United States Patent	12384001
Kind Code	B2
Date of Patent	August 12, 2025
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Electric tool

Abstract

An electric tool includes a motor, a first intermediate member configured to be displaced when a first accessory is attached to a first attachment portion, a second intermediate member configured to be displaced when a second accessory is attached to a second attachment portion, and a first interlock member. The first interlock member mechanically moves in conjunction with the respective displacements of the first intermediate member and the second intermediate member. The first interlock member is displaced in the same direction between when the first accessory is attached and when the second accessory is attached, and is cumulatively displaced when the first accessory and the second accessory are attached. The electric tool is configured in such a manner that power supply to the motor is permitted only in a state that the first interlock member is cumulatively displaced.

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Appl. No.: **17/856718**

Filed: **July 01, 2022**

Prior Publication Data

Document Identifier	Publication Date
US 20230023204 A1	Jan. 26, 2023

Foreign Application Priority Data

JP	2021-120299	Jul. 21, 2021

Publication Classification

Int. Cl.: **B24B23/02** (20060101); **B25F5/02** (20060101)

U.S. Cl.:

CPC **B24B23/028** (20130101); **B25F5/02** (20130101);

Field of Classification Search

CPC: B24B (23/028); B25F (5/026)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
2021/0220959	12/2020	Matsubara et al.	N/A	N/A

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Background/Summary

TECHNICAL FIELD

(1) The present disclosure relates to an electric tool configured to allow an accessory to be detachably attached thereto.

BACKGROUND

(2) Various kinds of accessories may be detachably attached to electric tools. For example, two types of detachably attachable accessories (a side handle and a cover) are prepared for a grinder including a tool accessory (also referred to as a wheel, a disk, a blade, or the like) configured to be rotationally driven. The side handle is attached to be held with the other hand when a user holds a handle of the grinder with one of his/her hands. The cover is attached to partially cover the tool accessory.

(3) For such a grinder, there is a demand for preventing the grinder from being used in a state that the accessory is not attached. For example, US2021/0220959A1 discloses a grinder including a first link member that is displaced when a side handle is attached, a first sensor that detects the displacement of the first link member, a second link member that is displaced when a cover is attached, a second sensor that detects the displacement of the second link member, and a controller. The controller permits power supply to the motor (i.e., the rotation of the tool accessory) only when the attachment of both the side handle and the cover is detected by the first sensor and the second sensor.

SUMMARY

(4) The present specification discloses an electric tool. This electric tool may include a motor, a first attachment portion for detachably attaching a first accessory, a second attachment portion for detachably attaching a second accessory that is a different type of accessory from the first accessory, a first intermediate member configured to be displaced by being directly or indirectly

pressed by the first accessory when the first accessory is attached to the first attachment portion, a second intermediate member configured to be displaced by being directly or indirectly pressed by the second accessory when the second accessory is attached to the second attachment portion, and a first interlock member. The first interlock member may be configured to mechanically move in conjunction with the respective displacements of the first intermediate member and the second intermediate member. The first interlock member may be further configured to be displaced in the same direction between when the first accessory is attached to the first attachment portion and when the second accessory is attached to the second attachment portion, and be cumulatively displaced when the first accessory and the second accessory are attached to the first attachment portion and the second attachment portion, respectively. The electric tool may be configured in such a manner that power supply to the motor is permitted only in a state that the first interlock member is cumulatively displaced.

(5) According to this electric tool, a novel structure is provided in which the power supply to the motor is permitted only in the state that the first accessory and the second accessory are attached to the first attachment portion and the second attachment portion respectively and thus the first interlock member is cumulatively displaced by moving in conjunction with the first intermediate member and the second intermediate member. Therefore, this electric tool can increase the design flexibility of the electric tool having the structure in which the power supply to the motor is permitted only in the state that the two types of accessories are attached thereto. For example, the first intermediate member, the second intermediate member, and the first interlock member can be collectively disposed in a free space in the housing. Further, since the first interlock member moves in conjunction with both the first intermediate member and the second intermediate member (i.e., the first interlock member is shared by the first intermediate member and the second intermediate member), this electric tool can efficiently realize the configuration that permits the power supply to the motor only in the state that both the first accessory and the second accessory are attached thereto. For example, in an embodiment in which the electric tool includes a sensor that detects the cumulative displacement of the first interlock member, the attachment of both the first accessory and the second accessory can be detected using the single sensor.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1** is a vertical cross-sectional view of a grinder according to one embodiment, and illustrates the grinder with a tool accessory, and a side handle and a cover as accessories detached therefrom.

(2) FIG. **2** is a horizontal cross-sectional view of the grinder, and illustrates the grinder with the tool accessory, and the side handle and the cover as the accessories detached therefrom.

(3) FIG. **3** is a partial enlarged view of FIG. **1**.

(4) FIG. **4** is a partial enlarged view of FIG. **1**.

(5) FIG. **5** is a partial enlarged view of FIG. **2**.

(6) FIG. **6** is a side view illustrating an assembly including a first intermediate member, a second intermediate member, a first interlock member, and a second interlock member, and each of the members is located at an initial position.

(7) FIG. **7** is a perspective view of the assembly illustrated in FIG. **6**.

(8) FIG. **8** is a front view illustrating the inner structure of the grinder, and each of the members in the assembly illustrated in FIG. **6** is located at the initial position.

(9) FIG. **9** is a perspective view illustrating the inner structure of the grinder, and each of the members in the assembly illustrated in FIG. **6** is located at the initial position.

(10) FIG. **10** is a vertical cross-sectional view of the grinder that corresponds to FIG. **1**, and

illustrates the grinder with the tool accessory, and the side handle and the cover as the accessories attached thereto.
(11) FIG. **11** is a horizontal cross-sectional view of the grinder that corresponds to FIG. **2**, and illustrates the grinder with the tool accessory, and the side handle and the cover as the accessories attached thereto.
(12) FIG. **12** is a partial enlarged view of FIG. **10**.
(13) FIG. **13** is a partial enlarged view of FIG. **10**.
(14) FIG. **14** is a partial enlarged view of FIG. **11**.
(15) FIG. **15** is a side view illustrating the assembly with only the side handle attached.
(16) FIG. **16** is a perspective view of the assembly illustrated in FIG. **15**.
(17) FIG. **17** is a side view illustrating the assembly with only the cover attached.
(18) FIG. **18** is a perspective view of the assembly illustrated in FIG. **17**.
(19) FIG. **19** is a side view illustrating the assembly with both the side handle and the cover attached.
(20) FIG. **20** is a perspective view of the assembly illustrated in FIG. **19**.

DETAILED DESCRIPTION OF THE EMBODIMENTS

(21) In one or more embodiment(s), the electric tool may include a sensor configured to directly or indirectly detect the cumulative displacement of the first interlock member, and a controller configured to control the power supply to the motor and configured to permit the power supply to the motor only in a state that the cumulative displacement of the first interlock member is detected by the sensor. According to this configuration, the attachment of both the first accessory and the second accessory can be detected using the single sensor. Therefore, the design flexibility of the electric tool can be improved. Further, compared to when two sensors are installed individually for the first accessory and the second accessory, respectively, this configuration can lead to a reduction in the number of sensors, i.e., electronic components and thus the number of wiring processes, thereby facilitating the manufacturing.
(22) In one or more embodiment(s), the electric tool may include a second interlock member configured to mechanically move in conjunction with the cumulative displacement of the first interlock member. The first intermediate member, the second intermediate member, and the first interlock member may be disposed on a first side with respect to the motor in an axial direction that is a direction in which a rotational axis of the motor extends. The sensor and the controller may be disposed on a second side opposite from the first side with respect to the motor in the axial direction. The second interlock member may extend from the first side to the second side. The sensor may be configured to detect the cumulative displacement of the first interlock member based on the displacement of the second interlock member. According to this configuration, the sensor and the controller, i.e., the electronic components are disposed on the second side, and therefore the first side does not have to be designed for insulation. This can make the electric tool compact. Further, a wiring for electrically connecting the sensor and the controller does not have to be laid so as to extend across motor, and therefore the wiring length can be reduced and the wiring installability can also be improved.
(23) In one or more embodiment(s), a first attachment direction for attaching the first accessory to the first attachment portion and a second attachment direction for attaching the second accessory to the second attachment portion may be different from each other. The first intermediate member and the second intermediate member may be configured to transmit a pressing force of the first accessory in the first attachment direction and a pressing force of the second accessory in the second attachment direction to the first interlock member while converting them into the same direction as each other. According to this configuration, the respective attachment directions of the first accessory and the second accessory do not have to match each other to realize the configuration in which the first interlock member moves in conjunction with both the first intermediate member and the second intermediate member, and therefore the design flexibility of

