

(21) Application No: 0706570.9  
(22) Date of Filing: 03.04.2007  
(30) Priority Data:  
(31) 102006016441 (32) 07.04.2006 (33) DE

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(51) INT CL:  
**B23B 45/02** (2006.01)

(52) UK CL (Edition X):  
**NOT CLASSIFIED**

(56) Documents Cited:  
**GB 2247580 A** **US 4578623 A**

(58) Field of Search:  
INT CL **B23B, B23Q, H02H**  
Other: **On line databases WPI,EPODOC**

(54) Abstract Title: **Electric machine tool and method for operating the latter**

(57) The invention is based on an electric machine tool and a method for operating an electric machine tool in which a tool is driven by an electric motor (10) in accordance with a position of a switch (18) for the power requirement, in particular a press switch.

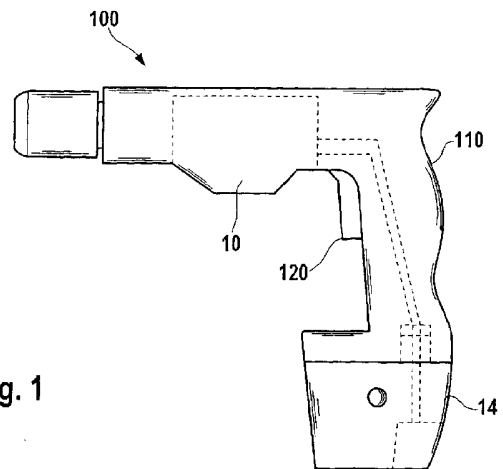


Fig. 1

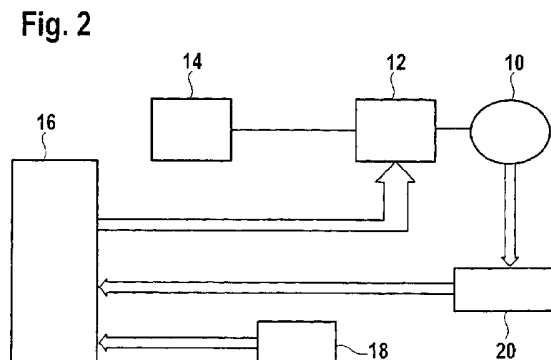


Fig. 2

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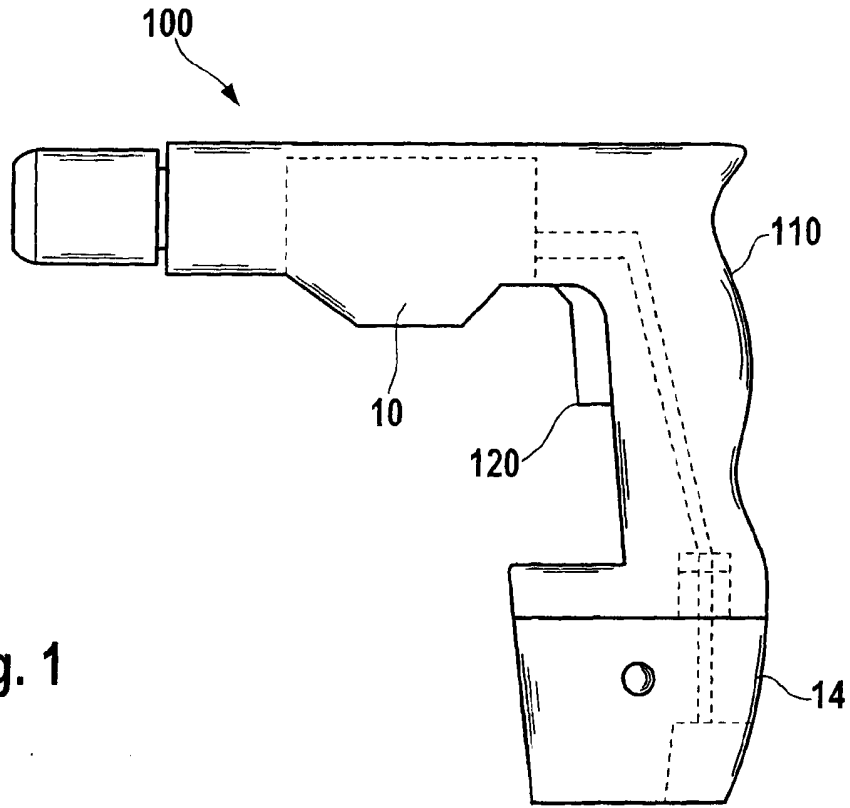


