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(72) Inventor(s):
Kiyoshi Idota

(73) Proprietor(s):
Nitto Kohki Co., Ltd.
(Incorporated in Japan)
9-4 Nakaikegami 2-Chome, Ohta-ku, Tokyo 146-8555, Japan

(74) Agent and/or Address for Service:
Stevens Hewlett & Perkins
1 St Augustine's Place, BRISTOL, BS1 4UD,
United Kingdom

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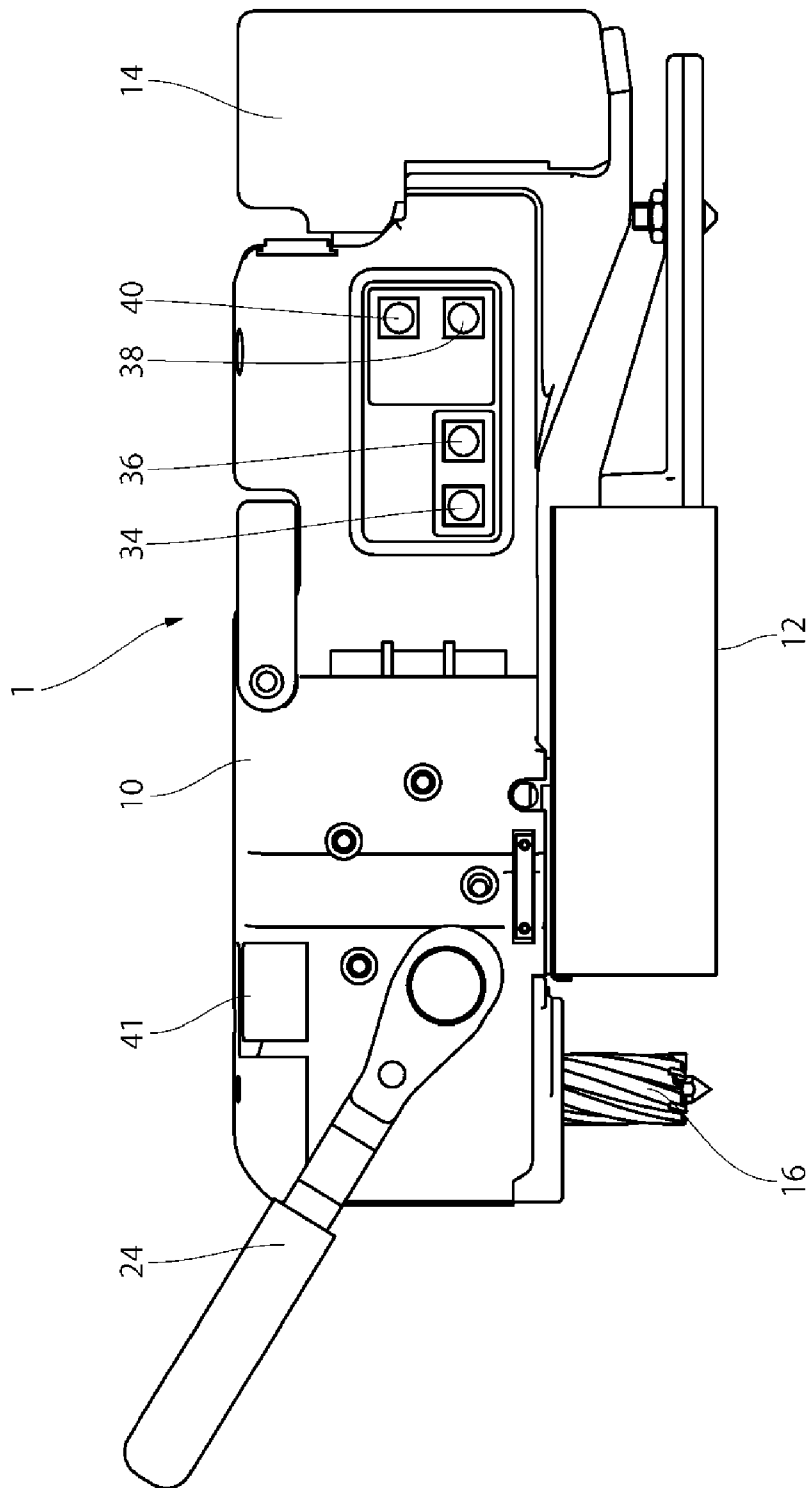