the electric tool can be improved.
(24) In one or more embodiment(s), the first intermediate member may be configured to move in conjunction with the first interlock member by moving pivotally and pressing the first interlock member when being directly or indirectly pressed by the first accessory. The second intermediate member may be configured to move in conjunction with the first interlock member by moving pivotally and pressing the first interlock member when being directly or indirectly pressed by the second accessory. According to this configuration, the first intermediate member and the second intermediate member can convert the pressing force of the first accessory applied in the first attachment direction and the pressing force of the second accessory applied in the second attachment direction into the same direction as each other with a small number of members.
(25) In one or more embodiment(s), the first attachment portion may include a third-side attachment portion disposed on a third side with respect to a plane containing the rotational axis of the motor and a fourth-side attachment portion disposed on a fourth side opposite from the third side with respect to the plane to allow the first accessory to be selectively attached. The third-side attachment portion and the fourth-side attachment portion may be disposed so as to be symmetric with each other with respect to the plane. The first intermediate member may include a third-side intermediate member disposed adjacent to the third-side attachment portion and a fourth-side intermediate member disposed adjacent to the fourth-side attachment portion. The third-side intermediate member and the fourth-side intermediate member may be disposed so as to be symmetric with each other with respect to the plane. The third-side intermediate member may be configured to be pivotal about a first pivotal axis. The fourth-side intermediate member may be configured to be pivotal about a second pivotal axis extending in the same direction as the first pivotal axis. A first pivotal direction may be opposite from a second pivotal direction. The first pivotal direction is a direction in which the third-side intermediate member moves pivotally when being directly or indirectly pressed by the first accessory. The second pivotal direction is a direction in which the fourth-side intermediate member moves pivotally when being directly or indirectly pressed by the first accessory. According to this configuration, the electric tool, on which the first accessory can be selectively attached to the two attachment positions, allows the first intermediate member and the first interlock member to work in conjunction with each other regardless of which attachment position is used to attach the first accessory.
(26) In one or more embodiment(s), the electric tool may include a first biasing member configured to bias the third-side intermediate member in a direction opposite from the first pivotal direction, and a second biasing member configured to bias the fourth-side intermediate member in a direction opposite from the second pivotal direction. Each of the third-side intermediate member and the fourth-side intermediate member may be in a non-contact state of not contacting the first interlock member or a non-pressing state of not pressing the first interlock member when being not directly or indirectly pressed by the first accessory. According to this configuration, when the first accessory is attached to the third-side attachment portion and the third-side intermediate member moves pivotally in the first pivotal direction to press the first interlock member, the fourth-side intermediate member disposed on the opposite side of the plane from the third-side intermediate member does not press the first interlock member in the direction opposite from the pressing direction of the third-side intermediate member under the biasing force of the second biasing member. Similarly, when the first accessory is attached to the fourth-side attachment portion and the fourth-side intermediate member moves pivotally in the second pivotal direction to press the first interlock member, the third-side intermediate member does not press the first interlock member in the direction opposite from the pressing direction of the fourth-side intermediate member under the biasing force of the first biasing member. Therefore, the first interlock member can be smoothly displaced in the intended direction.
(27) In one or more embodiment(s), the electric tool may include a housing. The first interlock member may include a first member pivotally supported by the housing. The first member may be

configured to move in conjunction with the first intermediate member by being pressed by the third-side intermediate member or the fourth-side intermediate member when the first accessory is attached to any of the third-side attachment portion and the fourth-side attachment portion. The first interlock member may include a second member configured to be engaged with the first member and the second intermediate member and move in conjunction with the first member and the second intermediate member. According to this configuration, since the first member is pivotally supported by the housing, the first interlock member (i.e., the first member and the second member engaged with the first member) can smoothly move pivotally even when the first accessory is attached to any of the third-side attachment portion and the fourth-side attachment portion and the first member is pressed by the third-side attachment member or the fourth-side attachment member (i.e., even when the first member is pressed by the third-side attachment member or the fourth-side attachment member only on one side with respect to the above-described plane).

(28) In one or more embodiment(s), the electric tool may be a grinder configured to rotate a tool accessory using a driving force of the motor. The first accessory may be a side handle. The second accessory may be a cover that partially covers the tool accessory.

(29) In the following description, the embodiments will be described in further detail with reference to the drawings. In an embodiment that will be described below, a handheld-type electric disk grinder (hereinafter simply referred to as a grinder) will be cited as an example of an electric tool.

(30) First, the overview of a grinder **10** will be described with reference to FIGS. **1**, **2**, **10**, and **11**. As illustrated in FIG. **10**, the grinder **10** is configured to rotationally drive a generally disk-shaped tool accessory (an accessory for processing) **28** mounted on a spindle **25**. The spindle **25** is rotated by a rotational driving force provided from an electric motor **31**. A grinding stone, a rubber pad, a brush, a blade, and the like are prepared as the tool accessory **28** mountable on the grinder **10**. A user selects the appropriate tool accessory **28** according to desired processing work and mounts it on the grinder **10**. According to the grinder **10**, processing work such as grinding, polishing, or cutting can be performed on a processing target material according to the type of the tool accessory **28**.

(31) In the following description, a direction in which a rotational axis AX**1** of the electric motor **31** (i.e., a motor shaft **32**) extends is defined to be a front-rear direction of the grinder **10**. One side in the front-rear direction on which the tool accessory **28** is located is defined to be a front side, and the opposite side therefrom is defined to be a rear side. Further, a direction in which a rotational axis AX**2** of the spindle **25** (i.e., a rotational axis of the tool accessory **28**) extends is defined to be a vertical direction of the grinder **10**. One side in the vertical direction on which the tool accessory **28** is located is defined to be a lower side, and the opposite side therefrom is defined to be an upper side. Further, a direction perpendicular to the vertical direction and the front-rear direction is defined to be a left-right direction of the grinder **10**. A right side in the left-right direction when the front side is viewed from the rear side is defined to be a right side of the grinder **10**, and the opposite side therefrom is defined to be a left side of the grinder **10**.

(32) As illustrated in FIGS. **1** and **10**, the grinder **10** includes a gear housing **20**, a motor housing **30**, a handle housing **40**, and an intermediate housing **36**. The electric motor **31** is contained in the motor housing **30**, which is located between the gear housing **20** and the handle housing **40** in the front-rear direction, i.e., the longitudinal direction of the grinder **10**. The electric motor **31** (the motor shaft **32**) is rotatably supported by a front-side bearing **34** and a rear-side bearing **35**. The electric motor **31** is driven by electric power supplied from outside (alternating-current power in the present embodiment, but may be direct-current power). The intermediate housing **36** is located between the gear housing **20** and the motor housing **30** in the front-rear direction, and is formed by two members in the present embodiment. The intermediate housing **36** functions as a bearing support that supports the front-side bearing **34**.

(33) As illustrated in FIGS. **1** and **10**, a mechanism for transmitting the rotational driving force of the electric motor **31** to the tool accessory **28** is contained in the gear housing **20**. More specifically, a small bevel gear **23**, a large bevel gear **24**, and the spindle **25** are contained in the gear housing **20**. The small bevel bear **23** is fixed around the motor shaft **32** at the front end portion of the motor shaft **32** of the electric motor **31**. The spindle **25** is supported rotatably about the rotational axis AX**2** by bearings disposed so as to be spaced apart from each other in the vertical direction. The rotational axis AX**2** intersects with (more specifically, intersects perpendicularly to) the rotational axis AX**1** of the electric motor **31**. The large bevel gear **24** is fixed around the spindle **25** on the upper side of the spindle **25**, and is meshed with the small bevel gear **23**. The gear housing **20** includes a second attachment portion **22** at the lower end portion thereof. The second attachment portion **22** is used to detachably attach a cover **300**. The second attachment portion **22** has a vertically extending cylindrical shape. The spindle **25** extends vertically in the gear housing **20**, and extends out of the gear housing **20** (more specifically, the second attachment portion **22**) on the lower side.

(34) As illustrated in FIG. **10**, an inner flange **26** is attached around the spindle **25** at the lower end portion of the spindle **25** extending out of the gear housing **20**. A male screw portion is formed on a lower portion of the spindle **25** with respect to the inner flange **26**, and a lock nut **27** is attached to this male screw portion. The position of the tool accessory **28** relative to the spindle **25** is fixed by sandwiching the tool accessory **28** between the inner flange **26** and the lock nut **27** and tightening the lock nut **27**.

(35) The handle housing **40** is a portion to be held by the user with one of his/her hands when the grinder **10** is in use. As illustrated in FIG. **10**, the handle housing **40** has a cylindrical shape extending generally in the front-rear direction. A switch **41** for driving the electric motor **31** is contained inside the handle housing **40**.

(36) As illustrated in FIGS. **1** and **10**, a controller **43** is further contained near the upper portion of the handle housing **40** in the handle housing **40**. The controller **43** is located above the switch **41**. The controller **43** and the switch **41** are disposed on the rear side with respect to the electric motor **31** in the front-rear direction. The controller **43** is electrically connected to the electric motor **31** and the switch **41**. The controller **43** controls the driving of the electric motor **31** by controlling power to be supplied to the electric motor **31**. In the present embodiment, the controller **43** includes a high temperature protection circuit, an over current protection circuit, and an over discharge protection circuit. However, one or two of these protection circuits may be omitted.

(37) As illustrated in FIGS. **1** and **10**, an operation member **50** is provided at lower portions of the motor housing **30** and the handle housing **40**. The operation member **50** is configured to be displaceable between an OFF position for putting the switch **41** in an OFF state, and an ON position for putting the switch **41** in an ON state. The operation member **50** is an elongated member extending in the front-rear direction. The operation member **50** includes a front end portion **51** and a protrusion **53**. The front end portion **51** is inserted in a through-hole formed at the bottom portion of the motor housing **30** and extending in the front-rear direction. The front end portion **51** has a recessed and protruding shape engaged with the motor housing **30**, and this allows the operation member **50** to be held on the motor housing **30** in an undetachable state. The operation member **50** is configured to be pivotal in the counterclockwise direction from the OFF position illustrated in FIG. **10** to the ON position (not illustrated) with an engagement portion between the front end portion **51** and the motor housing **30** serving as a supporting point therefor. As illustrated in FIGS. **1** and **10**, the protrusion **53** extends upward from the upper portion of the operation member **50**.