Fig. 1

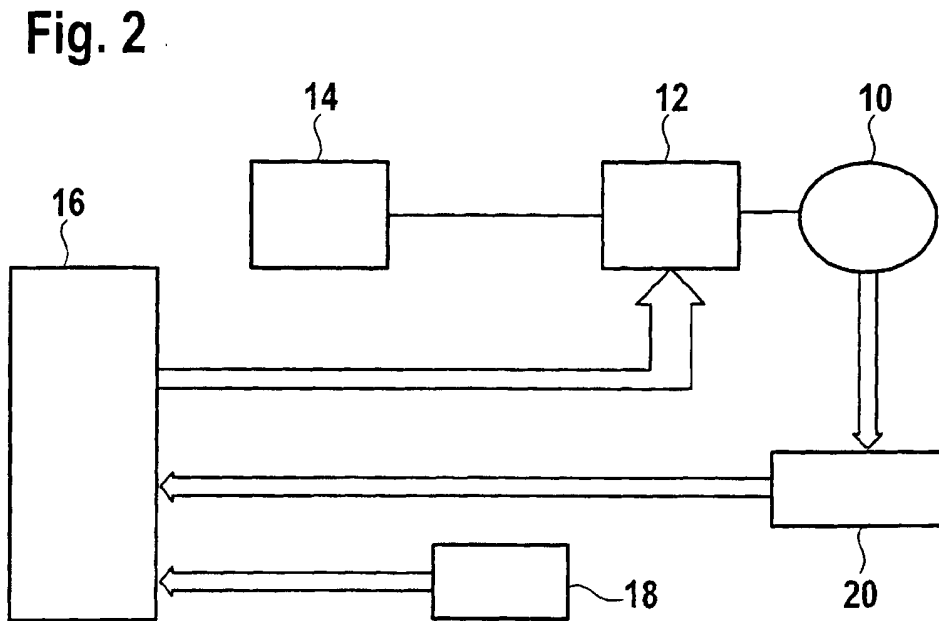


Fig. 2

5 Electric machine tool and method for operating the latter

Prior art

The invention is based on a method for operating an  
10 electric machine tool and an electric machine tool  
according to the preambles of the independent Claims.

In the case of known electric machine tools the operation  
of a pushbutton by the finger of the user results in the  
15 motor being supplied with current, which as a rule is  
proportional to or at least increases monotonically with  
the pushbutton position. The motor turns. If the load  
moment which is required by the motor now increases to an  
extent such that the motor comes to a standstill (blocking  
20 case), energisation of the motor is as a rule maintained  
with an unchanged pushbutton position. It is also known to  
stop the motor through an overload protection circuit,  
which responds after a certain time in the blocking case.  
As a rule the response of the overload protection circuit  
25 takes place by thermal means, e.g. by way of a bimetallic  
switch or a PTC resistor. However this kind of stoppage has  
considerable disadvantages.

There is no response when the current through the motor,  
30 which is predetermined by the pushbutton position, is too  
low, as the design has to be such that - even when the  
motor torque is at a maximum - there is no direct response,  
but only after a certain time, as a rule after several

seconds. In order to restart the motor, it is then frequently necessary to operate a restart switch or at least to wait for a certain period until the overload protection circuit has cooled down. This period is in most cases subject to significant variances. An overload protection circuit is for these reasons preferred if people or objects might be at risk or damage to the motor may occur through short-time blocking of the motor. In all other cases energisation is not usually interrupted in the blocking case.

#### Advantages of the invention

The invention is based on a method for operating an electric machine tool in which a tool is driven by an electric motor in accordance with a position of a switch for the power requirement, in particular a press switch.

It is proposed that rotor position detection be used to identify a blocking case and energisation of the motor be interrupted upon identification of the blocking case. Where a battery-operated electric machine tool is concerned, it is possible to prevent further and unnecessary energisation of the motor in the blocking case from discharging the battery unit in the state of standstill. The energy which is stored in the battery unit can as a result be used for more useful work, e.g. more screwing motions can be carried out. Moreover, the battery unit is subjected to less stress, as its heating is proportional to the product of time and current squared, i.e. a short-time high current delivery results in a distinctly higher degree of heating than a long-lasting low current delivery. In addition, direct cutoff of the current following blocking of the

inserted tool guarantees improved protection for people,  
workpieces and machine tools. This is of particular  
advantage when there is a possibility of the occurrence of  
high blocking moments which cannot be expected by the user  
5 and/or can hardly be controlled. The invention is of  
advantage in particular for electric machine tools with a  
battery unit for supplying current to the electric motor.  
The invention is suitable for all types of electric machine  
tools, in particular preferably for cordless screwdrivers  
10 and cordless drills.

A further essential advantage can be seen in the fact that  
blocking of the motor is also identified when the motor is  
supplied with an adjustable current by means of a circuit  
15 for detecting the motor current. Circuits of this kind are  
as a rule used to limit the torque of an electric motor.

