a pad **41**. The pad **41** is circular as viewed in the up-down direction. The pad **41** includes a flat surface **42** (refer to FIG. **2**) for attaching sanding paper (not illustrated). The flat surface **42** is a bottom surface of the pad **41**, and expands horizontally (in a direction orthogonal to the up-down direction). As illustrated in FIG. **2**, the pad **41** includes four attachment holes **43** and a plurality of flow holes **44**.

[0054] The plurality of flow holes **44** is in communication with the containing space **28** via an inner space in the pad **41**. Sanding paper (not illustrated) is attached to the bottom surface of the pad **41**. Holes are defined on the sanding paper at positions corresponding to the through-holes **44** of the pad **41**.

[0055] When the fan **66** is rotated according to the rotation of the motor shaft **61**, air that contains dust generated due to the sanding work flows into the containing space **28** via the holes of the sanding paper and the flow holes **44**. At this time, the air is guided radially outward by the fan **66**. The air directed in this manner enters the dust collection passage **29** and flows into the dust collection device via the dust collection nozzle **30**. The dust generated during the sanding work can be collected into the dust collection device with the aid of the flow of air.

[0056] The bearing box **67** is rotatably supported by bearings **64** and **65** disposed on a shaft portion (a circular cylindrical portion extending in the up-down direction) of the fan **66**. The bearings **64** and **65** are eccentric with respect to the motor shaft **61**. A display plate **26**, which indicates an eccentricity amount thereof, is disposed at the top portion of the front housing portion **21** (refer to FIG. **1**). The fan **66** and the bearings **64** and **65** are interposed between a retainer **68** located below them and the bearing **63**. The axial positions (positions in the up-down direction) of the bearing **63**, **64**,

and **65** and the fan **66** are fixed by tightening a screw **69** inserted through the retainer **68** from below and extending into the motor shaft **61**. Further, the pad **41** and the bearing box **67** are coupled using screws **45** inserted in the attachment holes **43** from below.

[0057] The above-described sander **10** operates in the following manner. First, when the user operates the switch button **51** to drive the electric motor **60**, the motor shaft **61** starts rotating. The rotation of the motor shaft **61** is transmitted to the bearing box **67** supporting the bearings **64** and **65** via the bearings **64** and **65** eccentric with respect to the motor shaft **61**. Accordingly, the bearing box **67** and the tool accessory **40** coupled with the bearing box **67** perform an eccentric circular motion and a rotational motion. When the sanding paper attached to the flat surface **42** of the pad **41** is pressed against a workpiece in this state, the workpiece is sanded.

[0058] Now, a method for connecting the duct collection nozzle **30** and the dust collection device will be described. As illustrated in FIGS. **8** and **9**, the dust collection nozzle **30** has a circular cylindrical shape in the present embodiment. Further, the dust collection nozzle **30** has a tapered shape reducing in diameter toward the distal end (the rear end) thereof. Two flange portions **31** and **31** for a twist lock are defined on the outer circumferential surface of the dust collection nozzle **30** near the proximal end of the dust collection nozzle **30**. As will be used herein, the term "twist lock" refers to any engagement that can be established and released by a rotational operation. The two flange portions **31** and **31** are spaced apart from each other circumferentially, and extend circumferentially. Each of the flange portions **31** and **31** protrudes radially outward, as a result of which a groove **34** is defined between the rear surface of the rear housing portion **23** and the flange portions **31** and **31**.

[0059] Each of the flange portions **31** and **31** includes a stopper **35** at one circumferential end thereof. The stopper **35** extends between the flange portion **31** or **31** and the rear surface of the rear housing portion **23**, and closes the groove **34**. The stopper **35** is not defined at the other circumferential end of each of the flange portions **31** and **31**, as a result of which the groove **34** is opened. Each of the flange portions **31** and **31** includes a helical lead surface **33** (refer to FIG. **9**) facing the rear surface of the rear housing portion **23**. The lead surface **33** is defined in such a manner that the width of the groove **34** (the distance between the flange portion **31** and the rear surface of the rear housing portion **23**) reduces from the one circumferential end toward the other circumferential end of the flange portion **31** or **31**.