(38) As illustrated in FIGS. **1** and **10**, a lock-off member **54** is attached to the operation member **50**. The lock-off member **54** is provided at an approximately central position of the operation member **50** in the front-rear direction. The lock-off member **54** is supported by the operation member **50** via a pin **57** supported in a boss formed inside the operation member **50**. The lock-off member **54** is pivotal about the pin **57**. The lock-off member **54** is constantly biased by a torsion spring (not

illustrated) in the clockwise direction as viewed from the left side.
(39) The lock-off member **54** includes an abutment edge portion **55** and an operation edge portion **56**. When the lock-off member **54** is located at an initial position illustrated in FIGS. **1** and **10**, the operation edge portion **56** protrudes downward via a hole of the lock-off member **54**. Further, the abutment edge portion **55** is in abutment with an abutment portion **33**, which is formed at the rear end and the bottom portion of the motor housing **30** so as to protrude from the motor housing **30** downward. Therefore, even when the user performs an operation of pressing the operation member **50** upward to displace the operation member **50** from the OFF position (refer to FIGS. **1** and **10**) to the ON position (hereinafter also referred to as an ON operation), the pivotal movement of the operation member **50** is prohibited. On the other hand, when the user operates the lock-off member **54** by pulling the operation edge portion **56** rearward with his/her finger, the lock-off member **54** moves pivotally in the counterclockwise direction against the biasing force of the torsion spring. As a result, the abutment edge portion **55** moves pivotally to a position at which it is out of abutment with the abutment portion **33**. As a result, the user can pivotally move the operation member **50** to the ON position.
(40) As illustrated in FIGS. **1** and **10**, a link member **45** is disposed above the operation member **50**. The link member **45** includes a through-hole extending through the link member **45** in the left-right direction, and a pin **48** is inserted in this through-hole. The pin **48** is supported in a boss formed inside the handle housing **40**. Due to thereto, the link member **45** is configured to be pivotal about the pin **48**. The link member **45** is biased by a torsion spring (not illustrated) in the counterclockwise direction as viewed from the left side.
(41) The link member **45** includes two arms **46** and **47** extending outward in a radial direction with respect to a pivotal axis of the link member **45**. The first arm **46** is located on the upper side and the second arm **47** is located on the lower side. When the link member **45** is located at an initial position (refer to FIGS. **1** and **10**), the distal end of the second arm **47** is in abutment with the protrusion **53** of the operation member **50**. When the user performs the operation of pressing the operation member **50** upward and the operation member **50** is displaced from the OFF position (refer to FIGS. **1** and **10**) to the ON position (not illustrated), the second arm **47** is raised upward by the protrusion **53**. Accordingly, the link member **45** moves pivotally in the clockwise direction against the biasing force of the torsion spring. At this time, the first arm **46** presses an input member **42** of the switch **41** rearward. As a result, the switch **41** is switched from the OFF state to the ON state. On the other hand, when the user releases the force pressing the operation member **50** upward, the link member **45** returns to the initial position under the biasing force of the torsion spring and the switch **41** returns to the OFF state. At the same time, the operation member **50** also returns to the OFF position by being pressed by the link member **45**.
(42) When the operation member **50** is operated from the OFF position to the ON position by the user as described above, the switch **41** detects the operation and transmits a control signal to the controller **43**. When receiving this control signal, the controller **43** supplies power to the electric motor **31** and drives the electric motor **31**. When the electric motor **31** is driven, the rotation of the motor shaft **32** is transmitted to the spindle **25** while being slowed down via the small bevel gear **23** and the large bevel bear **24**. At this time, the direction of the rotational motion is also converted from the direction around the motor shaft **32** into the direction around the rotational axis AX**2** of the spindle **25**. According to this mechanism, the spindle **25** is rotated around the rotational axis AX**2** in response to the rotation of the motor shaft **32**, and the tool accessory **28** fixed by the inner flange **26** and the lock nut **27** is rotated together with the spindle **25** as a result thereof.
(43) As illustrated in FIG. **11**, the grinder **10** further includes a side handle **200** and a cover **300** as two types of accessories. The side handle **200** is prepared to be held by the user with the opposite hand from his/her hand holding the handle housing **40**. The user can further stably hold the grinder **10** by using the side handle **200**. The side handle **200** includes a grip portion **210** to be held by the user, and an attachment portion **220** to be attached to the gear housing **20**. The attachment portion

220 has a columnar shape extending in the longitudinal direction of the side handle **200**, and extends out of one end of the grip portion **210** in the longitudinal direction of the side handle **200**. A male screw is formed on the outer peripheral surface of the distal end portion of the attachment portion **220**.

(44) As illustrated in FIGS. **2** and **11**, the gear housing **20** includes two first attachment portions **29***a* and **29***b* for detachably attaching the side handle **200**. The first attachment portion **29***a* is formed on the left side surface of the gear housing **20**, and the first attachment portion **29***b* is formed on the right side surface of the gear housing **20**. In other words, the first attachment portion **29***a* is located on one side (the left side) with respect to a plane P**1** containing the rotational axis AX**1** of the electric motor **31** (this plane also contains the rotational axis AX**2** of the spindle **25** in the present embodiment), and the first attachment portion **29***b* is located on the opposite side (the right side) with respect to the plane P**1**. The plane P**1** is an imaginary plane extending in the front-rear direction and the vertical direction. More specifically, the first attachment portions **29***a* and **29***b* are disposed so as to be symmetric with respect to the plane P**1**. Each of the first attachment portions **29***a* and **29***b* is configured in the form of a through-hole that establishes communication between the inside and the outside of the gear housing **20**. A female screw threadably engaged with the male screw of the attachment portion **220** of the side handle **200** is formed on the inner surface forming this through-hole.

(45) The side handle **200** can be attached to the gear housing **20** by screwing the attachment portion **220** of the side handle **200** into selected one from the two first attachment portions **29***a* and **29***b*. The user can arbitrarily select the attachment portion of the side handle **200** from the first attachment portions **29***a* and **29***b* according to the type of the work intended to be performed using the grinder **10** or according to whether the user is right-handed or left-handed. FIG. **11** illustrates the grinder **10** with the side handle **200** selectively attached to the first attachment portion **29***a*.

(46) As illustrated in FIG. **10**, the cover **300** includes a cover main body **310** to cover a part of the tool accessory **28** therewith, and an attachment portion **320** to be attached to the second attachment portion **22**. The cover main body **310** covers an approximately rear half portion of the tool accessory **28**. The cover main body **310** covers the upper surface and the circumferential surface of the tool accessory **28** in the present embodiment, but may cover the upper surface, the lower surface, and the circumferential surface between the upper surface and the lower surface depending on the type of the tool accessory **28** in use. The attachment portion **320** has a generally annular opened shape, and extends from the upper surface of the cover main body **310** upward. The attachment portion **320** includes two flanges (not illustrated) opposite in the circumferential direction around the rotational axis AX**2** at two distal ends in the circumferential direction. A bolt (not illustrated) is inserted into a screw hole formed at each of the flanges and is tightened with the attachment portion **320** disposed so as to surround the second attachment portion **22** of the gear housing **20**, by which the radius of the annular shape of the attachment portion **320** reduces and the attachment portion **320** is fixed to the second attachment portion **22**.

(47) The above-described grinder **10** can drive the electric motor **31** only in a state that the side handle **200** is attached to any of the first attachment portions **29***a* and **29***b* of the gear housing **20** and the cover **300** is attached to the second attachment portion **22**. In a state that at least one of the side handle **200** and the cover **300** is not attached, the controller **43** prohibits the driving of the electric motor **31** (i.e., the power supply to the electric motor **31**) even when the user operates the operation member **50** to the ON position and the control signal indicating that the switch **41** is in the ON state is transmitted from the switch **41** to the controller **43**. On the other hand, in the state that both the side handle **200** and the cover **300** are attached, the controller **43** permits the driving of the electric motor **31** when the control signal indicating that the switch **41** is in the ON state is transmitted from the switch **41** to the controller **43**. In the following description, such a configuration will be described in detail with reference to the drawings.

(48) The grinder **10** includes first intermediate members **60***a* and **60***b*, a second intermediate

member **70**, a first interlock member **80**, a second interlock member **90**, and a sensor **44**. As illustrated in FIGS. **5**, **7**, and **9**, the first intermediate members **60***a* and **60***b* are shaped identically to each other. The first intermediate member **60***a* is a member having a rod-like portion extending in a direction slightly angled with respect to the rotational axis AX**1**. More precisely, the first intermediate member **60***a* extends so as to be separating from the rotational axis AX**1** from the rear end thereof toward the front end thereof. A protrusion portion **61***a*, which protrudes outward in the radial direction with respect to the rotational axis AX**1**, is formed at the front end of the rod-like portion of the first intermediate member **60***a*. A pressing portion **63***a*, which protrudes in a claw-like manner outward in the radiation direction, is formed at the rear end of the rod-like portion of the first intermediate member **60***a*. Columnar shaft portions **62***a*, which protrude toward the upper side and the lower side, respectively, are formed near the rear end of the first intermediate member **60***a* (refer to FIG. **7**). As illustrated in FIGS. **8** and **9**, the shaft portions **62***a* are supported in bosses **36***a* formed in the intermediate housing **36**, and the first intermediate member **60***a* is pivotal about a first pivotal axis AX**3** (refer to FIG. **7**). Similarly, the first intermediate member **60***b* includes a protrusion portion **61***b*, a pressing portion **63***b*, and shaft portions **62***b*. The shaft portions **62***b* are supported in bosses **36***b* formed in the intermediate housing **36**, and the first intermediate member **60***b* is pivotal about a second pivotal axis AX**4** (refer to FIG. **7**). The first pivotal axis AX**3** and the second pivotal axis AX**4** are in parallel with each other, and both extend in the vertical direction.