A connection between a battery unit energising the motor  
and the motor can be interrupted in a favourable manner in  
20 the blocking case. The battery unit is subjected to less  
stress and can be used for longer.

According to a co-ordinated aspect of the invention, a  
method for operating an electric machine tool is proposed  
25 in which a tool is driven by an electric motor in  
accordance with a position of a switch for the power  
requirement, in particular a press switch, wherein a  
connection of a battery unit energising the motor to the  
motor is interrupted upon identification of a blocking  
30 case. It is therefore advantageously possible to prevent  
unnecessary discharge of the battery unit and improve  
utilisation of the capacity and service life of the battery  
unit.

The blocking case can advantageously be detected by means of a signal from at least one rotation angle sensor associated with a motor shaft. For this purpose a permanent magnet, for example, which stimulates one or a plurality of Hall sensor(s), can be disposed on the motor shaft. This is of particular advantage with regard to a so-called EC motor with electrical commutation, as rotor position detection is necessary for motors of this kind and therefore no additional components have to be added.

The blocking case can alternatively or additionally be identified by means of a signal of a synchronous generated voltage of the motor and/or a harmonic thereof.

The blocking case can be established when there is a signal change below a predetermined threshold value within a predetermined period.

Energisation can then be interrupted directly following identification of the blocking case. Unnecessary discharge of the battery unit is prevented.

The motor is advantageously only re-energised when the position of the switch is changed in the direction of a higher power requirement. The user maintains control of the electric machine tool and can adapt to a higher load.

It is alternatively or additionally possible for the motor only to be re-energised when the power requirement is reduced and then increased again. Due to the fact that the motor can be restarted from the blocking case, a screw can be turned further under the visual control of the user, for

example. The user can in this case adapt to the required forces, in particular when the load and blocking moments are high.

5 An electric machine tool is proposed in which the driving energy for a tool is provided by an electric motor in accordance with a position of a switch for the power requirement, in particular a press switch, and in which rotor position detection is used to identify a blocking  
10 case and an electronics unit interrupts energisation of the motor upon identification of the blocking case. Power electronics are expediently provided for current interruption, which electronics preferably interrupt energisation of the motor directly after the blocking case  
15 has been identified.

According to a co-ordinated aspect of the invention, an electric machine tool is proposed in which a tool can be driven by an electric motor in accordance with a position  
20 of a switch for the power requirement, in particular a press switch, wherein the electronics unit interrupts a connection between a battery unit energising the motor and the motor in a blocking case. It is therefore advantageously possible to prevent unnecessary discharge of  
25 the battery unit and improve utilisation of the capacity and service life of the battery unit.

At least one rotation angle sensor associated with a motor shaft can be provided to identify the blocking case. This  
30 is of particular advantage in the case of EC motors, as these components are already provided to operate the motor.

A synchronous generated voltage of the motor and/or a harmonic thereof may additionally or alternatively be detectable in order to identify the blocking case.

## 5 Drawings

Further advantages will emerge from the following description of the drawings. An embodiment of the invention is represented in the drawings. The drawings, the  
10 description and the Claims contain numerous features in combination. The person skilled in the art will expediently also consider the features individually and amalgamate them to form further appropriate combinations.

## 15 In the drawings:

Fig. 1 shows a preferred electric machine tool with a user function according to Figure 2 and

Fig. 2 shows a block diagram relating to a preferred  
20 user function.

## Description of the embodiment

Figure 1 shows a preferred electric machine tool 100 with  
25 a battery unit 14 disposed in a handle 110, the connection of which unit to a motor 10 can be interrupted in the blocking case by an electronics unit 16. A switch 120 on the handle 110 can be closed in order to start the electric machine tool 100. Energisation of the motor 10 can be  
30 interrupted in an at least partially automated manner by the battery unit 14 upon identification of a blocking case, in spite of the depressed switch 120.



The block diagram which is represented in Figure 2 for implementing a user function in the blocking case for preferred battery-operated electric machine tools illustrates a preferred configuration of the invention.

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The electric motor 10, which is preferably formed as an EC motor, comprises power electronics 12. A battery unit 14 is responsible for supplying electricity to the electric machine tool. The motor 10, formed as an EC motor,  
10 comprises a rotor position detection unit 20 by way of which the rotor position of a rotor of the motor 10 can be detected. The electric machine tool is a cordless screwdriver, for example.

15 The electronics unit 16 for controlling and adjusting the electric machine tool receives signals from the rotor position detection unit 20 on the basis of which the motor 10, formed as an EC motor, is controlled during normal operation.