Fig. 1

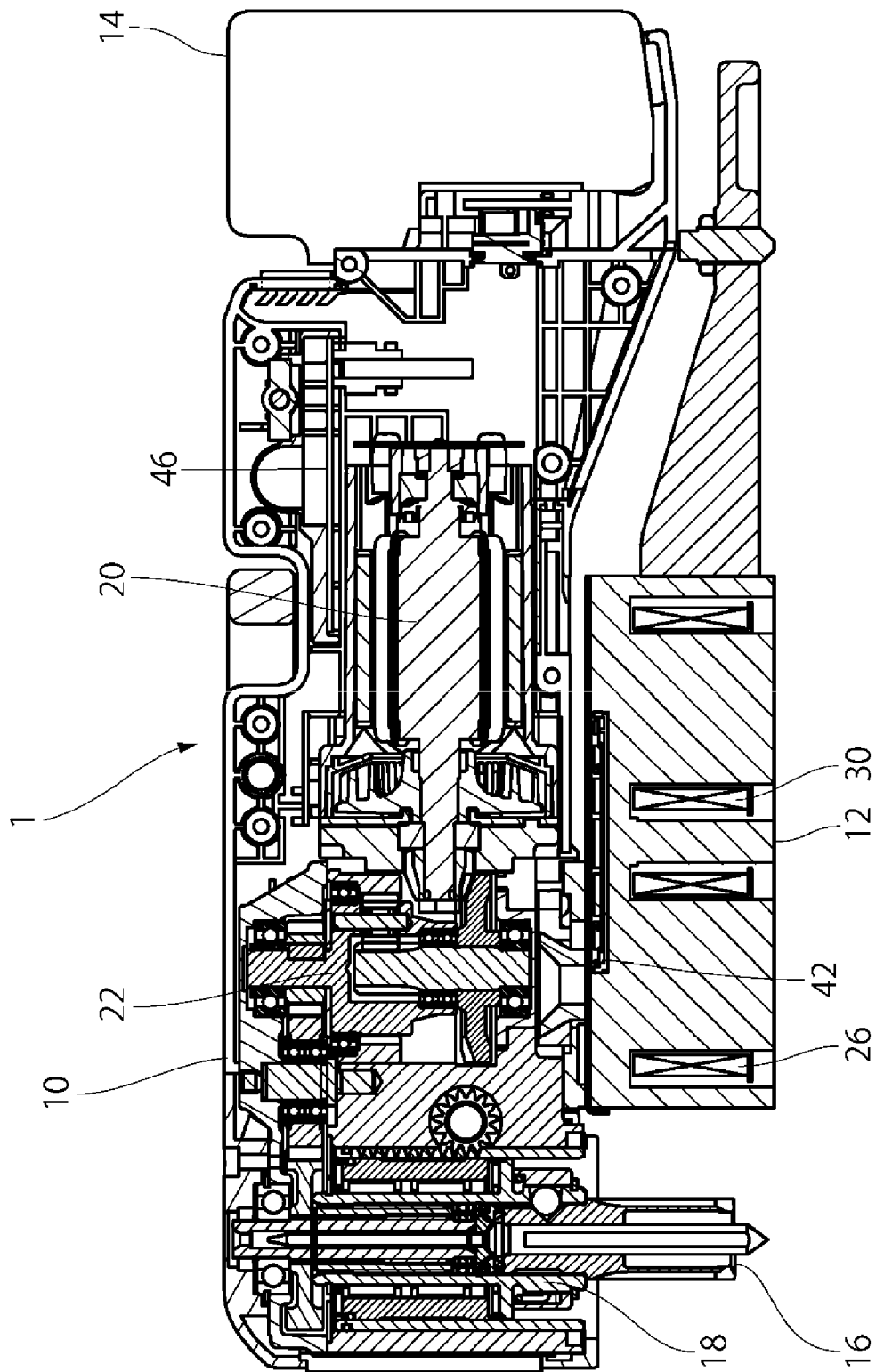


Fig. 2

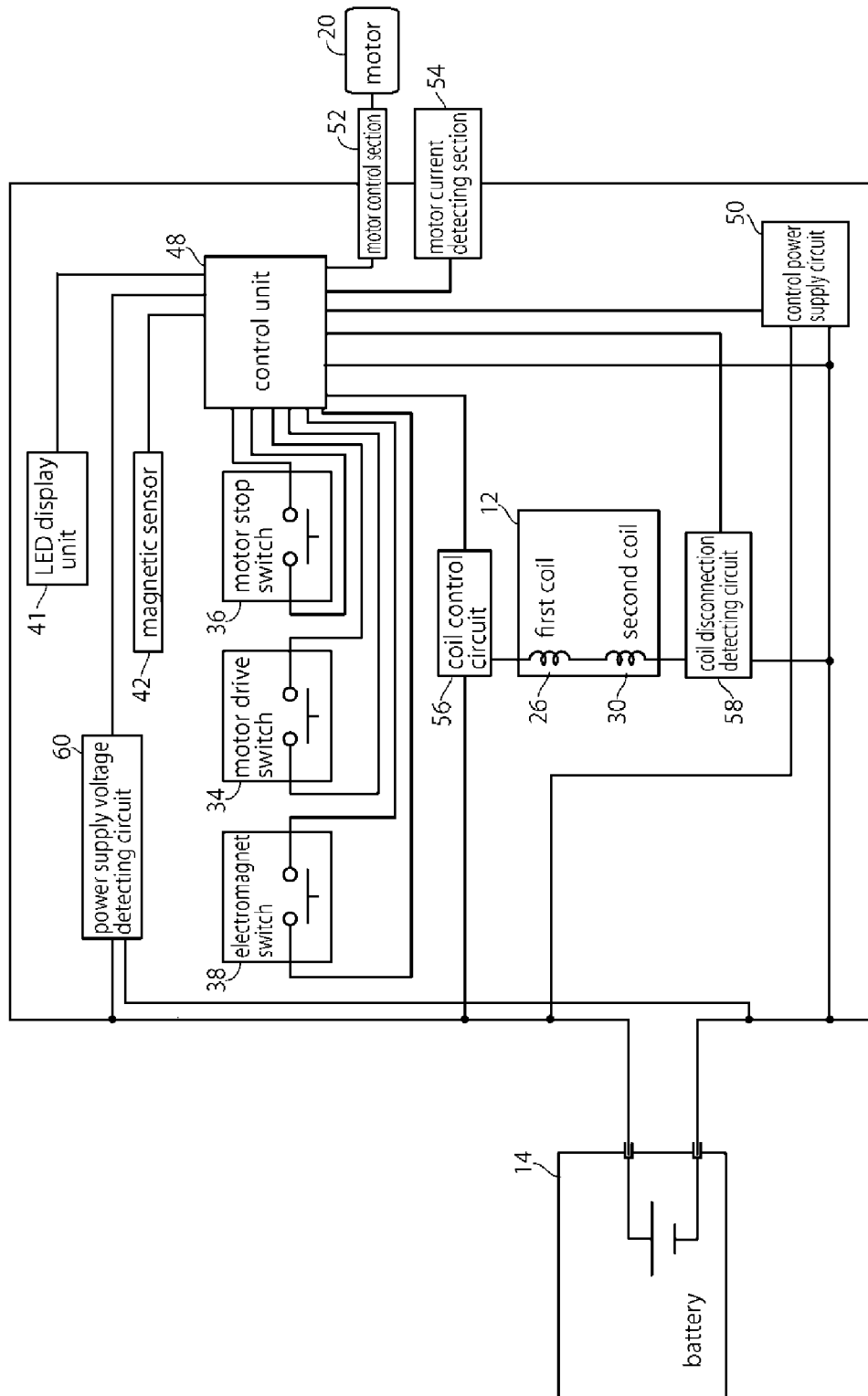


Fig. 3

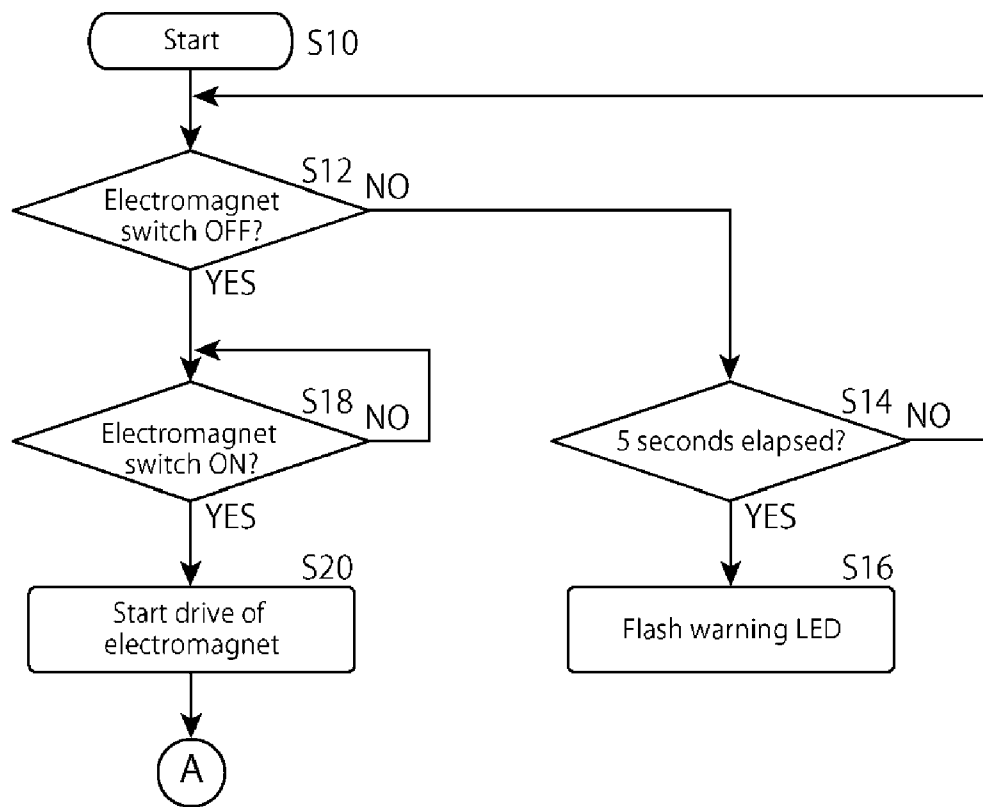


Fig. 4

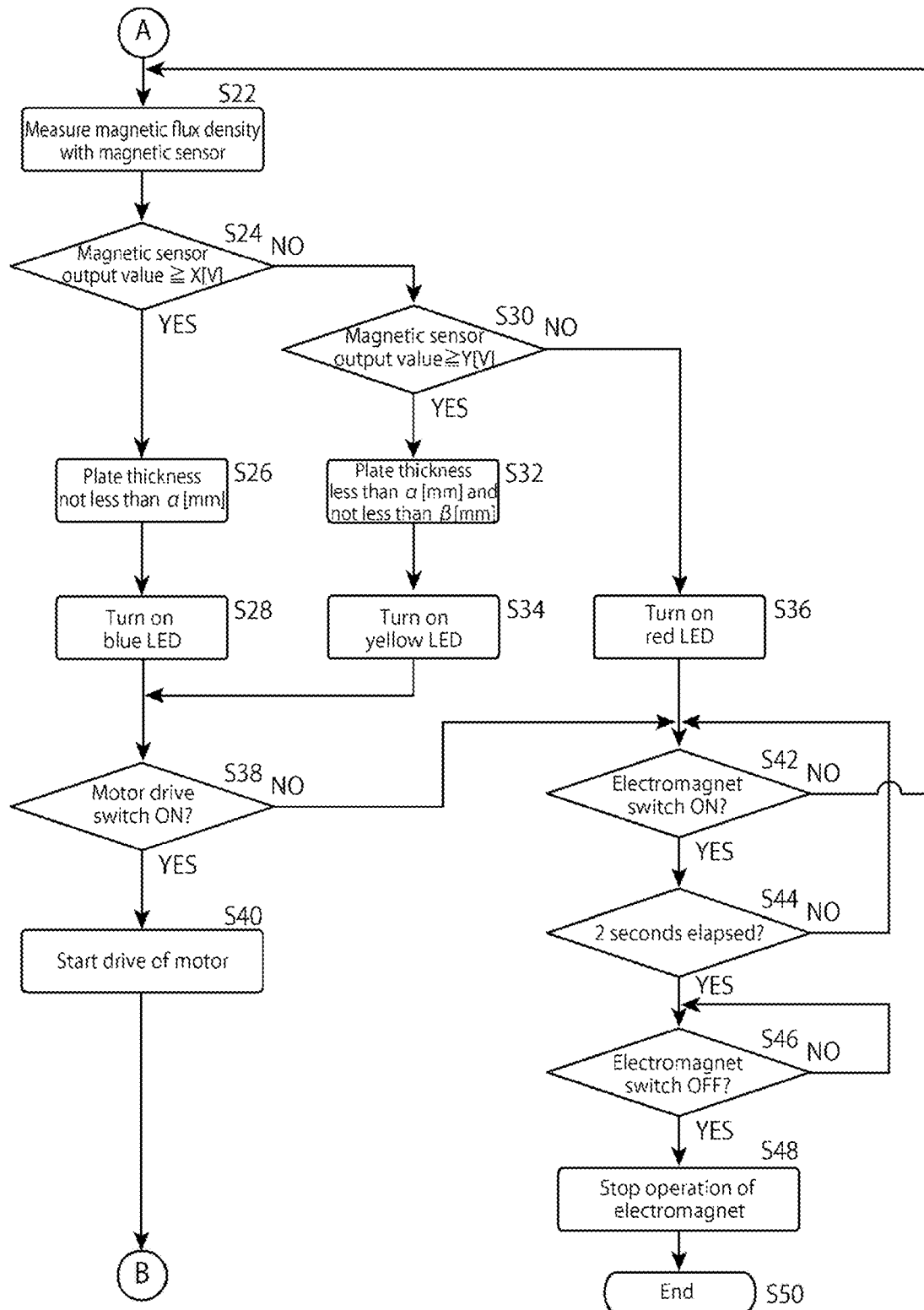


Fig. 5

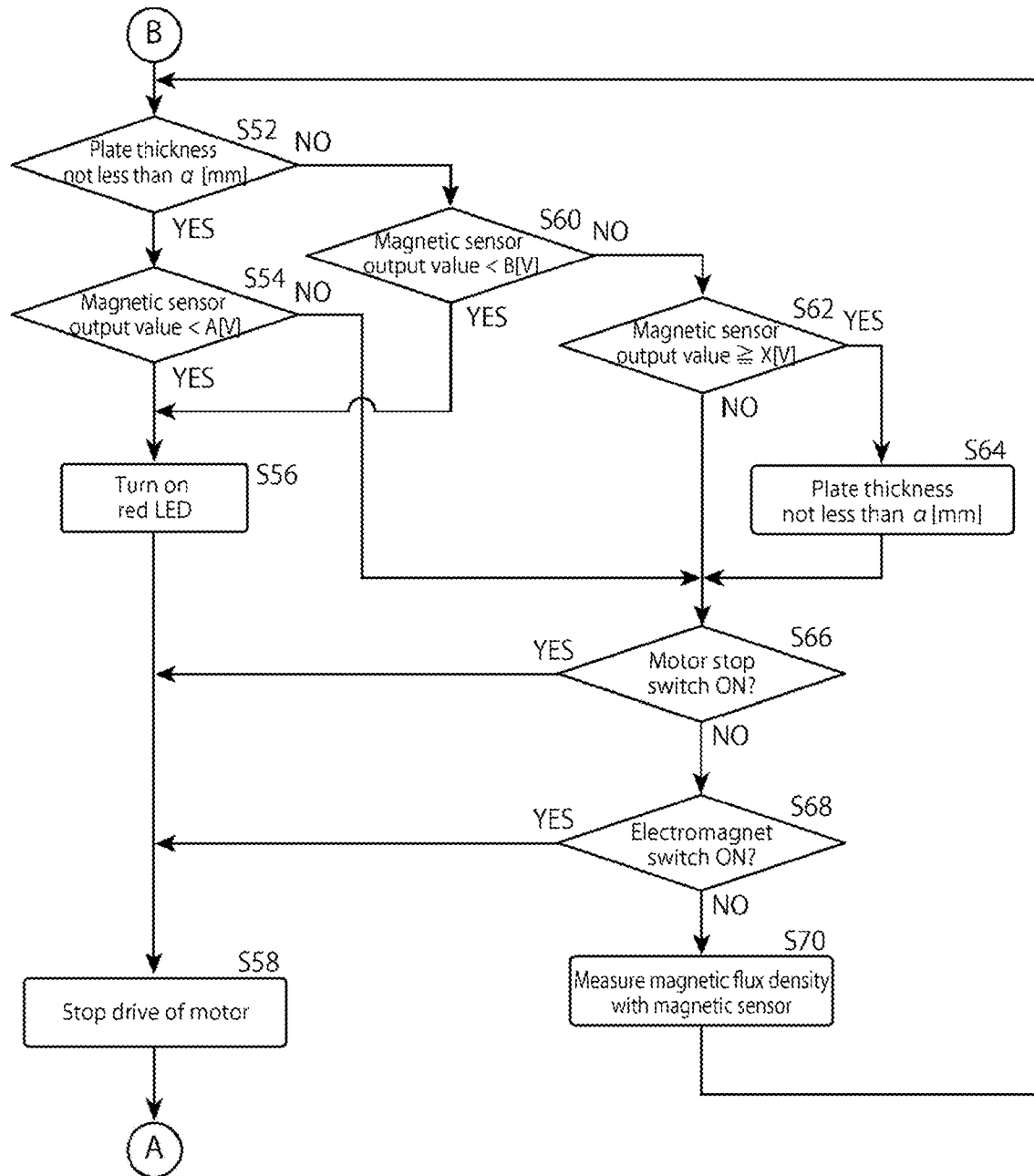


Fig. 6

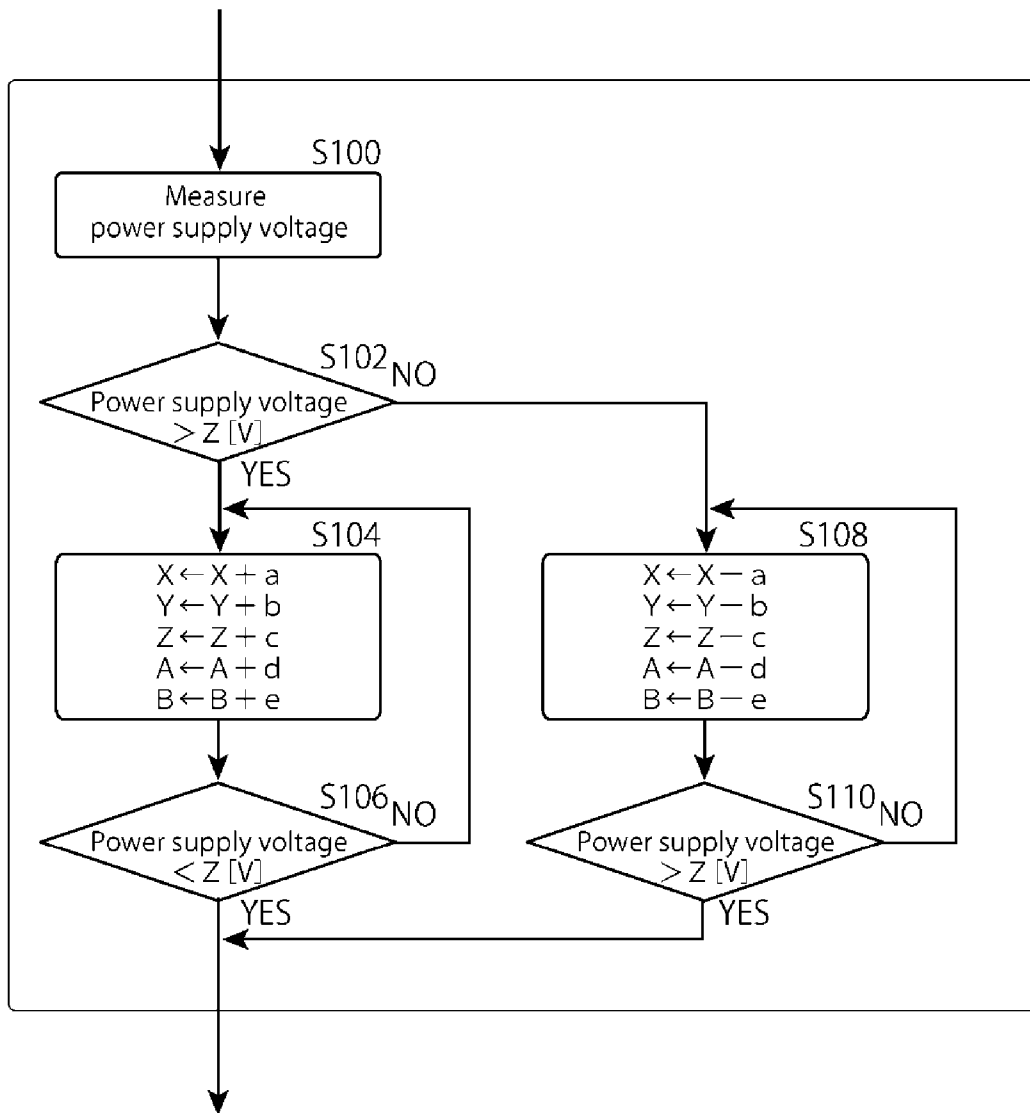


Fig. 7

Description

Title of Invention:

Portable Machine Tool

Technical Field:

[0001] The present invention relates to portable machine tools and, more particularly, to a portable machine tool configured to perform machining operation with a machine tool body secured to a workpiece by an electromagnet.

Background Art:

[0002] Among machine tools such as drilling machines, there is a portable machine tool configured to be carried by a worker to a worksite to perform machining operation on a workpiece. Such a portable machine tool may be secured to a workpiece by various methods. One type of portable machine tool uses magnetic adhesion by an electromagnet to secure itself to a workpiece in view of ease of handling and convenience (Patent Literatures 1 and 2).