(49) As illustrated in FIGS. **8** and **9**, torsion springs **64***a* are disposed around the shaft portions **62***a* of the first intermediate member **60***a*. Similarly, torsion springs **64***b* are disposed around the shaft portions **62***b* of the first intermediate member **60***b*. The torsion springs **64***a* bias the first intermediate member **60***a* in the counterclockwise direction as viewed from above (i.e., a direction for displacing the protrusion portion **61***a* rearward). The torsion springs **64***b* bias the first intermediate member **60***b* in the clockwise direction as viewed from above (i.e., a direction for displacing the protrusion portion **61***b* rearward).

(50) As illustrated in FIG. **5**, the first intermediate members **60***a* and **60***b* are disposed adjacent to the first attachment portions **29***a* and **29***b*, respectively. The first intermediate members **60***a* and **60***b* are disposed so as to be symmetric with each other with respect to the plane P**1** (refer to FIGS. **2** and **11**). When the first intermediate members **60***a* and **60***b* are located at initial positions illustrated in FIG. **5**, the protrusion portions **61***a* and **61***b* located at the front ends of the first intermediate members **60***a* and **60***b* are contained in the first attachment portions **29***a* and **29***b*, respectively.

(51) As illustrated in FIGS. **1**, **7**, and **9**, the second intermediate member **70** is a member having a rod-like portion extending in the front-rear direction. A pressed portion **71**, which protrudes downward, is formed at the front end of the rod-like portion of the second intermediate member **70**. As illustrated in FIG. **7**, columnar shaft portions **72**, which protrude to the right side and the left side, respectively, are formed at the rear end of the rod-like portion of the second intermediate member **70**. Further, an arched portion **73**, which extends upward in an arched manner, is formed at the rear end of the rod-like portion of the second intermediate member **70**. The arched portion **73** has a shape symmetric in the left-right direction with respect to the rotational axis AX**1**. Columnar engagement portions **74**, which protrude to the right side and the left side, respectively, are formed at both the ends of the arched portion **73** (only the engagement portion **74** on the left side can be seen in FIG. **7**).

(52) As illustrated in FIGS. **1**, **9**, and **10**, the second intermediate member **70** is disposed near the bottom portion of the intermediate housing **36** in such a manner that an approximately half portion on the rear side thereof is contained in the intermediate housing **36**. An approximately half portion on the front side of the second intermediate member **70** extends out of a hole of the intermediate housing **36** forward and is exposed. The pressed portion **71** located at the front end of the second intermediate member **70** is positioned near the second attachment portion **22** of the gear housing **20**.

(53) The distal ends of the shaft portions **72** of the second intermediate member **70** are supported in bosses (not illustrated) formed in the intermediate housing **36**, and the second intermediate member **70** is pivotal about a third pivotal axis AX**5** extending in the left-right direction (refer to FIG. **7**). As illustrated in FIGS. **8** and **9**, torsion springs **75** are disposed around the shaft portions **72** of the second intermediate member **70**. The torsion springs **75** bias the second intermediate member **70** in the counterclockwise direction as viewed from the left side (i.e., a direction for displacing the pressed portion **71** downward).

(54) The first interlock member **80** is a member configured to mechanically move in conjunction with both the first intermediate member **60***a* or **60***b* and the second intermediate member **70** (the details thereof will be described below). As illustrated in FIG. **7**, the first interlock member **80** includes two members, i.e., a first member **81** and a second member **82** in the present embodiment. The first member **81** is a generally U-shaped member opened on the lower side thereof. Two lower end portions **83** of the first member **81** protrude forward. The lower end portions **83** are located at the same positions as the first intermediate members **60***a* and **60***b* in the vertical direction. The lower end portions **83** each have a tapering shape reducing in width toward the front side in such a manner that the center of gravity of the first member **81** is located at a position closer to the rear end than to the front end thereof.

(55) As illustrated in FIGS. **7** and **9**, a pressed portion **84**, which protrudes from the lower end portion **83** inward in the radial direction with respect to the rotational axis AX**1**, is formed at the front edge of each of the two lower end portions **83**. The pressed portion **84** has a columnar shape in the present embodiment. The pressed portions **84** are located adjacent to the pressing portions **63***a* and **63***b* in front of the pressing portions **63***a* and **63***b* of the first intermediate members **60***a* and **60***b*, respectively. As illustrated in FIG. **5**, when the first intermediate members **60***a* and **60***b* are located at the initial positions, the pressing portions **63***a* and **63***b* and the two pressed portions **84** are in contact with each other in the front-rear direction, respectively, but the pressing portions **63***a* and **63***b* are in a state of not pressing the two pressed portions **84** forward (referred to as a non-pressing state).

(56) As illustrated in FIGS. **5** and **7**, an engagement portion **86**, which protrudes from the lower end portion **83** inward in the radial direction with respect to the rotational axis AX**1**, is further formed at each of the two lower end portions **83**. The engagement portion **86** is located on the rear side with respect to the pressed portion **84**. The engagement portion **86** has a columnar shape in the present embodiment.

(57) Columnar shaft portions **85**, which protrude toward the left side and the right side, respectively, are formed at the upper end portion of the first member **81**. The distal ends of the shaft portions **85** are supported in bosses (not illustrated) formed in the intermediate housing **36**, and the first member **81** is pivotal about a fourth pivotal axis AX**6** extending in the left-right direction (refer to FIG. **7**).

(58) This first member **81** is configured mechanically move in conjunction with the first intermediate member **60***a* or **60***b*. More specifically, when the side handle **200** is attached to the first attachment portion **29***a* as illustrated in FIG. **14**, the distal end of the attachment portion **220** of the side handle **200** presses the protrusion portion **61***a* of the first intermediate member **60***a* inward. According thereto, the first intermediate member **60***a* moves pivotally from the initial position illustrated in FIG. **5** to a position illustrated in FIG. **14** in the clockwise direction as viewed from above against the biasing forces of the torsion springs **64***a*. At this time, the pressing portion **63***a* of the first intermediate member **60***a* presses the left-side pressed portion **84** of the first member **81** forward while moving pivotally as illustrated in FIG. **14**. As a result, the first member **81** moves pivotally about the fourth pivotal axis AX**6** located on the shaft portions **85** from a position illustrated in FIGS. **6** and **7** to a position illustrated in FIGS. **15** and **16** forward (i.e., in such a manner that the lower end portion **83** is displaced forward).

(59) On the other hand, when the side handle **200** is detached from the first attachment portion **29***a*,

i.e., the grinder **10** returns to the state that the side handle **200** does not press the protrusion portion **61***a* of the first intermediate member **60***a*, the first intermediate member **60***a* returns from the position illustrated in FIG. **14** to the initial position illustrated in FIG. **5** by moving pivotally in the counterclockwise direction as viewed from above under the biasing forces of the torsion springs **64***a*. At this time, the first member **81** returns from the position illustrated in FIGS. **15** and **16** to the position illustrated in FIGS. **6** and **7** under a biasing force of a not-illustrated biasing member provided in the intermediate housing **36**.

(60) When the side handle **200** is attached to the first attachment portion **29***b*, the distal end of the attachment portion **220** of the side handle **200** presses the protrusion portion **61***b* of the first intermediate member **60***b* inward, and the first intermediate member **60***b* moves pivotally in the counterclockwise direction as viewed from above (i.e., in the opposite direction from when the side handle **200** is attached to the first attachment portion **29***a* and the first intermediate member **60***a* is pressed by the side handle **200**) against the biasing forces of the torsion springs **64***b*, although this is not illustrated. At this time, the pressing portion **63***b* of the first intermediate member **60***b* presses the right-side pressed portion **84** of the first member **81** forward while moving pivotally. As a result, the first member **81** moves forward pivotally about the fourth pivotal axis AX**6** located on the shaft portions **85** similarly to when the side handle **200** is attached to the first attachment portion **29***a*. Further, when the side handle **200** is detached from the first attachment portion **29***b*, the first intermediate member **60***b* and the first member **81** return to the respective initial positions similarly.

(61) In this manner, the first member **81** is configured to move in conjunction with the first intermediate member **60***a* or the first intermediate member **60***b* by being pressed by the first intermediate member **60***a* or the first intermediate member **60***b* when the side handle **200** is selectively attached to any of the first attachment portions **29***a* and the **29***b*.

