



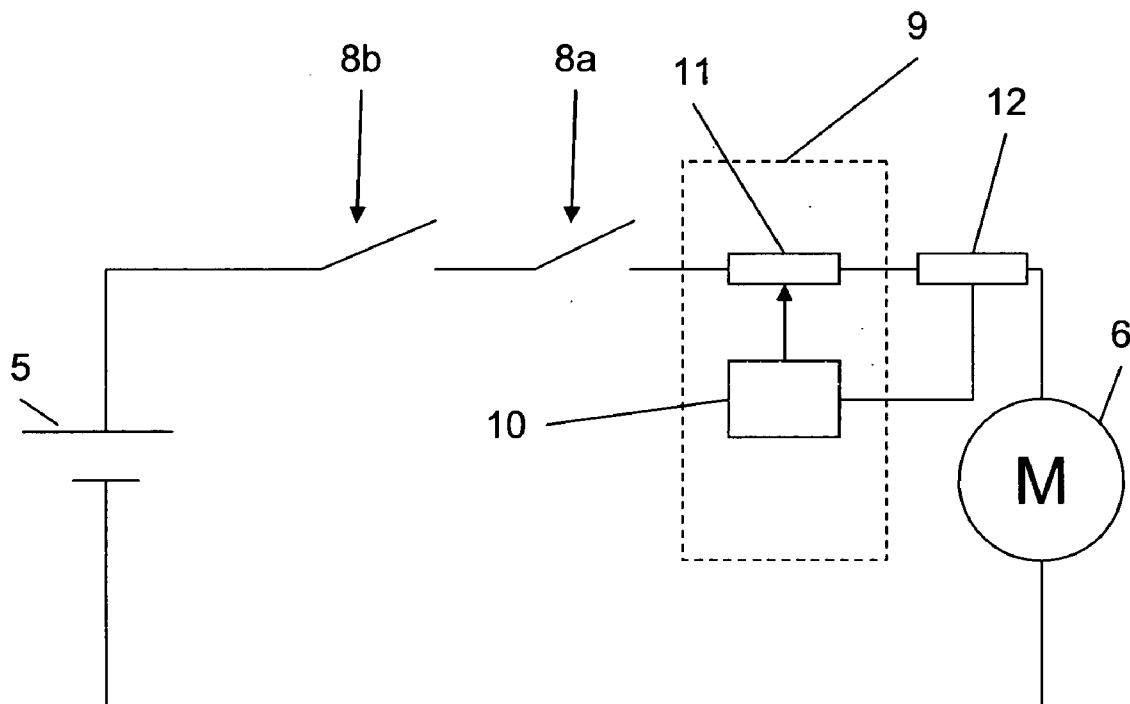
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(19) **United States**(12) **Patent Application Publication**
Björnlinger et al.(10) **Pub. No.: US 2013/0020102 A1**(43) **Pub. Date: Jan. 24, 2013**(54) **POWER TOOLS****Publication Classification**(75) Inventors: **Johan Björnlinger**, Huskvarna (SE);
Pär Martinsson, Jonkoping (SE); **Johan Svennung**, Jonkoping (SE); **Peter Lameli**, Nurtigent (DE); **Ottmar Locher**, Ulm (DE); **Christoph Schiedt**, Burgrieden (DE); **Martin Bepler**, Ulm (DE); **Hans Waigel**, Schnurpflingen (DE)(51) **Int. Cl.**
E21B 15/04 (2006.01)(52) **U.S. Cl.** **173/2**(57) **ABSTRACT**

A typically battery-operated power tool, such as a chainsaw or hedge trimmer, comprising a working element (4), a motor (6) arranged to drive the working element (4) and a controller (9) arranged to control the speed at which the motor drives the working element (4), in which there is provided a sensor (12) for at least one factor indicative of the efficiency with which the power tool is being operated, the controller (9) being arranged to vary the speed at which the motor (6) drives the working element (4) should the factor indicate that the power tool is being operated in a sub-optimal manner. Typically, the factor is the pressure which the user is applying the power tool, and the sensor (12) is a sensor for the current flowing through the motor (6).

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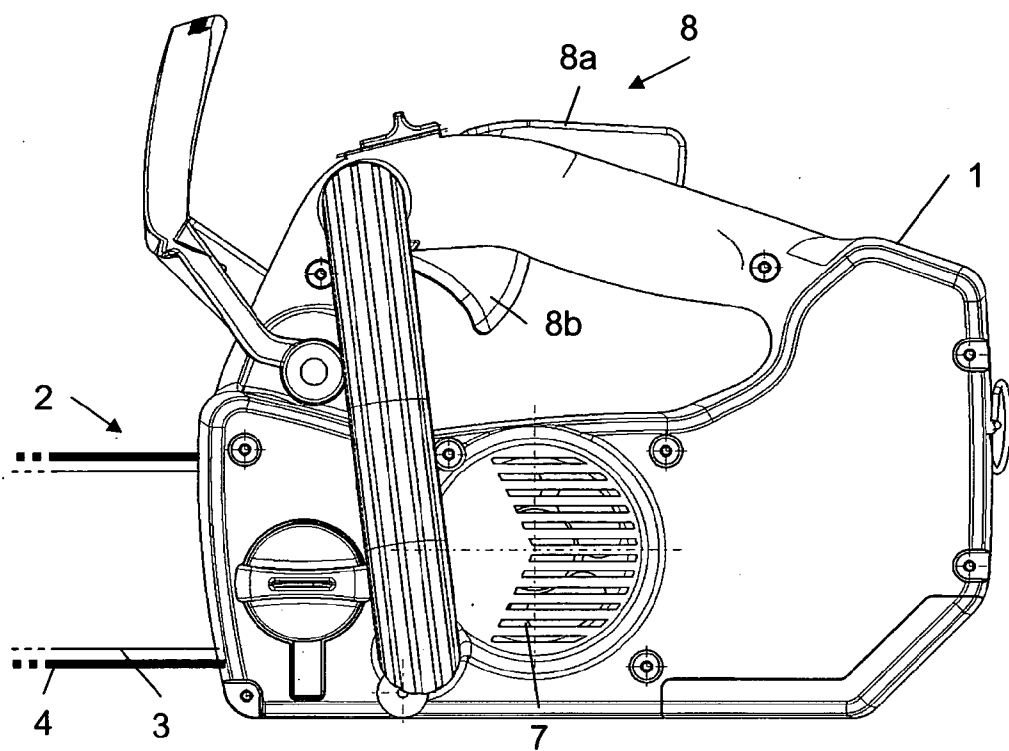