[0003] Magnetic adhesion by an electromagnet is usually designed so as to provide a sufficiently large force. However, there are cases where the machine tool body is undesirably lifted from the workpiece by reaction force that the machine tool receives from the workpiece during machining operation or by other external force applied to the machine tool body. If such occurs, a gap is produced between the electromagnet and the workpiece, resulting in a sudden reduction in magnetic holding force by the electromagnet. Consequently, it may become impossible to secure the portable machine tool to the workpiece, and there is a danger that the portable machine tool may fall or drop. It is particularly dangerous if the portable machine tool falls while a machining tool such as a drill or an annular cutter is being rotationally driven. For this reason, a drill device disclosed in Patent Literature 2 is provided with a Hall element for measuring a magnetic flux generated from an electromagnet, and if the output voltage V of the Hall element exceeds a predetermined threshold value V_a , it is determined that lifting has occurred, and the rotation of a drill motor or a feed motor is stopped.

Citation List:

Patent Literature:

[0004] Patent Literature 1: Japanese Patent Application Publication No. 2014-231129

Patent Literature 2: Japanese Utility Model Registration Application
Publication No. H 03-126512

Summary of Invention:

Technical Problem:

[0005] However, the magnitude of magnetic flux density around the electromagnet when the electromagnet is magnetically attached to the workpiece varies with the thickness and constituent material of the workpiece. Therefore, if the predetermined threshold value is set to a relatively high value based on a workpiece which is relatively thick or which comprises a material having a relatively strong magnetic property, it may be impossible to properly detect lifting when the electromagnet is magnetically attached to a workpiece which is relatively thin or has a relatively weak magnetic property. Conversely, if the predetermined threshold value is set to a relatively low value based on a workpiece which is relatively thin or which comprises a material having a relatively weak magnetic property, it may be impossible to properly detect lifting when the electromagnet is magnetically attached to a workpiece which is relatively thick or has a relatively strong magnetic property.

[0006] Accordingly, an object of the present invention is to provide a portable machine tool capable of properly detecting lifting of the electromagnet irrespective of variation in the plate thickness or constituent material of a workpiece to which the electromagnet is magnetically attached.

Solution to Problem:

[0007] That is, the present invention provides a portable machine tool including the following: a machine tool body; an electromagnet mounted to the machine tool body to secure the machine tool body to a workpiece; a magnetic sensor disposed around the electromagnet; a control unit configured to control operation of the electromagnet; and

a drive unit for driving a machining tool mounted to the machine tool body to perform machining operation on the workpiece. The control unit is configured to set a normal operating range based on an output value of the magnetic sensor when the electromagnet is in operation and before the machining operation by the drive unit is started, and to determine that the electromagnet has been lifted from the workpiece if the output value of the magnetic sensor after the machining operation has been started deviates from the normal operating range.

[0008] In the portable machine tool of the present invention, a normal operating range is set based on an output value of the magnetic sensor measured when the electromagnet is in operation and before the machining operation by driving an electric motor is started. It is therefore possible to set a normal operating range appropriate for the plate thickness and constituent material of a workpiece to which the electromagnet is magnetically attached. Consequently, lifting of the electromagnet can be properly determined and detected irrespective of variation in the plate thickness and constituent material of the workpiece.

[0009] Specifically, the magnetic sensor may be configured to detect a magnetic flux density in a magnetic circuit of the electromagnet formed through the workpiece, and the output value may be a value representing the magnitude of the magnetic flux density.

[0010] Further, the arrangement may be as follows. The normal operating range is a range having a lower limit defined by a lifting determination reference value determined based on the magnitude of the output value. The control unit is configured to determine that the electromagnet has been lifted from the workpiece if the output value of the magnetic sensor after the machining operation has been started becomes less than the lifting determination reference value.

[0011] Further, the arrangement may be as follows. The control unit is configured to detect a supply voltage supplied to the electromagnet. The control unit is configured to set the normal operating range on the basis of the supply voltage and an output value

of the magnetic sensor when the electromagnet is in operation and before machining operation by the drive unit is started.

[0012] In the above-described case, the control unit may be configured to reset the normal operating range on the basis of the magnitude of the supply voltage if the supply voltage changes during the machining operation.

[0013] With the above-described arrangement, it is possible to minimize the effect of change in magnetic flux density due to the change in supply voltage and hence possible to detect lifting of the electromagnet even more stably.

[0014] Further, the arrangement may be as follows. The control unit sets the normal operating range to a range having a lower limit defined by a predetermined first lifting determination reference value if the output value of the magnetic sensor when the electromagnet is in operation and before the machining operation by the drive unit is started is not less than a predetermined first threshold value. The control unit sets the normal operating range to a range having a lower limit defined by a predetermined second lifting determination reference value that is smaller than the first lifting determination reference value if the output value is less than the first threshold value and not less than a predetermined second threshold value that is smaller than the first threshold value.

[0015] In the above-described case, the arrangement may be such that the drive unit is disabled from being started to be driven if the output value of the magnetic sensor when the electromagnet is in operation and before the machining operation by the drive unit is started is less than the second threshold value.

[0016] Further, the arrangement may be as follows. The portable machine tool further includes a display unit configured to display a status of the portable machine tool. The display unit is configured to give different indications on the following conditions, respectively: the output value of the magnetic sensor when the electromagnet is in operation and before the machining operation by the drive unit is started is not less than the first threshold value; less than the first threshold value and

not less than the second threshold value; and less than the second threshold value.

[0017] Embodiments of a portable machine tool according to the present invention will be explained below on the basis of the accompanying drawings.

Brief Description of Drawings:

[0018] Fig. 1 is a side view of a portable machine tool according to an embodiment of the present invention.

Fig. 2 is a sectional view of the portable machine tool shown in Fig. 1.

Fig. 3 is a functional block diagram of the portable machine tool shown in Fig. 1.

Fig. 4 is a first flowchart showing an operation of the portable machine tool according to the embodiment of the present invention.

Fig. 5 is a second flowchart showing an operation of the portable machine tool according to the embodiment of the present invention.

Fig. 6 is a third flowchart showing an operation of the portable machine tool according to the embodiment of the present invention.

Fig. 7 is a flowchart showing an operation relating to the resetting of threshold values among operations of a portable machine tool according to another embodiment of the present invention.