(62) As illustrated in FIG. **7**, the second member **82** is a generally U-shaped member opened on the lower side thereof. As illustrated in FIGS. **5** and **7**, the second member **82** is disposed on the radially inner side with respect to the first member **81**. As illustrated in FIG. **7**, the second member **82** includes, on the upper end thereof, a protrusion upper end portion **89** which protrude upward. The protrusion upper end portion **89** includes a right-side side wall and a left-side side wall. The protrusion upper end portion **89** further includes a beam portion **891**, which connects the right-side side wall and the left-side side wall at upper and rear positions of them. The beam portion **891** has a columnar shape extending in the left-right direction. A through-hole **892** extending in the front-rear direction (refer to FIGS. **3** and **12**) is formed below the beam portion **891**. The two lower ends of the second member **82** extend to the lower side with respect to the lower end portions **83** of the first member **81**. An engagement portion **87**, which includes a generally U-shaped cutout opened on the lower side, is formed at each of the two lower ends of the second member **82**. The two engagement portions **74** of the second intermediate member **70** are inserted in the cutouts of the two engagement portions **87**, respectively. Due to this configuration, the second member **82** and the second intermediate member **70** are engaged with each other.

(63) The second member **82** is configured to mechanically move in conjunction with the second intermediate member **70** and the first member **81**. First, the interlocking movement between the second member **82** and the second intermediate member **70** will be described. As illustrated in FIGS. **10** and **12**, when the cover **300** (more specifically, the attachment portion **320**) is attached to the second attachment portion **22**, the upper end of the attachment portion **320** presses the pressed portion **71** of the second intermediate member **70** upward. According thereto, the second intermediate member **70** moves pivotally about the third pivotal axis AX**5** located on the shaft portions **72** from a position illustrated in FIGS. **6** and **7** to a position illustrated in FIGS. **17** and **18** in the clockwise direction as viewed from the left side against the biasing forces of the torsion springs **75**. At this time, the engagement portions **87** engaged with the engagement portions **74** of the second intermediate member **70** are pressed rearward, and the second member **82** moves

pivotally about a fifth pivotal axis AX**7** (refer to FIG. **7**) located on the engagement portions **74** from a position illustrated in FIGS. **6** and **7** to a position illustrated in FIGS. **17** and **18** in the counterclockwise direction as viewed from the left side.

(64) On the other hand, when the cover **300** is detached from the second attachment portion **22**, i.e., the grinder **10** returns to the state that the cover **300** does not press the pressed portion **71** of the second intermediate member **70**, the second intermediate member **70** returns from the position illustrated in FIGS. **17** and **18** to the position illustrated in FIGS. **6** and **7** by moving pivotally in the counterclockwise direction as viewed from the left side under the biasing forces of the torsion springs **75**. At this time, the engagement portions **87** of the second member **82** engaged with the engagement portions **74** of the second intermediate member **70** are pressed forward, and therefore the second member **82** also moves pivotally and returns from the position illustrated in FIGS. **17** and **18** to the position illustrated in FIGS. **6** and **7**.

(65) In this manner, the second member **82** is configured to move in conjunction with the second intermediate member **70** by being pressed by the second intermediate member **70** when the cover **300** is attached to the second attachment portion **22**.

(66) Next, the interlocking movement between the second member **82** and the first member **81** will be described. As illustrated in FIGS. **5** and **7**, two engagement holes **88** are formed at vertically extending portions of the second member **82** on the left side and the right side sandwiching the rotational axis AX**1** therebetween (hereinafter referred to as a left portion and a right portion), respectively (only the engagement hole **88** on the right side can be seen in FIG. **7**). The two engagement holes **88** are configured in the form of holes extending through the left portion and the right portion in the left-right direction, respectively. The engagement holes **88** are located at positions closer to the engagement portions **74** of the second intermediate member **70** than the shaft portions **85** of the first member **81** are. The engagement portions **86** of the first interlock member **80** are inserted in the two engagement holes **88**, respectively. Due to this configuration, the second member **82** and the first member **81** are engaged with each other.

(67) Therefore, when the first member **81** moves pivotally about the fourth pivotal axis AX**6** by being pressed by the first intermediate member **60***a* or the first intermediate member **60***b* due to the attachment of the side handle **200**, the engagement portions **86** press the second member **82** forward. As a result, the second member **82** moves pivotally about the fifth pivotal axis AX**7** extending in the left-right direction (refer to FIG. **7**) from the position illustrated in FIGS. **6** and **7** to a position illustrated in FIGS. **15** and **16**. The fifth pivotal axis AX**7** is located on the engagement portions **74**. Further, when the side handle **200** is detached and the first member **81** moves pivotally in the opposite direction, the engagement portions **86** press the second member **82** rearward. As a result, the second member **82** moves pivotally and returns from the position illustrated in FIGS. **15** and **16** to the position illustrated in FIGS. **6** and **7**.

(68) Further, when the second intermediate member **70** moves pivotally due to the attachment of the cover **300**, and the second member **82** moves pivotally in the counterclockwise direction as viewed from the left side in conjunction with the second intermediate member **70**, the second member **82** presses the engagement portions **86** of the first member **81** forward. According thereto, the first member **81** moves pivotally about the fourth pivotal axis AX**6** located on the shaft portions **85** from the position illustrated in FIGS. **6** and **7** to a position illustrated in FIGS. **17** and **18** in the clockwise direction as viewed from the left side. Further, when the cover **300** is detached and the second member **82** moves pivotally in the opposite direction, the second member **82** presses the engagement portions **86** rearward. As a result, the first member **81** moves pivotally and returns from the position illustrated in FIGS. **17** and **18** to the position illustrated in FIGS. **6** and **7**.

(69) Due to such a configuration, the second member **82** can move in conjunction with both the second intermediate member **70** and the first member **81**. As clearly understood from the above description, the second member **82** is displaced in the same direction between when the side handle **200** is attached and when the cover **300** is attached.

(70) The above-described interlocking movements of the first intermediate member **60***a* or **60***b*, the second intermediate member **70**, and the first interlock member **80** (the first member **81** and the second member **82**) realize a cumulative displacement of the first interlock member **80** when both the side handle **200** and the cover **300** are attached. More specifically, when the side handle **200** is attached first, the first interlock member **80** is displaced (moves pivotally) from the initial position illustrated in FIGS. **6** and **7** to the position illustrated in FIGS. **15** and **16** as described above. Then, when the cover **300** is attached in addition to the side handle **200**, the first interlock member **80** is further displaced (moves pivotally) from the position illustrated in FIGS. **15** and **16** to a position illustrated in FIGS. **19** and **20** in the same direction as when the side handle **200** is attached. On the other hand, when the side handle **300** is attached first, the first interlock member **80** is displaced (moves pivotally) from the initial position illustrated in FIGS. **6** and **7** to the position illustrated in FIGS. **17** and **18** as described above. Then, when the side handle **200** is attached in addition to the cover **300**, the first interlock member **80** is further displaced (moves pivotally) from the position illustrated in FIGS. **17** and **18** to the position illustrated in FIGS. **19** and **20** in the same direction as when the cover **300** is attached. In this manner, when both the side handle **200** and the cover **300** are attached, the first interlock member **80** is cumulatively displaced from the initial position illustrated in FIGS. **6** and **7** to the position illustrated in FIGS. **19** and **20** regardless of the order in which the side handle **200** and the cover **300** are attached.

(71) The second interlock member **90** is configured to mechanically move in conjunction with such a cumulative displacement of the first interlock member **80**. As illustrated in FIGS. **6** and **7**, the second interlock member **90** is a rod-like member extending in the front-rear direction. As illustrated in FIGS. **1** and **10**, the second interlock member **90** extends from the front side with respect to the electric motor **31** to the rear side with respect to the electric motor **31**. The second interlock member **90** is disposed along the inner upper surface of the motor housing **30** displaceably in the front-rear direction. As illustrated in FIGS. **3** and **12**, the second interlock member **90** extends through the through-hole **892** formed on the protrusion upper end portion **89** of the second member **82** of the first interlock member **80** and extends to the front side with respect to the second member **82**.

(72) As illustrated in FIGS. **6** and **7**, an engagement portion **91**, which protrudes upward, is formed at the front end of the second interlock member **90**. The engagement portion **91** extends to the upper side with respect to the beam portion **891** of the protrusion upper end portion **89**. A recessed portion **97**, which is recessed in a circular-arc manner, is formed at the proximal portion of the rear side of the engagement portion **91**. Protrusion portions **92** and **93** are formed near the rear end of the second interlock member **90**. The protrusion portions **92** and **93** protrude downward, and are spaced apart from each other in the front-rear direction. A positioning protrusion portion **94**, which protrudes forward, is formed on the front end surface of the protrusion portion **92**. A positioning protrusion portion **95**, which protrudes rearward, is formed on the rear end surface of the protrusion portion **93**.

(73) As illustrated in FIGS. **4** and **13**, a coil spring **96** as one example of a biasing member is disposed between the protrusion portion **92** and the protrusion portion **93**. The rear end of the coil spring **96** is seated on the front end surface of the protrusion portion **92**, and the front end of the coil spring **96** is seated on a portion of the motor housing **30** that hangs out between the protrusion portion **92** and the protrusion portion **93**. The coil spring **96** is disposed so as to surround the positioning protrusion portions **94** and **95**, and a movement of the coil spring **96** in a direction perpendicular to the front-rear direction is restricted thereby. The coil spring **96** is disposed in a compressed state, and constantly biases the second interlock member **90** rearward. The protrusion portion **93** functions as a stopper that restricts a rearward movement of the second interlock member **90** by abutting against the portion of the motor housing **30** that hangs out between the protrusion portion **92** and the protrusion portion **93**.