[0060] The dust collection nozzle **30** further includes a recessed portion **32** for press-fit engagement between the distal end of the dust collection nozzle **30** and the flange portions **31** and **31**. In the present embodiment, the recessed portion **32** is adjacent to the flange portions **31** and **31**. The recessed portion **32** is annularly defined along the outer circumferential surface of the dust collection nozzle **30**. As will be used herein, the term "press-fit engagement" refers to any engagement relationship that can be established and released by an insertion/extraction operation.

[0061] The dust collection nozzle **30** configured in this manner can be connected to various dust collection devices via a connector. At this time, the user can selectively connect a connector applicable to the twist lock and a connector applicable to the press-fit engagement. First, an example of the connector applicable to the press-fit engagement will be described. In the following description, a dust bag **100** according to the present embodiment as one example of the dust collection device is connected to the dust collection nozzle **30**. As illustrated in FIGS. **10** and **11**, the dust bag **100** includes a bag main body **110** and a connector **120**. The bag main body **110** includes a frame **111** and a bag **112** fixed to the frame **111** so as to surround the frame **111**. The bag **112** is generally rectangularly shaped. The frame **111** has an outline slightly smaller than the bag **112**, and is shaped to maintain the shape of the bag **112**.

[0062] The connector **120** includes a rubber sleeve **121** and a cover **125**. A through-hole of the rubber sleeve **121** is in communication with the inside of the bag main body **110**. The rubber sleeve **121** includes, at the rear edge thereof, a protrusion portion **123** that protrudes radially outward. The protrusion portion **123** extends annularly along the circumferential direction. The rubber sleeve **121** further includes a recessed portion **124** adjacent to the protrusion portion **123** in front of the protrusion portion **123**. The recessed portion **124** extends annularly along the circumferential direction. The rubber sleeve **121** further includes, at the front edge thereof, a protrusion portion **122** that protrudes radially inward. The protrusion portion **122** is defined due to an annular groove being defined on the inner circumferential surface of the rubber sleeve **121** in the rear of the protrusion portion **122**.

[0063] The cover **125** is disposed outside the rubber sleeve **121** so as to surround the rubber sleeve **121**. More specifically, the cover **125** includes a sleeve holding portion **126**, a connection portion **129**, and two operation members **130**. The sleeve holding portion **126** is tubularly shaped, and circumferentially surrounds the rubber sleeve **121**. The sleeve holding portion **126** includes a recessed portion **127** and a protrusion portion **128**. The recessed portion **127** extends annularly along the circumferential direction on the inner surface of the sleeve holding portion **126**. The protrusion portion **128** is located in front of the recessed portion **127** and protrudes radially inward, and extends annularly along the circumferential direction.

[0064] The rubber sleeve **121** is held by the sleeve holding portion **126** in a state of being fitted in the sleeve holding portion **126**. At this time, the protrusion portion **123** of the rubber sleeve **121** is fitted in the recessed portion **127** of the sleeve holding portion **126**, and the protrusion portion **128** of the sleeve holding portion **126** is fitted in the recessed portion **124** of the rubber sleeve **121**. Due to that, the rubber sleeve **121** is restricted from moving radially and axially relative to the sleeve holding portion **126**. The rubber sleeve **121** is made of rubber, and therefore can be easily attached to the sleeve holding portion **126** using elastic deformation of the rubber sleeve **121**. The rubber sleeve **121** is attached in the sleeve holding portion **126** in such a manner that the front end thereof is located at a position deeper (closer to the rear side) than the front end of the sleeve holding portion **126**.

[0065] The connection portion **129** is tubularly shaped, and the sleeve holding portion **126** is fitted inside the connection portion **129**. The rear edge portion of the connection portion **129** is coupled with the frame **111** using screws **113**. The two operation members **130** are attached to the outer surface of the connection portion **129**. Each of the operation members **130** is configured to be displaceable between an engagement position at which the front edge thereof is engaged with the sleeve holding portion **126**, and

a disengagement position by a manual operation. When the operation member **130** is located at the engagement position, this engagement restricts a movement of the sleeve holding portion **126** relative to the connection portion **129**. When the operation member **130** is located at the disengagement position, the sleeve holding portion **126** can be extracted out of the connection portion **129** by axially moving the sleeve holding portion **126** relative to the connection portion **129**.