Description of Embodiments:

[0019] A portable machine tool 1 according to an embodiment of the present invention includes, as shown in Fig. 1, a machine tool body 10 and an electromagnet 12 attached to the lower side of the machine tool body 10. A battery 14 is removably attached to the rear side of the machine tool body 10 to serve as a main power supply of the portable machine tool 1. As shown in Fig. 2, the machine tool body 10 includes a machining tool mounting unit 18 configured to be removably equipped with an annular cutter 16 (machining tool) and is provided therein with an electric motor 20 (drive unit) for rotationally driving the machining tool mounting unit 18. The machining tool mounting unit 18 and the electric motor 20 are drivably connected to each other through

a gear mechanism 22 comprising a plurality of gears. As shown in Fig. 1, the machine tool body 10 has a lever 24 attached thereto to move up and down the machining tool mounting unit 18, together with the annular cutter 16, by pivoting the lever 24. As shown in Fig. 2, the electromagnet 12 has a ring-shaped first coil 26 and a similar ring-shaped second coil 30. When the first coil 26 and the second coil 30 are supplied with electric power from the battery 14 in a state where the portable machine tool 1 is placed on a magnetic material, the machine tool body 10 is secured to a workpiece, i.e., the magnetic material, by magnetic holding force generated by the electromagnet 12. The portable machine tool 1 is a drilling machine configured to perform machining operation on the workpiece by pressing the annular cutter 16, which is being rotationally driven by the electric motor 20, against the workpiece in a state where the machine tool body 10 is secured to the workpiece by the electromagnet 12.

[0020] As shown in Fig. 1, the machine tool body 10 has the following switches arranged on a side thereof: a motor drive switch 34 for starting the drive of the electric motor 20; a motor stop switch 36 for stopping the drive of the electric motor 20; and an electromagnet switch 38 for starting and stopping the operation of the electromagnet 12. The machine tool body 10 further has an illumination switch 40 on the side thereof. The illumination switch 40 is used to turn on and off an illuminating device (not shown) disposed on the lower side of a forward portion of the machine tool body 10. These switches 34, 36, 38 and 40 are all momentary switches, which maintain an ON state only as long as a user is pressing the same and which return to an OFF state when released from the user's hand. The machine tool body 10 is further provided with an LED display unit 41 for showing the worker the status of the portable machine tool 1.

[0021] As shown in Fig. 2, the electromagnet 12 has a magnetic sensor 42 attached thereto. The magnetic sensor 42 is configured to measure the magnitude of magnetic flux density in a magnetic circuit of the electromagnet 12 formed around the electromagnet 12 through the workpiece.

[0022] The portable machine tool 1 has a control circuit board 46 in the machine tool

body 10, and the control circuit board 46 is provided with a control unit 48 (Fig. 3) for controlling the electric motor 20, the electromagnet 12, and so forth. When the battery 14 is loaded to the machine tool body 10, electric power is supplied from the battery 14 to the control unit 48 through a control power supply circuit 50, and thus the control unit 48 is activated. The control unit 48 controls the drive of the electric motor 20 and the operation of the electromagnet 12 according to the actuation state of the motor drive switch 34, the motor stop switch 36, and the electromagnet switch 38 and also according to the operating state of the portable machine tool 1 at the time. When driving the electric motor 20, the control unit 48 transmits a control signal to a motor control section 52 to control the rotational speed of the electric motor 20. At this time, the control unit 48 detects the amount of electric current flowing through the electric motor 20 with a motor current detecting section 54, thereby monitoring the load condition of the electric motor 20. When operating the electromagnet 12, the control unit 48 controls electric power to be supplied to the first coil 26 and the second coil 30 through a coil control circuit 56. The first coil 26 and the second coil 30 are connected in series; therefore, electric power supplied to the first coil 26 and that supplied to the second coil 30 are normally the same as each other. A coil disconnection detecting circuit 58 is configured to detect disconnection of the first coil 26 and the second coil 30 by detecting the electric current flowing through the first coil 26 and the second coil 30. When disconnection of the first coil 26 or the second coil 30 is detected, the control unit 48 stops the control and turns on the LED display unit 41 to notify the user of the disconnection of the coil 26 or 30. The control unit 48 also stores in memory the fact of disconnection of the coil 26 or 30 and notifies the user of the disconnection of the coil 26 or 30 by turning on the LED display unit 41 when the battery 14 is connected again, after being temporarily disconnected, to resume control by the control unit 48.

[0023] The control circuit board 46 is further provided with a power supply voltage detecting circuit 60 for detecting the voltage (power supply voltage) of the battery 14

connected to the machine tool body 10.

[0024] The operation of the portable machine tool 1 is explained below based on the flowcharts of Figs. 4 to 6. As shown in Fig. 4, when the battery 14 is loaded to the machine tool body 10 and then electric power is supplied to the control unit 48 from the battery 14 loaded to the machine tool body 10, control by the control unit 48 is started (S10). First, the control unit 48 determines whether or not the electromagnet switch 38 is in OFF position, i.e., not pressed (S12). If the electromagnet switch 38 is in OFF position, the control unit 48 awaits and when the electromagnet switch 38 is pressed to move from OFF position to ON position (S18), the control unit 48 starts operation of the electromagnet 12 (S20). When the electromagnet 12 is activated, the portable machine tool 1 is secured to a workpiece by magnetic holding force of the electromagnet 12.

[0025] When the control is started (S12), if the electromagnet switch 38 is not in OFF position, that is, the electromagnet switch 38 is in ON position as a result of being pressed, the control unit 48 does not start operation of the electromagnet 12, and if this state continues for 5 seconds (S14), the control unit 48 flashes the LED display unit 41 to give a warning indication (S16). This prevents the electromagnet 12 from starting to operate at the same time as the control is started when the battery 14 is loaded in a state where the worker is mistakenly pressing the electromagnet switch 38, which would otherwise cause magnetic adhesion to occur unexpectedly. If the worker releases his or her hand from the electromagnet switch 38, thereby allowing the electromagnet switch 38 to move to OFF position, the warning indication on the LED display unit 41 is canceled, and the control proceeds to step S18. It should be noted that the control unit 48 will not start driving the electric motor 20 even if the motor drive switch 34 is turned ON before the operation of the electromagnet 12 is started.

[0026] When the electromagnet 12 is activated, as shown in Fig. 5, the control unit 48 measures the magnetic flux density around the electromagnet 12 with the magnetic sensor 42 (S22). If the output value of the magnetic sensor 42, which represents the

magnitude of the measured magnetic flux density, is not less than a predetermined first threshold value X [V] (S24), the control unit 48 determines that the plate thickness of the member to which the electromagnet 12 is magnetically attached is not less than α [mm] (S26), and turns on a blue LED of the LED display unit 41 (S28) to show the worker that the plate thickness is sufficiently large and that the magnitude of magnetic holding force of the electromagnet 12 is sufficiently large. If the output value of the magnetic sensor 42 is less than X [V] (S24) and not less than a predetermined second threshold value Y [V] that is smaller than X (S30), the control unit 48 determines that the plate thickness is less than α [mm] and not less than β [mm] (S32), and turns on a yellow LED of the LED display unit 41 (S34) to show the worker that the operating conditions are within a safe operating range but the plate thickness is slightly thin and the magnetic holding force of the electromagnet 12 is slightly weak. The term “safe operating range” as used herein means a range of magnetic flux density in which it is possible to obtain a magnetic holding force sufficiently strong for the portable machine tool 1 to perform machining operation without risk. If the motor drive switch 34 is pressed to ON position (S38) in a state where the blue LED or the yellow LED is ON, the control unit 48 starts driving the electric motor 20 (S40).