(74) When the second interlock member **90** is located at an initial position illustrated in FIGS. **6**

and **7**, the engagement portion **91** of the second interlock member **90** and the beam portion **891** of the second member **82** are spaced apart from each other in the front-rear direction. When only the side handle **200** as one of the side handle **200** and the cover **300** is attached, the engagement portion **91** and the beam portion **891** of the second member **82** contact each other as illustrated in FIGS. **15** and **16** due to the pivotal movement of the second member **82** of the first interlock member **80**. At this time, the beam portion **891** does not press the engagement portion **91** forward. Therefore, the second interlock member **90** stays at the initial position. When only the cover **300** as one of the side handle **200** and the cover **300** is attached, the engagement portion **91** and the beam portion **891** of the second member **82** contact each other as illustrated in FIGS. **17** and **18** due to the pivotal movement of the second member **82** of the first interlock member **80**. At this time, the beam portion **891** does not press the engagement portion **91** forward. Therefore, the second interlock member **90** stays at the initial position.

(75) When both the side handle **200** and the cover **300** are attached, the beam portion **891** of the second member **82** presses the engagement portion **91** forward as illustrated in FIGS. **19** and **20** due to the further pivotal movement of the second member **82** of the first interlock member **80**. According thereto, the second interlock member **90** is displaced forward from a position illustrated in FIG. **3** to a position illustrated in FIG. **12** against the biasing force of the coil spring **96**. Since the recessed portion **97** is formed at the proximal portion of the engagement portion **91**, the beam portion **891** is contained in the recessed portion **97** as illustrated in FIG. **12** when the second interlock member **90** is displaced forward. Therefore, the beam portion **891** does not apply a downward force to the second interlock member **90**. As a result, the second interlock member **90** can be smoothly displaced forward.

(76) On the other hand, when at least one of the side handle **200** and the cover **300** is detached, the second member **82** returns from the position illustrated in FIGS. **19** and **20** to the position illustrated in FIGS. **15** and **16** or the position illustrated in FIGS. **17** and **18**. As a result, the force with which the beam portion **891** of the second member **82** presses the engagement portion **91** forward is released, and the second interlock member **90** returns to the initial position illustrated in FIG. **3** under the biasing force of the coil spring **96**.

(77) In this manner, the second interlock member **90** moves in conjunction with the first interlock member **80** so as to be displaced according to whether the first interlock member **80** is cumulatively displaced. In other words, the second interlock member **90** is displaced forward only when the first interlock member **80** is cumulatively displaced, and is displaced rearward only when the cumulative displacement is released.

(78) Such a displacement of the second interlock member **90** (i.e., the cumulative displacement of the first interlock member **80**) is detected by the sensor **44**. More specifically, as illustrated in FIGS. **4** and **13**, the sensor **44** is mounted on a board **441** so as to vertically face the protrusion portion **92** of the second interlock member **90**. The sensor **44** is disposed on the rear side with respect to the electric motor **31**. In the present embodiment, the sensor **44** is a Hall sensor. A magnet **49** is embedded in the protrusion portion **92** so as to be exposed downward. As illustrated in FIGS. **4** and **13**, the magnet **49** passes over across the sensor **44** in the front-rear direction when the second interlock member **90** is displaced in the front-rear direction. In the present embodiment, the sensor **44** is a bipolar detection-type sensor, and the magnet **49** is configured in such a manner that the N pole and the S pole are arranged in the front-rear direction. Therefore, the sensor **44** can detect the displacement of the second interlock member **90** (the cumulative displacement of the first interlock member **80**) based on which of the N pole and the S pole is detected. The type of the sensor **44** is not especially limited, and, for example, may be a unipolar detection-type Hall sensor or may be any known type of magnetic sensor other than the Hall sensor (for example, an MR sensor). The layout of the switch **41** and the magnet **49** can be changed as appropriate according to the characteristics of the sensor **44**.

(79) This sensor **44** is electrically connected to the controller **43**, and an output of the sensor **44** is

input to the controller **43**. When the displacement of the second interlock member **90** (the cumulative displacement of the first interlock member **80**) is not detected by the sensor **44**, i.e., at least one of the side handle **200** and the cover **300** is not attached, the controller **43** prohibits the driving of the electric motor **31** (i.e., the power supply to the electric motor **31**). On the other hand, when the displacement of the second interlock member **90** (the cumulative displacement of the first interlock member **80**) is detected by the sensor **44**, i.e., both the side handle **200** and the cover **300** are attached, the controller **43** permits the driving of the electric motor **31** upon the transmission of the control signal indicating that the switch **41** is in the ON state from the switch **41** to the controller **43**. Such prohibition/permission control regarding the driving of the electric motor **31** may be realized by software executed by a CPU of the controller **43** or may be performed only by hardware (for example, a switching element that switches on/off the electric connection between the controller **43** and the electric motor **31** according to an input from the sensor **44** may be used).

(80) According to the above-described grinder **10**, a novel structure is provided in which the power supply to the electric motor **31** is permitted only in the state that both the side handle **200** and the cover **300** are attached and thus the first interlock member **80** is cumulatively displaced by moving in conjunction with the first intermediate member **60***a* or **60***b* and the second intermediate member **70**. Therefore, the grinder **10** can improve the design flexibility of the grinder having the structure in which the power supply to the motor is permitted only in the state that both the side handle and the cover are attached thereto. For example, the first intermediate members **60***a* and **60***b*, the second intermediate member **70**, and the first interlock member **80** can be collectively disposed in a free space in the intermediate housing **36**, like the above-described embodiment. Further, since the first interlock member **80** moves in conjunction with both the first intermediate member **60***a* or **60***b* and the second intermediate member **70** (i.e., the first interlock member **80** is shared by the first intermediate member **60***a* or **60***b* and the second intermediate member **70**), the grinder **10** can efficiently realize the configuration that permits the power supply to the electric motor **31** only in the state that both the side handle **200** and the cover **300** are attached. For example, the attachment of both the side handle **200** and the cover **300** can be detected using the single sensor **44**. The reduction in the number of sensors can lead to a reduction in the number of electronic components and thus a reduction in the number of wiring processes, thereby facilitating the manufacturing.

(81) Further, according to the grinder **10**, the first intermediate members **60***a* and **60***b*, the second intermediate member **70**, and the first interlock member **80** are disposed on the front side with respect to the electric motor **31**, and the sensor **44** and the controller **43** (i.e., electronic components) are disposed on the rear side with respect to the electric motor **31**. Then, the cumulative displacement of the first interlock member **80** is detected by the sensor **44** via the second interlock member **90**. Therefore, the portion on the front side with respect to the electric motor **31** (for example, the intermediate housing **36**) does not have to be designed for insulation. This can make the grinder **10** compact. Further, a wiring for electrically connecting the sensor **44** and the controller **43** does not have to be laid so as to extend across the electric motor **31**, and therefore the wiring length can be reduced and the wiring installability can also be improved.

(82) Further, according to the grinder **10**, although the attachment direction for attaching the side handle **200** to the first attachment portion **29***a* or the first attachment portion **29***b* (approximately the left-right direction) and the attachment direction for attaching the cover **300** to the second attachment portion **22** (the vertical direction) are different, the respective pressing forces of the side handle **200** and the cover **300** applied in these two attachment directions are converted into the same direction as each other (the front-rear direction) with the aid of the first intermediate member **60***a* or **60***b* and the second intermediate member **70**. Therefore, the above-described two attachment directions do not have to match each other, and thus the design flexibility of the grinder **10** can be improved.

(83) Further, according to the grinder **10**, the first intermediate member **60***a* or **60***b* moves in conjunction with the first interlock member **80** by moving pivotally and pressing the first interlock

member **80** (the first member **81**) when being pressed by the side handle **200**. Further, the second intermediate member **70** moves in conjunction with the first interlock member **80** by moving pivotally and pressing the first interlock member **80** (the second member **82**) when being pressed by the cover **300**. The first intermediate members **60***a* and **60***b* and the second intermediate member **70** are configured to be pivotal in this manner, whereby the respective pressing forces of the side handle **200** and the cover **300** applied in the above-described two attachment directions can be converted into the same direction as each other with a small number of members.

(84) Further, according to the grinder **10**, the first attachment portions **29***a* and **29***b* and the first intermediate members **60***a* and **60***b* are disposed so as to be symmetric with each other with respect to the plane P**1** (refer to FIG. **11**) containing the rotational axis AX**1** of the electric motor **31**. Then, the first intermediate members **60***a* and **60***b* are configured to move pivotally in opposite directions from each other when the side handle **200** is attached. Due to this configuration, regardless of which of the first attachment portion **29***a* and **29***b* is used to attach the side handle **200** thereto, the grinder **10** allows the first intermediate member **60***a* or **60***b* corresponding to this attachment position to move in conjunction with the first interlock member **80**. Therefore, the grinder **10** allows the user to select the attachment position of the side handle **200** from the first attachment portions **29***a* and **29***b*, thereby achieving excellent convenience for the user.