[0066] The dust bag **100** configured in this manner can be connected to the sander **10** by press-fitting the dust collection nozzle **30** of the sander **10** into the rubber sleeve **121**. Therefore, the dust bag **100** can be attached and detached with an easy operation. Further, the protrusion portion **122** of the rubber sleeve **121** is fitted in the recessed portion **32** of the dust collection nozzle **30** with the dust collection nozzle **30** press-fitted in the rubber sleeve **121**. Therefore, the connection force between the connector **120** and the dust connection nozzle **30** can be enhanced compared to a structure in which tapered tubular bodies not having a recess and a protrusion are fitted to each other. Further, such a connection using the press-fit engagement is free from constraints on the rotational angle position of the connector **120** relative to the sander **10**, thereby allowing the dust bag **100** to be attached to the sander **10** at a desired rotational angle position. Such a rotational angle position is normally a position where the height of the dust bag **100** is minimized.

[0067] Next, an example of the connector applicable to the twist lock will be described. In the following description, a connector **200** according to the present embodiment is connected to the dust collection nozzle **30**. The connector **200** is also referred to as a cuff. As illustrated in FIG. **12**, the connector **200** has a generally circular cylindrical shape, and includes a through-hole **201** at the center thereof. The connector **200** includes a large-diameter portion **210**, a small-diameter portion **220**, and a connection portion **230** connecting the large-diameter portion **210** and the small-diameter portion **220**. The large-diameter portion **210** includes a helical engagement groove **211** on the inner circumferential surface thereof. The engagement groove **211** is used for a direct or indirect connection to any dust conveyance means (for example, a hose having a connector). The connector **200** and the dust conveyance means can be connected by threadedly inserting the dust conveyance means having an externally threaded shape in conformity with the engagement groove **211** into the large-diameter portion **210**.

[0068] The small-diameter portion **220** is smaller in outer diameter and inner diameter than the large-diameter portion **210**. Two claw portions **221** for the twist lock are defined at the edge portion of the small-diameter portion **220** (the edge portion opposite from the connection portion **230**). The two claw portions **221** are spaced apart from each other circumferentially. Each of the claw portions **221** protrudes radially inward. The connection portion **230** is smaller in outer diameter and inner diameter than the small-diameter portion **220**. A plurality of reinforcement ribs **231** is defined on the outer circumferential surface of the connection portion **230**.

[0069] The connector **200** configured in this manner can be connected to the sander **10** by inserting the dust collection nozzle **30** into the connector **200** and rotating the connector **200**. More specifically, the user first inserts the connector **200** in such a manner that the two claw portions **221** pass forward through spaces between the two flange portions **31** of the dust collection nozzle **30**. Next, the user rotates the connector **200** in such a manner that the claw portions **221** approach the stoppers **35** by passing through inside the groove **34**. This rotational operation continues until an axial force is acquired to the degree that a further rotation is prohibited by the lead surfaces **33** or the claw portions **221** are brought into abutment with the stoppers **35**. According to such engagement between the flange portions **31** and the claw portions **221**, the connection force between the connector **200** and the dust collection nozzle **30** is enhanced and makes it difficult for the connector **200** to be disengaged from the dust collection nozzle **30**. Especially, the flange portions **31** include the lead surfaces **33**, and therefore the axial force is added to the engagement between the flange portions **31** and the claw portions **221**, which can facilitate a further robust connection between the dust collection nozzle **30** and the connector **200**. However, the flange portions **31** may not include the lead surfaces **33**. In other words, the front side surfaces of the flange portions **31** may be defined in such a manner that the groove **34** is kept constant in width circumferentially.