[0027] If the output value of the magnetic sensor 42 is less than Y [V] and thus not within the safe operating range (S30), the control unit 48 causes the LED display unit 41 to turn on a red LED (S36) to show the worker that a sufficient magnetic holding force is unavailable because the plate thickness is excessively thin. Under this circumstance, the control unit 48 will not start driving the electric motor 20 even if the motor drive switch 34 is pressed to ON position.

[0028] If the electromagnet switch 34 is long pressed to keep the ON state for not less than 2 seconds in a state where the electric motor 20 is not driven although the electromagnet 12 is in operation (S42, S44) and then the long press of the electromagnet switch 34 is canceled to turn OFF the electromagnet switch 34 (S46), the control unit 48 stops the operation of the electromagnet 12 (S48). With this step, a

series of control steps are terminated (S50).

[0029] When the drive of the electric motor 20 is started at step S40, the control unit 48 executes control shown in Fig. 6 to detect lifting of the portable machine tool 1 during machining operation and to detect a change in plate thickness of the workpiece. The control unit 48 first confirms that the plate thickness of the workpiece is determined to be not less than α [mm] (S52). If the plate thickness is determined to be not less than α [mm], the control unit 48 compares the output value of the magnetic sensor 42 with a predetermined first lifting determination reference value A [V] (S54). The first lifting determination reference value A [V] is a lower limit of a normal operating range set when the plate thickness is not less than α [mm]. The first lifting determination reference value A [V] is smaller than the first threshold value X [V]. The term “normal operating range” as used herein means a range of magnetic flux density in which it is possible to consider that the portable machine tool 1 is not lifted from the workpiece but is properly secured to the workpiece during machining operation. The control unit 48 determines that the electromagnet 12 has been lifted from the workpiece if the output value of the magnetic sensor 42 is less than the first lifting determination reference value A [V], i.e., out of the normal operating range, and the control unit 48 turns on the red LED of the LED display unit 41 (S56) to show the worker the lifting of the electromagnet 12, and stops the drive of the electric motor 20 (S58). After stopping the electric motor 20, the control by the control unit 48 returns to the above-described step 22.

[0030] If, at step S54, the output value of the magnetic sensor 42 is not less than the first lifting determination reference value (A [V]), i.e., within the normal operating range, the control unit 48 determines that the electromagnet 12 is not lifted from the workpiece, and continues the drive of the electric motor 20. If the motor stop switch 36 is pressed to ON position (S66) or the electromagnet switch 38 is pressed to ON position (S68) when the drive of the electric motor 20 is being continued, the control unit 48 stops the drive of the electric motor 20 (S58) and returns to the control at the

above-described step S22. If neither the motor stop switch 36 nor the electromagnet switch 38 is pressed, i.e., both are in OFF position, the magnetic flux density around the electromagnet 12 is measured again with the magnetic sensor 24 (S70), and the control returns to the above-described step S52.

[0031] If it is determined that the plate thickness is not greater than α [mm], i.e., less than α [mm], and not less than β [mm] (S52), the output value of the magnetic sensor 42 is compared with a predetermined second lifting determination reference value B [V] (S60). The second lifting determination reference value B [V] is a lower limit of the normal operating range when the plate thickness is less than α [mm] and not less than β [mm]. The second lifting determination reference value B [V] is smaller than the second threshold value Y [V] and the first lifting determination reference value A [V]. If the output value of the magnetic sensor 42 is less than the second lifting determination reference value B [V], i.e., out of the normal operating range (S60), the control unit 48 determines that the electromagnet 12 has been lifted from the workpiece. Then, the control unit 48 turns on the red LED of the LED display unit 41 (S56) to show the worker the lifting of the electromagnet 12, and stops the drive of the electric motor 20 (S58). If the output value of the magnetic sensor 42 is not less than B [V] (S60), the control unit 48 compares the output value of the magnetic sensor 12 with the first threshold value X [V] (S62). If the output value of the magnetic sensor 42 is not less than X [V], it is determined that the plate thickness has increased to not less than α [mm] (S64). This assumes a case where the plate thickness was less than α [mm] at the beginning, but because another plate was attached to the bottom of the workpiece in the middle of the operation, the total plate thickness has increased to not less than α [mm]. Thereafter, the process proceeds to step 66 to perform the above-described control.

[0032] As has been stated above, the portable machine tool 1 is configured to set a normal operating range based on the output value of the magnetic sensor 42 when the electromagnet 12 is in operation and before machining operation by the electric motor

20 is started. Therefore, it is possible to set a normal operating range appropriate for the plate thickness of a workpiece to which the electromagnet 12 is magnetically attached, and hence possible to determine lifting of the electromagnet 12 even more stably and properly. It should be noted that the output value of the magnetic sensor 42 decreases also in a case that the electromagnet 12 moves from a portion of the workpiece having a relatively thick plate thickness to a relatively thin workpiece portion when the electromagnet 12 sideslips without lifting from the workpiece. In this regard, if the output value of the magnetic sensor 42 comes out of the normal operating range as a result of the sideslip, the control unit 48 also determines that the electromagnet 12 has been lifted. In other words, the determination about lifting in this patent application includes determination about the occurrence of the above-described sideslip.

[0033] In another embodiment of the present invention, resetting of threshold values based on the power supply voltage, shown in Fig. 7, is executed after the measurement of magnetic flux density by the magnetic sensor 42 at S22 in Fig. 5 and at S70 in Fig. 6. The other control processes are the same as those of the foregoing embodiment.

[0034] In the resetting of threshold values based on the power supply voltage, first, a supply voltage supplied to the electromagnet 12, i.e., the voltage (power supply voltage) of the battery 14, is measured (S100), and the measured power supply voltage is compared with a predetermined threshold value Z [V] (S102). If the power supply voltage is greater than Z [V], the threshold values and reference values (X , Y , Z , A , and B) are modified to values incremented by predetermined increment-decrement values (a , b , c , d , and e), respectively (S104). Namely: a is added to X ; b is added to Y ; c is added to Z ; d is added to A ; and e is added to B . Then, the measured power supply voltage is compared with the modified Z [V] (S106), and if the power supply voltage is not less than Z [V], the threshold values and reference values (X , Y , Z , A , and B) are modified to values further incremented by the predetermined increment-decrement values (a , b , c , d , and e), respectively (S104). This is executed until the measured