(85) Further, according to the grinder **10**, the first intermediate members **60***a* and **60***b* biased by the torsion springs **64***a* and **64***b* in the opposite directions from each other, respectively, are in the non-pressing state of not pressing the first interlock member **80** (the first member **81**) at the initial positions (refer to FIG. **5**) where they are not pressed by the side handle **200**. Therefore, when the side handle **200** is attached to the first attachment portion **29***a* and the first intermediate member **60***a* moves pivotally to press the first interlock member **80** (the first member **81**), the first intermediate member **60***b* disposed on the side opposite from the first intermediate member **60***a* with respect to the plane P**1** (refer to FIG. **11**) does not press the first interlock member **80** (the first member **81**) in the direction opposite from the pressing direction of the first intermediate member **60***a* under the biasing forces of the torsion springs **64***b*. Similarly, when the side handle **200** is attached to the first attachment portion **29***b*, the pressing force in the opposite direction from the pressing force of the first intermediate member **60***b* is applied from the first intermediate member **60***a* to the first interlock member **80** (the first member **81**). Therefore, the first interlock member **80** can be smoothly displaced in the intended direction. A similar effect can also be acquired even when the first intermediate members **60***a* and **60***b* are in the state of not contacting the first interlock member **80** (the first member **81**) at the initial positions (refer to FIG. **5**).

(86) Further, according to the grinder **10**, the first interlock member **80** includes the first member **81** and the second member **82**. The first member **81** is supported pivotally on the intermediate housing **36**, and moves in conjunction with the first intermediate member **60***a* or the first intermediate member **60***b* by being pressed by the first intermediate member **60***a* or the first intermediate member **60***b* when the side handle **200** is attached. The second member **82** is engaged with the first member **81**, and moves in conjunction with the second intermediate member **70** and the first member **81**. According to this configuration, since the first member **81** is pivotally supported by the intermediate housing **36**, the first member **81** and thus the first interlock member **80** can smoothly move pivotally even when the side handle **200** is attached and the first member **81** is pressed by only one of the first intermediate member **60***a* and the first intermediate member **60***b* (i.e., pressed on only one of the right side and the left side of the first member **81**).

(87) Having described the embodiments of the present disclosure, the above-described embodiments are intended to only facilitate the understanding of the present teaching, 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 includes equivalents thereof. Further, each of the elements described in the claims and the specification can be combined in any manner 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.
(88) For example, in a case where the sensor **44** is disposed on the front side with respect to the electric motor **31**, the second interlock member **90** may be omitted. In this case, the magnet **49** may be embedded in the first interlock member **80** (the second member **82**), and the sensor **44** may directly detect the cumulative displacement of the first interlock member **80**.
(89) Further, any type of sensor that detects the cumulative displacement of the first interlock member **80** directly or indirectly (for example, via the second interlock member **90**) may be used instead of the sensor **44**. Such a sensor may be a micro switch, or may be a photoelectric sensor, an ultrasonic distance sensor, or the like.
(90) Further, the first intermediate member **60***a* or **60***b* may be indirectly pressed by the side handle **200** via another additional movable member when the side handle **200** is attached. Similarly, the second intermediate member **70** may be indirectly pressed by the cover **300** via another additional movable member when the cover **300** is attached.
(91) Further, the mechanism that transmits the displacements of the first intermediate member **60***a* or **60***b* and the second intermediate member **70** to the first interlock member **80** and the mechanism that transmits the displacement of the first interlock member **80** to the second interlock member **90** may be realized by any mechanical mechanism (for example, a link mechanism) without being limited to the above-described embodiments.
(92) Further, the number of first attachment portions for attaching the side handle **200** may be one. In this case, the number of first intermediate members is also changed to one. Further, the first interlock member **80** may have any structure capable of realizing the above-described cumulative displacement, and may be, for example, formed by one member.
(93) Further, the configuration that permits the driving of the electric motor **31** only in the state that both the side handle **200** and the cover **300** are attached and the first interlock member **80** is cumulatively displaced may be realized mechanically instead of being realized electrically by the controller **43**. For example, an operation member for switching the switch between the ON state and the OFF state (for example, a slide switch) may be disposed on the upper surface of the intermediate housing **36**. In this case, a displacement of the operation member from the OFF position to the ON position may be restricted by abutment of the operation member or an additional interlock member that moves in conjunction with the operation member against the first interlock member **80** or an additional interlock member that moves in conjunction with the first interlock member **80** in the state that the first interlock member **80** is not cumulatively displaced. Further, the driving of the electric motor **31** may be permitted according to retraction of the first interlock member **80** or the additional interlock member that moves in conjunction with the first interlock member **80** to a position at which it does not impede the displacement of the operation member from the OFF position to the ON position in the state that the first interlock member **80** is cumulatively displaced. The sensor **44** can be omitted in such an alternative embodiment.
(94) Further, the above-described embodiments can be applied to not only the grinder **10** but also any electric tool configured to allow two types of accessories to be attached thereto.
(95) The corresponding relationship between each component in the above-described embodiments and each component in the claims will b e described below. However, each component in the embodiments is merely one example and shall not limit each component in the claims. The grinder **10** is one example of an “electric tool.” The electric motor **31** is one example of a “motor.” The side handle **200** is one example of a “first accessory.” The cover **300** is one example of a “second accessory.” The first attachment portions **29***a* and **29***b* are one example of a “first attachment portion” and are examples of a “third-side attachment portion” and a “fourth-side attachment portion,” respectively. The second attachment portion **22** is one example of a “second attachment portion.” The first intermediate members **60***a* and **60***b* are one example of a “first intermediate member” and are examples of a “third-side intermediate member” and a “fourth-side intermediate member,” respectively. The second intermediate member **70** is one example of a “second

intermediate member." The first interlock member **80** is one example of a "first interlock member." The sensor **44** is one example of a "sensor." The controller **43** is one example of a "controller." The second interlock member **90** is one example of a "second interlock member." The plane P**1** is one example of a "plane." The first pivotal axis AX**3** is one example of a "first pivotal axis." The second pivotal axis AX**4** is one example of a "second pivotal axis." The torsion springs **64***a* and **64***b* are examples of a "first biasing member" and a "second biasing member," respectively. The intermediate housing **36** is one example of a "housing." The first member **81** and the second member **82** are examples of "a first member" and a "second member," respectively. The tool accessory **28** is one example of a "tool accessory."

DESCRIPTION OF THE REFERENCE NUMERALS

(96) **10**: grinder, **20**: gear housing, **22**: second attachment portion, **23**: small bevel gear, **24**: large bevel gear, **25**: spindle, **26**: inner flange, **27**: lock nut, **28**: tool accessory, **29***a*, **29***b*: first attachment portion, **30**: motor housing, **31**: electric motor, **32**: motor shaft, **33**: abutment portion, **34**: front-side bearing, **35**: rear-side bearing, **36**: intermediate housing, **36***a*, **36***b*: boss, **40**: handle housing, **41**: switch, **42**: input member, **43**: controller, **44**: sensor, **45**: link member, **46**, **47**: arm, **48**: pin, **49**: magnet, **50**: operation member, **51**: front end portion, **53**: protrusion, **54**: lock-off member, **55**: abutment edge portion, **56**: operation edge portion, **57**: pin, **60***a*, **60***b*: first intermediate member, **61***a*, **61***b*: protrusion portion, **62***a*, **62***b*: shaft portion, **63***a*, **63***b*: pressing portion, **64***a*, **64***b*: torsion spring, **70**: second intermediate member, **71**: pressed portion, **72**: shaft portion, **73**: arched portion, **74**: engagement portion, **75**: torsion spring, **80**: first interlock member, **81**: first member, **82**: second member, **83**: lower end portion, **84**: pressed portion, **85**: shaft portion, **86**, **87**: engagement portion, **88**: engagement hole, **89**: protrusion upper end portion, **90**: second interlock member, **91**: engagement portion, **92**, **93**: protrusion portion, **94**, **95**: positioning protrusion portion, **96**: coil spring, **97**: recessed portion, **200**: side handle, **210**: grip portion, **220**: attachment portion, **300**: cover, **310**: cover main body, **320**: attachment portion, **441**: board, **891**: beam portion, **892**: through-hole, P**1**: plane, AX**1**, AX**2**: rotational axis, AX**3**: first pivotal axis, AX**4**: second pivotal axis, AX**5**: third pivotal axis, AX**6**: fourth pivotal axis, AX**7**: fifth pivotal axis

Claims

1. An electric tool comprising: a motor; a first attachment portion for detachably attaching a first accessory; a second attachment portion for detachably attaching a second accessory that is a different type of accessory from the first accessory; a first intermediate member configured to be displaced by being directly or indirectly pressed by the first accessory when the first accessory is attached to the first attachment portion; a second intermediate member configured to be displaced by being directly or indirectly pressed by the second accessory when the second accessory is attached to the second attachment portion; and a first interlock member configured to mechanically move in conjunction with the respective displacements of the first intermediate member and the second intermediate member, and configured to be displaced in the same direction between when the first accessory is attached to the first attachment portion and when the second accessory is attached to the second attachment portion, and be cumulatively displaced when the first accessory and the second accessory are attached to the first attachment portion and the second attachment portion, respectively, wherein the electric tool is configured in such a manner that power supply to the motor is permitted only in a state that the first interlock member is cumulatively displaced.

2. The electric tool according to claim 1, further comprising: a sensor configured to directly or indirectly detect the cumulative displacement of the first interlock member; and a controller configured to control the power supply to the motor and configured to permit the power supply to the motor only in a state that the cumulative displacement of the first interlock member is detected by the sensor.

3. The electric tool according to claim 2, further comprising a second interlock member configured

to mechanically move in conjunction with the cumulative displacement of the first interlock member, wherein the first intermediate member, the second intermediate member, and the first interlock member are disposed on a first side with respect to the motor in an axial direction that is a direction in which a rotational axis of the motor extends, the sensor and the controller are disposed on a second side opposite from the first side with respect to the motor in the axial direction, the second interlock member extends from the first side to the second side, and the sensor is configured to detect the cumulative displacement of the first interlock member based on the displacement of the second interlock member.