20

By way of a switch 18, which is formed as a pushbutton, a user delivers a power requirement to the electronics unit 16 when, for example, he wants to screw a screw into a workpiece which has been actively connected to a screwing  
25 tool of the electric machine tool. The position of the switch 18, formed as a pushbutton, is characteristic of the magnitude of the power requirement on the part of the user. If the switch 18, formed as a pushbutton, is pressed into its maximum end position, the power requirement is maximum,  
30 in a centre position it is accordingly lower.

The detection of the rotor position by the rotor position detection unit 20 permits identification of a blocking

case, following which energisation of the motor 10 is interrupted by the power electronics unit 12. Blocking identification, cutoff of energisation and resumption of energisation of the motor 10 preferably take place  
5 by means of the electronics unit 16, with the power electronics unit 12 being controlled accordingly.

The blocking case can be detected by means of a signal from at least one rotation angle sensor associated with a motor  
10 shaft and/or identified without a rotation angle sensor by means of a signal of a synchronous generated voltage of the motor 10 and/or a harmonic thereof.

The blocking case is established when there is a signal  
15 change below a predetermined threshold value within a predetermined period, in particular when the signal value in question does not change. The motor 10 does not continue to turn in the blocking case, so that, for example, the angle of rotation no longer changes. Energisation of the  
20 motor 10 is interrupted by the electronics unit 16 directly after the blocking case has been identified.

The motor 10 is only re-energised when the position of the switch 18 is changed in the direction of a higher power  
25 requirement or this is completely released and then operated again. The user can continue the screwing motion under visual control and is prepared for the higher load and the forces which are to be expected.

24.03.06

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Claims

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1. Method for operating an electric machine tool (100) in which a which a tool is driven by an electric motor (10) in accordance with a position of a switch (18) for the power requirement, in particular a press switch, **characterised in**  
10 **that** energisation of the motor (10) is interrupted upon identification of a blocking case derived from a signal from a rotor position detection unit (20).

2. Method according to Claim 1, **characterised in that** a  
15 connection between a battery unit (14) energising the motor (10) and the motor (10) is interrupted in the blocking case.

3. Method for operating an electric machine tool in which  
20 a tool is driven by an electric motor (10) in accordance with a position of a switch (18) for the power requirement, in particular a press switch, in particular according to Claim 1, **characterised in that** a connection of a battery unit (14) energising the motor (10) to the motor (10) is  
25 interrupted upon identification of a blocking case.

4. Method according to any one of the preceding Claims, **characterised in that** the blocking case is detected by means of a signal from at least one rotation angle sensor  
30 associated with a motor shaft.

5. Method according to any one of the preceding Claims, **characterised in that** the blocking case is identified by means of a signal of a synchronous generated voltage of the motor (10) and/or a harmonic thereof.

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6. Method according to either of Claims 4 and 5, **characterised in that** the blocking case is established when there is a signal change below a predetermined threshold value within a predetermined period.

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7. Method according to any one of the preceding Claims, **characterised in that** the motor (10) is only re-energised when the position of the switch (18) is changed in the direction of a higher power requirement

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8. Method according to any one of the preceding Claims, **characterised in that** the motor (10) is only re-energised when the power requirement is reduced and then increased again.

20

9. Electric machine tool in which a tool can be driven by an electric motor (10) in accordance with a position of a switch (18) for the power requirement, in particular a press switch, **characterised by** an electronics unit (16) which interrupts energisation of the motor (10) upon identification of a blocking case derived from a signal from a rotor position detection unit (20).

25

10. Electric machine tool in which a tool can be driven by an electric motor (10) in accordance with a position of a switch (18) for the power requirement, in particular a press switch, **characterised by** an electronics unit (16) which interrupts a connection between a battery unit (14)

30

energising the motor (10) and the motor (10) in a blocking case.

11. Electric machine tool according to either of Claims 9  
5 and 10, **characterised in that** at least one rotation angle sensor associated with a motor shaft is provided to identify the blocking case.

12. Electric machine tool according to any one of Claims 9  
10 to 11, **characterised in that** a synchronous generated voltage of the motor (10) and/or a harmonic thereof can be detected in order to identify the blocking case.

13. A method of operating an electric machine tool  
15 substantially as herein described with reference to the accompanying drawings.

14. An electric machine tool substantially as herein described with reference to the accompanying drawings.

12

**Application No:** GB0706570.9

**Examiner:** Tony Martin

**Claims searched:** All claims

**Date of search:** 30 July 2007

## Patents Act 1977: Search Report under Section 17

### Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 and 9 at least	GB2247580 A Toshiba see claim 1
X	" "	US4578623 A Matsushita see claim 7

### Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

### Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC<sup>X</sup>:

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Worldwide search of patent documents classified in the following areas of the IPC

B23B; B23Q; H02H

The following online and other databases have been used in the preparation of this search report

On line databases WPI,EPODOC

### International Classification:

Subclass	Subgroup	Valid From
None		