[0070] The connector **200** configured in this manner is, for example, usable in a manner illustrated in FIG. **13**. In this example, the small-diameter portion **220** is connected to the dust collection nozzle **30** of the sander **10** according to the above-described procedure, and one end of a hose **250** is connected to the large-diameter portion **210** via a sleeve **251** having an externally threaded shape in conformity with the engagement groove **211**. The other end of the hose **250** is connected to a dust collector **254** serving as one example of the dust collection device via a sleeve **252**. The dust collector **254** is configured to allow a person to carry it on his/her back. The dust collector **254** is also referred to as a knapsack-type dust collector.

[0071] In the above-described manner, according to the dust collection nozzle **30**, the connector **200** having the twist lock structure and the connector **120** having the press-fit engagement structure can be selectively attached to the dust collection nozzle **30**. This leads to an increase in the number of types of connectors attachable to the dust collection nozzle **30**, thereby improving the versatility of the dust collection nozzle **30**. Therefore, the sander **10** and the dust collection device can be connected to each other with improved convenience.

[0072] In the following description, an antistatic measure at the sander **10** and the connector **120** or **200** will be described. First, the antistatic measure when the connector **120** is connected to the dust collection nozzle **30** will be described. The rubber sleeve **121** of the connector **120** is made of a conductive material. On the other hand, the cover **125** of the connector **120** is made of an insulating material. In this manner, the cover **125** made of an insulating material is arranged outside the rubber sleeve **121** so that the rubber sleeve **121** is not exposed, and therefore an unpleasant electric discharge from the connector **120** to the user's hand does not occur even when the dust bag **100** is charged with static electricity of a high potential at the connector **120** due to the dust.

[0073] Further, the static electricity with which the dust bag **100** is charged can be released from the rubber sleeve **121** made of the conductive material to the sander **10**. More specifically, the dust collection nozzle **30** is made of an insulating material. Therefore, an unpleasant electric discharge from the dust collection nozzle **30** to the user's hand does not occur. As illustrated in FIG. **5**, a metallic earth wire

70 is disposed in the dust collection passage **29**. As illustrated in FIGS. **5** and **8**, one end of the earth wire **70** has a ring-like shape, and is exposed by protruding from the outer circumferential surface of the dust collection nozzle **30** via a slit of the dust collection nozzle **30** at the distal end of the dust collection nozzle **30**. Therefore, the earth wire **70** is in contact with the rubber sleeve **121** made of the conductive material with the connector **120** attached to the dust collection nozzle **30**. As illustrated in FIG. **5**, the other end of the earth wire **70** is in contact with an outer race of the bearing **63**.

[0074] The bearing **63**, the motor shaft **61**, the fan **66**, the bearings **64** and **65**, the bearing box **67**, and the screws **45** are metallic, and are in contact sequentially to allow an electric current to flow through them. Therefore, the static electricity of the dust bag **100** can be released from the rubber sleeve **121** to the screws **45** via the earth wire **70**, the bearing **63**, the motor shaft **61**, the fan **66**, the bearings **64** and **65**, and the bearing box **67**. Then, the static electricity released to the screws **45** is discharged from the heads of the screws **45** to the workpiece beyond the sanding paper attached to the flat surface **42** of the tool accessory **40**. As a result, the dust bag **100** can be prevented from being charged with static electricity of a high potential. According to this configuration, the static electricity with which the dust bag **100** is charged can be efficiently released via the metallic earth wire **70**. Further, the metallic power transmission member (the motor shaft **61**, the bearings **64** and **65**, and the bearing box **67**) and other components originally existing in the sander **10** are used as the route for releasing the static electricity, and this reduces the necessity of additional members and specifications for releasing the static electricity, thereby contributing to the simplification of the apparatus configuration.

[0075] Next, the antistatic measure when the connector **200** is connected to the dust collection nozzle **30** will be described. The hose **250** has a two-layered structure (or a dual structure) with the inside made of a conductive material and the outside made of an insulating material. The sleeves **251** and **252** are made of insulating materials, but may have a two-layered structure with the inside made of a conductive material and the outside made of an insulating material similarly to the hose **250**. The connector **200**, in particular, at least the outer surface **202** thereof is made of a static dissipative material. The static dissipative material used for the connector **200** is, for example, static dissipative ABS resin. The static dissipative material may also be referred to as an antistatic material. In the present embodiment, the connector **200** is entirely made of the static dissipative material. The static dissipative material is a material less electrostatically chargeable and highly contributive to comparatively quick dissipation of static electricity. The static dissipative material can be defined to be, for example, a material having surface resistivity equal to or higher than 1×10^{5} (Ω/sq.) and equal to or lower than 1×10^{13} (Ω/sq.).