4. The electric tool according to claim 1, wherein a first attachment direction for attaching the first accessory to the first attachment portion and a second attachment direction for attaching the second accessory to the second attachment portion are different from each other, and the first intermediate member and the second intermediate member are configured to transmit a pressing force of the first accessory in the first attachment direction and a pressing force of the second accessory in the second attachment direction to the first interlock member while converting the pressing force of the first accessory and the pressing force of the second accessory into the same direction as each other.

5. The electric tool according to claim 4, wherein the first intermediate member is configured to move in conjunction with the first interlock member by moving pivotally and pressing the first interlock member when being directly or indirectly pressed by the first accessory, and the second intermediate member is configured to move in conjunction with the first interlock member by moving pivotally and pressing the first interlock member when being directly or indirectly pressed by the second accessory.

6. The electric tool according to claim 5, wherein the first attachment portion includes a third-side attachment portion disposed on a third side with respect to a plane containing a rotational axis of the motor and a fourth-side attachment portion disposed on a fourth side opposite from the third side with respect to the plane to allow the first accessory to be selectively attached, the third-side attachment portion and the fourth-side attachment portion are disposed so as to be symmetric with each other with respect to the plane, the first intermediate member includes a third-side intermediate member disposed adjacent to the third-side attachment portion and a fourth-side intermediate member disposed adjacent to the fourth-side attachment portion, the third-side intermediate member and the fourth-side intermediate member are disposed so as to be symmetric with each other with respect to the plane, the third-side intermediate member is configured to be pivotal about a first pivotal axis, the fourth-side intermediate member is configured to be pivotal about a second pivotal axis extending in the same direction as the first pivotal axis, and a first pivotal direction is opposite from a second pivotal direction, the first pivotal direction being a direction in which the third-side intermediate member moves pivotally when being directly or indirectly pressed by the first accessory, the second pivotal direction being a direction in which the fourth-side intermediate member moves pivotally when being directly or indirectly pressed by the first accessory.

7. The electric tool according to claim 6, further comprising: a first biasing member configured to bias the third-side intermediate member in a direction opposite from the first pivotal direction; and a second biasing member configured to bias the fourth-side intermediate member in a direction opposite from the second pivotal direction, wherein each of the third-side intermediate member and the fourth-side intermediate member is in a non-contact state of not contacting the first interlock member or a non-pressing state of not pressing the first interlock member when being not directly or indirectly pressed by the first accessory.

8. The electric tool according to claim 6, further comprising a housing, wherein the first interlock member includes: a first member pivotally supported by the housing, and configured to move in conjunction with the first intermediate member by being pressed by the third-side intermediate member or the fourth-side intermediate member when the first accessory is attached to any of the third-side attachment portion and the fourth-side attachment portion; and a second member

configured to be engaged with the first member and the second intermediate member and move in conjunction with the first member and the second intermediate member.

9. The electric tool according to claim 1, wherein the electric tool is a grinder configured to rotate a tool accessory using a driving force of the motor, wherein the first accessory is a side handle, and the second accessory is a cover that partially covers the tool accessory.

10. The electric tool according to claim 1, further comprising: a sensor configured to directly or indirectly detect the cumulative displacement of the first interlock member; and a controller configured to control the power supply to the motor and configured to permit the power supply to the motor only in a state that the cumulative displacement of the first interlock member is detected by the sensor, wherein a first attachment direction for attaching the first accessory to the first attachment portion and a second attachment direction for attaching the second accessory to the second attachment portion are different from each other, and the first intermediate member and the second intermediate member are configured to transmit a pressing force of the first accessory in the first attachment direction and a pressing force of the second accessory in the second attachment direction to the first interlock member while converting the pressing force of the first accessory and the pressing force of the second accessory into the same direction as each other.

11. The electric tool according to claim 1, further comprising: a sensor configured to directly or indirectly detect the cumulative displacement of the first interlock member; a controller configured to control the power supply to the motor and configured to permit the power supply to the motor only in a state that the cumulative displacement of the first interlock member is detected by the sensor; and a second interlock member configured to mechanically move in conjunction with the cumulative displacement of the first interlock member, wherein the first intermediate member, the second intermediate member, and the first interlock member are disposed on a first side with respect to the motor in an axial direction that is a direction in which a rotational axis of the motor extends, the sensor and the controller are disposed on a second side opposite from the first side with respect to the motor in the axial direction, the second interlock member extends from the first side to the second side, the sensor is configured to detect the cumulative displacement of the first interlock member based on the displacement of the second interlock member, a first attachment direction for attaching the first accessory to the first attachment portion and a second attachment direction for attaching the second accessory to the second attachment portion are different from each other, and the first intermediate member and the second intermediate member are configured to transmit a pressing force of the first accessory in the first attachment direction and a pressing force of the second accessory in the second attachment direction to the first interlock member while converting the pressing force of the first accessory and the pressing force of the second accessory into the same direction as each other.

12. The electric tool according to claim 1, further comprising: a sensor configured to directly or indirectly detect the cumulative displacement of the first interlock member; a controller configured to control the power supply to the motor and configured to permit the power supply to the motor only in a state that the cumulative displacement of the first interlock member is detected by the sensor; and a second interlock member configured to mechanically move in conjunction with the cumulative displacement of the first interlock member, wherein the first intermediate member, the second intermediate member, and the first interlock member are disposed on a first side with respect to the motor in an axial direction that is a direction in which a rotational axis of the motor extends, the sensor and the controller are disposed on a second side opposite from the first side with respect to the motor in the axial direction, the second interlock member extends from the first side to the second side, the sensor is configured to detect the cumulative displacement of the first interlock member based on the displacement of the second interlock member, a first attachment direction for attaching the first accessory to the first attachment portion and a second attachment direction for attaching the second accessory to the second attachment portion are different from each other, the first intermediate member and the second intermediate member are configured to

transmit a pressing force of the first accessory in the first attachment direction and a pressing force of the second accessory in the second attachment direction to the first interlock member while converting the pressing force of the first accessory and the pressing force of the second accessory into the same direction as each other, the first intermediate member is configured to move in conjunction with the first interlock member by moving pivotally and pressing the first interlock member when being directly or indirectly pressed by the first accessory, and the second intermediate member is configured to move in conjunction with the first interlock member by moving pivotally and pressing the first interlock member when being directly or indirectly pressed by the second accessory.

13. The electric tool according to claim 1, further comprising: a sensor configured to directly or indirectly detect the cumulative displacement of the first interlock member; a controller configured to control the power supply to the motor and configured to permit the power supply to the motor only in a state that the cumulative displacement of the first interlock member is detected by the sensor; and a second interlock member configured to mechanically move in conjunction with the cumulative displacement of the first interlock member, wherein the first intermediate member, the second intermediate member, and the first interlock member are disposed on a first side with respect to the motor in an axial direction that is a direction in which a rotational axis of the motor extends, the sensor and the controller are disposed on a second side opposite from the first side with respect to the motor in the axial direction, the second interlock member extends from the first side to the second side, the sensor is configured to detect the cumulative displacement of the first interlock member based on the displacement of the second interlock member, a first attachment direction for attaching the first accessory to the first attachment portion and a second attachment direction for attaching the second accessory to the second attachment portion are different from each other, the first intermediate member and the second intermediate member are configured to transmit a pressing force of the first accessory in the first attachment direction and a pressing force of the second accessory in the second attachment direction to the first interlock member while converting the pressing force of the first accessory and the pressing force of the second accessory into the same direction as each other, the first intermediate member is configured to move in conjunction with the first interlock member by moving pivotally and pressing the first interlock member when being directly or indirectly pressed by the first accessory, the second intermediate member is configured to move in conjunction with the first interlock member by moving pivotally and pressing the first interlock member when being directly or indirectly pressed by the second accessory, the first attachment portion includes a third-side attachment portion disposed on a third side with respect to a plane containing the rotational axis of the motor and a fourth-side attachment portion disposed on a fourth side opposite from the third side with respect to the plane to allow the first accessory to be selectively attached, the third-side attachment portion and the fourth-side attachment portion are disposed so as to be symmetric with each other with respect to the plane, the first intermediate member includes a third-side intermediate member disposed adjacent to the third-side attachment portion and a fourth-side intermediate member disposed adjacent to the fourth-side attachment portion, the third-side intermediate member and the fourth-side intermediate member are disposed so as to be symmetric with each other with respect to the plane, the third-side intermediate member is configured to be pivotal about a first pivotal axis, the fourth-side intermediate member is configured to be pivotal about a second pivotal axis extending in the same direction as the first pivotal axis, and a first pivotal direction is opposite from a second pivotal direction, the first pivotal direction being a direction in which the third-side intermediate member moves pivotally when being directly or indirectly pressed by the first accessory, the second pivotal direction being a direction in which the fourth-side intermediate member moves pivotally when being directly or indirectly pressed by the first accessory.

14. The electric tool according to claim 7, further comprising a housing, wherein the first interlock member includes: a first member pivotally supported by the housing, and configured to move in

conjunction with the first intermediate member by being pressed by the third-side intermediate member or the fourth-side intermediate member when the first accessory is attached to any of the third-side attachment portion and the fourth-side attachment portion; and a second member configured to be engaged with the first member and the second intermediate member and move in conjunction with the first member and the second intermediate member.