power supply voltage becomes less than the modified Z [V]. If the power supply voltage is not greater than Z [V] at S102, the threshold values and reference values (X, Y, Z, A, and B) are modified to values decremented by the predetermined increment-decrement values (a, b, c, d, and e), respectively (S108). Namely: a is subtracted from X; b is subtracted from Y; c is subtracted from Z; d is subtracted from A; and e is subtracted from B. Then, the measured power supply voltage is compared with the modified Z [V] (S110), and if the measured power supply voltage is not greater than Z [V], the threshold values and reference values (X, Y, Z, A, and B) are modified to values further decremented by the predetermined increment-decrement values (a, b, c, d, and e), respectively (S108). This is executed until the power supply voltage becomes greater than the modified Z [V]. For example, when the measured power supply voltage is 19.5 V, and the initial threshold value Z [V] is 18 V, and further the increment-decrement value c is 1 V, the power supply voltage (19.5 V) is greater than 18 V (S102); therefore, Z is reset to 19 V, which is greater than the initial threshold value Z [V] by 1 V (S104). The power supply voltage (19.5 V) is not less than the modified Z (19 V) (S106); therefore, Z is further reset to 20 V, which is greater than the modified threshold value Z [V] by 1 V (S104). Consequently, the power supply voltage (19.5 V) becomes less than the modified Z [20 V]; therefore, the threshold value resetting shown in Fig 7 is terminated. Meanwhile, the other threshold values and reference values (X, Y, A, and B) are also reset to incremented values according to the corresponding increment-decrement values (a, b, d, and e), respectively.

[0035] The above-described threshold value resetting based on the power supply voltage is executed before the electric motor 20 is driven to start machining operation (after S22 in Fig. 5) and also in the middle of machining operation performed by driving the electric motor 20 (after S70 in Fig 6).

[0036] When the battery 14 is used as a power supply, in particular, as the remaining battery capacity decreases, the power supply voltage decreases, and the voltage supplied to the electromagnet 12 also decreases. Consequently, the magnetic flux

density generated around the electromagnet 12 decreases. In other words, the magnitude of the magnetic flux density generated around the electromagnet 12 depends on not only the plate thickness of the workpiece but also the magnitude of the power supply voltage. In the above-described embodiments, the magnitudes of the threshold values and reference values are modified according to the magnitude of the power supply voltage to reset the normal operating range. Therefore, it is possible to minimize the effect of change in magnetic flux density due to the change in power supply voltage on the lifting determination and hence possible to detect lifting of the electromagnet 12 even more stably.

[0037] Although some embodiments of the present invention have been described above, the present invention is not limited to the described embodiments. For example, the present invention may be applied to a machine tool using a drill or other similar machining tool instead of the annular cutter. Further, although the foregoing embodiments use a battery as a main power supply, an external power supply, e.g., an AC power supply, may also be used as a main power supply. Further, although an electric motor is used as a drive unit, it is also possible to use other devices, e.g., an air motor, as a drive unit. In the foregoing embodiments, a normal operating range is set by determining the plate thickness in the following three grades: not less than α [mm]; less than α [mm] and not less than β [mm]; and less than β [mm]. However, it is also possible to set a normal operating range by determining the plate thickness in more finely defined grades or steplessly. It should be noted that the magnitude of the magnetic flux density generated around the electromagnet varies depending on the constituent material of a workpiece to which the electromagnet is magnetically attached. Therefore, when the portable machine tool is used for workpieces of different constituent materials, for example, it is not always necessary to make a determination about the plate thickness, but a normal operating range may be set directly on the basis of the output value of the magnetic sensor before machining operation.

List of Reference Signs:

[0038] 1: portable machine tool
10: machine tool body
12: electromagnet
14: battery
16: annular cutter
18: machining tool mounting unit
20: electric motor
22: gear mechanism
24: lever
26: first coil
30: second coil
34: motor drive switch
36: motor stop switch
38: electromagnet switch
40: illumination switch
41: LED display unit
42: magnetic sensor
46: control circuit board
48: control unit
50: control power supply circuit
52: motor control section
54: motor current detecting section
56: coil control circuit
58: coil disconnection detecting circuit
60: power supply voltage detecting circuit

Claims

1. A portable machine tool comprising:
 - a machine tool body;
 - an electromagnet mounted to the machine tool body to secure the machine tool body to a workpiece;
 - a magnetic sensor disposed around the electromagnet;
 - a control unit configured to control operation of the electromagnet; and
 - a drive unit for driving a machining tool mounted to the machine tool body to perform machining operation on the workpiece;wherein the control unit is configured to set a normal operating range based on an output value of the magnetic sensor when the electromagnet is in operation and before the machining operation by the drive unit is started, and to determine that the electromagnet has been lifted from the workpiece if the output value of the magnetic sensor after the machining operation has been started deviates from the normal operating range.
2. The portable machine tool of claim 1, wherein the magnetic sensor is configured to detect a magnetic flux density in a magnetic circuit of the electromagnet formed through the workpiece, the output value being a value representing a magnitude of the magnetic flux density.
3. The portable machine tool of claim 1 or 2, wherein the normal operating range is a range having a lower limit defined by a lifting determination reference value determined based on a magnitude of the output value; and
 - wherein the control unit is configured to determine that the electromagnet has been lifted from the workpiece if the output value of the magnetic sensor after the machining operation has been started becomes less than the lifting determination reference value.
4. The portable machine tool of any one of claims 1 to 3, wherein the control unit is configured to detect a supply voltage supplied to the electromagnet; and

wherein the control unit is configured to set the normal operating range on a basis of the supply voltage and the output value of the magnetic sensor when the electromagnet is in operation and before the machining operation by the drive unit is started.

5. The portable machine tool of claim 4, wherein the control unit is configured to reset the normal operating range on a basis of a magnitude of the supply voltage if the supply voltage changes during the machining operation.

6. The portable machine tool of any one of claims 1 to 5, wherein the control unit sets the normal operating range to a range having a lower limit defined by a predetermined first lifting determination reference value if the output value of the magnetic sensor when the electromagnet is in operation and before the machining operation by the drive unit is started is not less than a predetermined first threshold value; and

wherein the control unit sets the normal operating range to a range having a lower limit defined by a predetermined second lifting determination reference value that is smaller than the first lifting determination reference value if the output value is less than the first threshold value and not less than a predetermined second threshold value that is smaller than the first threshold value.

7. The portable machine tool of claim 6, wherein the drive unit is disabled from being started to be driven if the output value of the magnetic sensor when the electromagnet is in operation and before the machining operation by the drive unit is started is less than the second threshold value.

8. The portable machine tool of any one of claims 1 to 7, further comprising a display unit configured to display a status of the portable machine tool, the display unit being configured to give different indications on the following conditions, respectively: the output value of the magnetic sensor when the electromagnet is in operation and before the machining operation by the drive unit is started is not less than the first threshold value; less than the first threshold value and not less than the second threshold

value; and less than the second threshold value.