[0076] According to the connector **200**, at least the outer surface **202** is made of the static dissipative material, and this makes it difficult for the unpleasant electric discharge from the connector **200** to the user's hand to occur even when the user brings his/her hand close to the connector **200** in a state that the range from the connector **200** to the dust collector **254** is charged with static electricity of a high potential, compared with when the outer surface **202** is made of a conductive material. Further, since at least the outer surface **202** of the connector **200** is made of the static dissipative material, the static electricity accumulated at a portion closer to the dust collector **254** than the connector **200** can be released to the sander **10** via the inner portion (the portion made of the conductive member) of the hose **250** and the connector **200** compared with when the outer surface **202** is made of an insulating material. This makes it difficult for the range between the connector **200** and the dust collector **254** to be charged with static electricity of a high potential. The route for releasing the static electricity to the sander **10** via the connector **200** subsequent to the earth wire **70** in contact with the connector **200** is set in a similar manner to the above-described route.

[0077] The surface resistivity of the static dissipative material used for the connector **200** may be, for example, equal to or higher than 1×10^{7} (Ω/sq.) and equal to or lower than 1×10^{12} (Ω/sq.). Using such a material facilitates the release of the static electricity to the sander **10** via the connector **200** while further reliably reducing or removing the unpleasant electric discharge.

[0078] In the following description, a second embodiment will be described. The apparatus configuration of the second embodiment is similar to the first embodiment. In the following description, the second embodiment will be described focusing only on differences from the first embodiment. In the second embodiment, the display plate **26** disposed on the top portion of the front housing portion **21** (i.e., the first grip portion gripped by the user during machining work) is entirely made of conductive resin or a static dissipative material. The display plate **26** may be made of conductive elastomer. This material selection allows the user to feel an excellent fit when gripping the first grip portion.

[0079] As illustrated in FIG. **5**, the display plate **26** includes a protrusion portion **27** protruding downward as far as near the outer race of the bearing **62**. The separation distance between the protrusion portion **27** and the outer race of the bearing **62** is a distance through which the static electricity can be discharged (for example, several millimeters). The protrusion portion **27** and the outer race of the bearing **62** may be in contact with each other. The bearing **62** is a metallic component.

[0080] In the second embodiment, an additional route is secured in addition to the above-described route for releasing the static electricity from the earth wire **70**. More specifically, the additional route is a route passing through the earth wire **70**, the bearing **63**, the motor shaft **61**, the bearing **62**, and the protrusion portion **27** (i.e., the display plate **26**). The display plate **26** is a portion gripped by the user during the machining work, and therefore securing this route allows the connector **120** or the connector **200** and the display plate **26** (and thus the user gripping the first grip portion including the display plate **26**) to be kept at equal potentials constantly during the machining work. This makes it further difficult for the electric discharge considerable to the degree that the user feels unpleasant to occur.

[0081] A part of the display plate **26** including a part of the outer surface of the display plate **26** may be made of conductive resin or a static dissipative material instead of the display plate **26** being entirely made thereof. In this case, the portion made of conductive resin or a static dissipative material is arranged so as to allow the static electricity to be released from the bearing **62** to the outer surface of the display plate **26**. Alternatively, the portion made of conduc-

tive resin or a static dissipative material may be arranged at the portion gripped by the user around the display plate **26** so as to allow the static electricity to be released from the bearing **62** to the outer surface of the display plate **26**. Alternatively, in the case where the sander **10** is unequipped with the display plate **26**, the top portion of the front housing portion **21** may be entirely or partially made of conductive resin or a static dissipative material so as to allow the static electricity to be released from the bearing **62** to the outer surface of the top portion of the front housing portion **21**.

[0082] The corresponding relationship between each component in the above-described embodiments and each component of the claims will be described below. However, each component in the embodiments is merely one example and shall not limit each component of the claims. The sander **10** is one example of a "machining apparatus". The connectors **120** and **200** are one example of a "connector". The dust bag **100** and the dust collector **254** are one example of a "dust collection device". The through-hole **201** is one example of a "through-hole". The outer surface **202** is one example of an "outer surface". The claw portion **221** is one example of a "claw portion for a twist lock". The rubber sleeve **121** is one example of a "rubber sleeve". The protrusion portion **122** is one example of a "protrusion portion". The dust collection nozzle **30** is one example of a "dust collection nozzle". The earth wire **70** is one example of an "earth member". The motor shaft **61**, the bearings **62**, **63**, **64**, and **65**, and the bearing box **67** are one example of a "power transmission member". The top portion of the front housing portion **21** is one example of a "grip portion". The electric motor **60** is one example of a "direct-current motor". The cover **125** is one example of a "cover". The flange portion **31** is one example of a "first engagement portion" and a "flange portion". The recessed portion **32** is one example of a "second engagement portion" and a "recessed portion".

[0083] Having described embodiments, the above-described embodiments are intended to only facilitate the understanding of the present teachings, and are not intended to limit the present invention thereto. The present invention can be modified or improved without departing from the spirit thereof, and the present invention includes equivalents thereof. Further, each of the elements described in the claims and the specification can be combined or omitted in any manner within a range that allows it to remain capable of solving at least a part of the above-described problems or bringing about at least a part of the above-described advantageous effects.

[0084] For example, the rubber sleeve **121** may include a recessed portion instead of the protrusion portion **122**. In this case, the dust collection nozzle **30** may include a protrusion portion engageable with the recessed portion of the rubber sleeve **121** instead of the recessed portion **32**.

[0085] Further, the route for releasing the static electricity from the connector **120** or the connector **200** to outside via the sander **10** is not limited to the above-described example, and may be secured using any conductive member.

[0086] Further, the engagement structure between the connector **120** or the connector **200** and the dust collection nozzle **30** is not limited to the above-described example, and can be modified to any engagement structure. For example, the engagement structure between the connector **120** and the dust collection nozzle **30** may be modified to a structure in which tapered tubular bodies not having a recess and a protrusion are fitted to each other or may be modified to an engagement structure using a twist lock. In the case of the latter, the position of the stopper **35** may be set so as to allow the connector **120** to be attached to the dust collection nozzle **30** at an appropriate rotational angle position relative to the dust collection nozzle **30**. Alternatively, the engagement structure between the connector **200** and the dust collection nozzle **30** may be modified to a press-fit engagement structure.

[0087] Further, the above-described various engagement structures between the connector **120** or the connector **200** and the dust collection nozzle **30**, and the above-described configurations for the antistatic measure may be implemented independently of each other.

[0088] Further, the above-described embodiments are applicable to not only random orbit sanders but also various machining apparatuses connectable to a dust collection device, such as other various types of sanders, portable circular saws, sliding circular saws, grinders, drills, and rotary hammers.

DESCRIPTION OF THE REFERENCE NUMERALS

[0089] **10** sander, **20** housing, **21** front housing portion, **22** connection portion, **23** rear housing portion, **24** intake port, **25** exhaust port, **26** display plate, **27** protrusion portion, **28** containing space, **29** dust collection passage, **30** dust collection nozzle, **31** flange portion, **32** recessed portion, **33** lead surface, **34** groove, **35** stopper, **40** tool accessory, **41** pad, **42** flat surface, **43** attachment hole, **44** flow hole, **45** screw, **50** controller, **51** switch button, **51***a* hinge shaft, **52** switch unit, **53** power connector jack, **54** switch holder, **60** electric motor, **61** motor shaft, **62**, **63**, **64**, **65** bearing, **66** fan, **67** bearing box, **68** retainer, **69** screw, **70** earth wire, **100** dust bag, **110** bag main body, **111** frame, **112** bag, **113** screw, **120** connector, **121** rubber sleeve, **122** protrusion portion, **123** protrusion portion, **124** recessed portion, **125** cover, **126** sleeve holding portion, **127** recessed portion, **128** protrusion portion, **129** connection portion, **130** operation member, **200** connector, **201** through-hole, **202** outer surface, **210** large-diameter portion, **211** engagement groove, **220** small-diameter portion, **221** claw portion, **230** connection portion, **231** reinforcement rib, **250** hose, **251**, **252** sleeve, **254** dust collector

1. A connector configured to directly or indirectly connect a machining apparatus and a dust collection device, the connector comprising:

a through-hole configured to establish communication between the machining apparatus and the dust collection device; and

an outer surface made of a static dissipative material.

2. The connector according to claim **1**, wherein surface resistivity of the outer surface is equal to or higher than 1×10^{5} (Ω/sq.) and equal to or lower than 1×10^{13} (Ω/sq.).

3. The connector according to claim **2**, wherein the surface resistivity of the outer surface is equal to or higher than 1×10^{7} (Ω/sq.) and equal to or lower than 1×10^{12} (Ω/sq.).

4. The connector according to claim **1**, further comprising a claw portion for a twist lock, the claw portion being usable for the connection to the machining apparatus.

5. The connector according to claim **1**, further comprising a rubber sleeve including an inner circumferential surface

with a circumferentially extending recessed portion and/or protrusion portion defined thereon.

6. A machining apparatus comprising:

the connector according to claim **1**; and

a dust collection nozzle connectable to the connector.

7. The machining apparatus according to claim **6**, further comprising a metallic earth member disposed in contact with the connector with the connector attached to the dust collection nozzle.

8. The machining apparatus according to claim **6**, further comprising a metallic power transmission member,

wherein the machining apparatus is configured to release static electricity from the connector to the power transmission member.

9. The machining apparatus according to claim **6**, further comprising a grip portion configured to be held by a user with his/her hand during machining,

wherein the machining apparatus is configured to release the static electricity from the connector to the grip portion.

10. The machining apparatus according to claim **9**, wherein the grip portion includes an outer surface at least partially made of conductive resin or a static dissipative material.

11. The machining apparatus according to claim **10**, wherein the outer surface of the grip portion is at least partially made of conductive elastomer.

12. The machining apparatus according to claim **9**, further comprising a direct-current motor disposed right below the grip portion.

13. A connector configured to directly or indirectly connect a machining apparatus and a dust collection device, the connector comprising:

a rubber sleeve made of a conductive material and including an inner circumferential surface with a circumferentially extending recessed portion and/or protrusion portion defined thereon; and

a cover made of an insulating material and disposed outside the rubber sleeve so as to surround the rubber sleeve.

14. A machining apparatus comprising:

a dust collection nozzle usable to discharge dust generated due to machining out of the machining apparatus,

the dust collection nozzle including a first engagement portion for a twist lock and a second engagement portion for press-fit engagement.

15. The machining apparatus according to claim **14**, wherein the dust collection nozzle has a generally circular cylindrical shape, and

the first engagement portion includes a flange portion defined on an outer circumferential surface of the dust collection nozzle engageably with a claw portion of a connector configured to directly or indirectly connect the dust collection nozzle to a dust collection device.

16. The machining apparatus according to claim **15**, wherein the flange portion has a helical lead surface.

17. The machining apparatus according to claim **15**, wherein the second engagement portion includes a protrusion portion and/or a recessed portion circumferentially extending on the outer circumferential surface of the dust collection nozzle engageably with a recessed portion and/or a protrusion portion extending circumferentially on an inner circumferential surface of a rubber sleeve of the connector, and

the protrusion portion and/or the recessed portion of the second engagement portion is located between a distal end and the flange portion of the dust collection nozzle.

18. The connector according to claim **1**, further comprising:

a claw portion for a twist lock, the claw portion being usable for the connection to the machining apparatus; and

a rubber sleeve including an inner circumferential surface with a circumferentially extending recessed portion and/or protrusion portion defined thereon.

19. The machining apparatus according to claim **6**, further comprising:

a metallic power transmission member; and

a grip portion configured to be held by a user with his/her hand during machining,

wherein the machining apparatus is configured to release static electricity from the connector to the power transmission member and to release the static electricity from the connector to the grip portion.

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