Fig 1

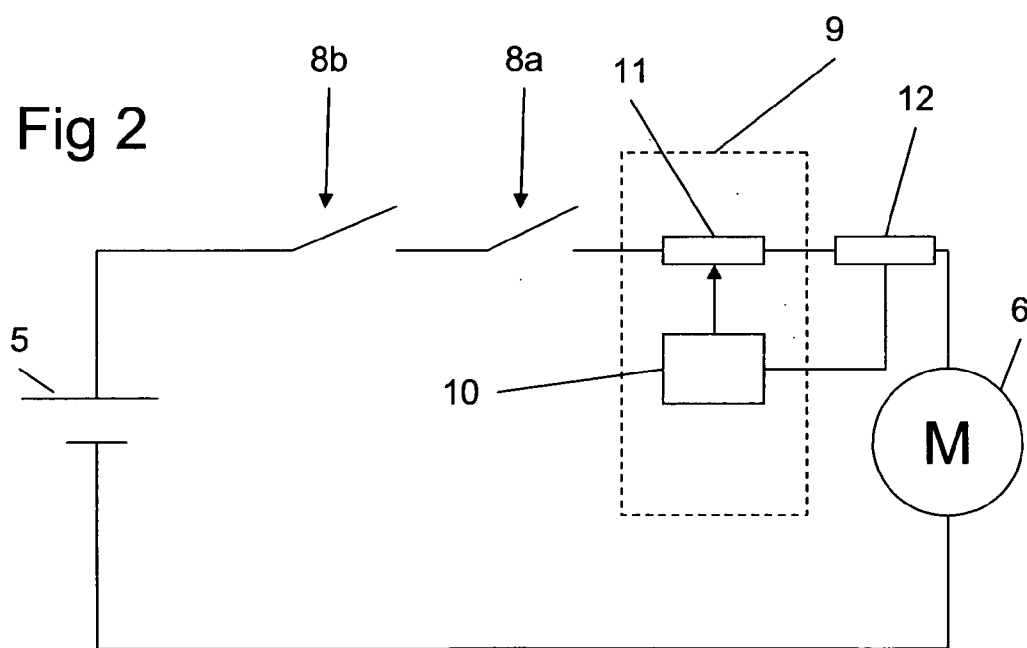


Fig 2

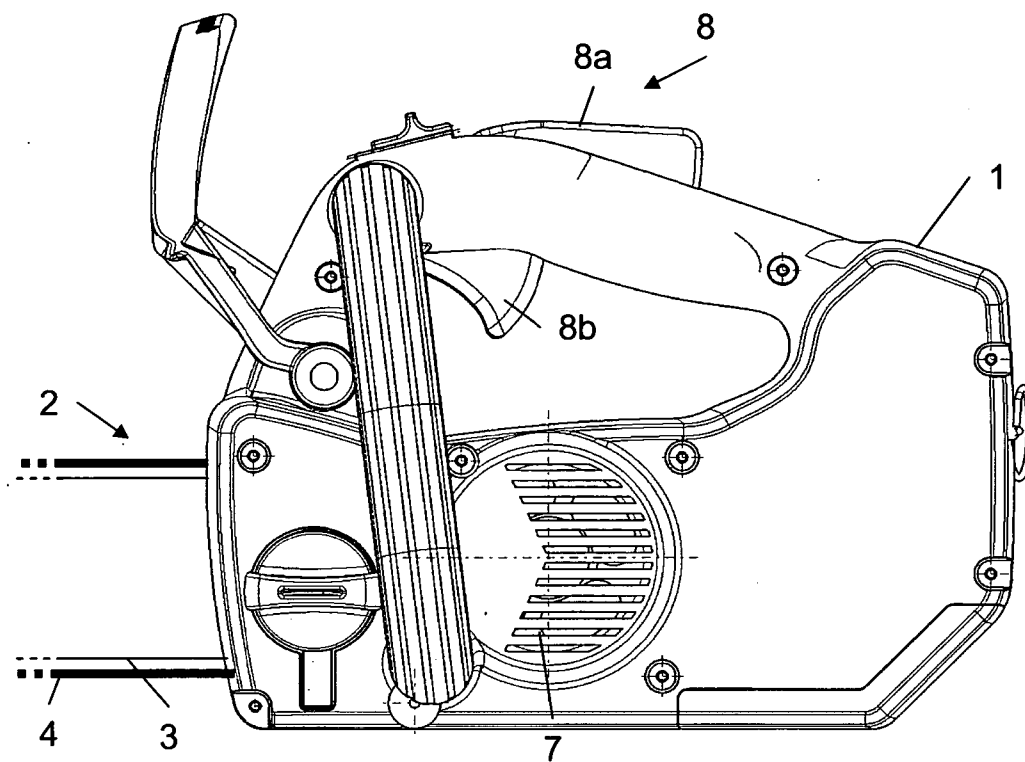


Fig 1

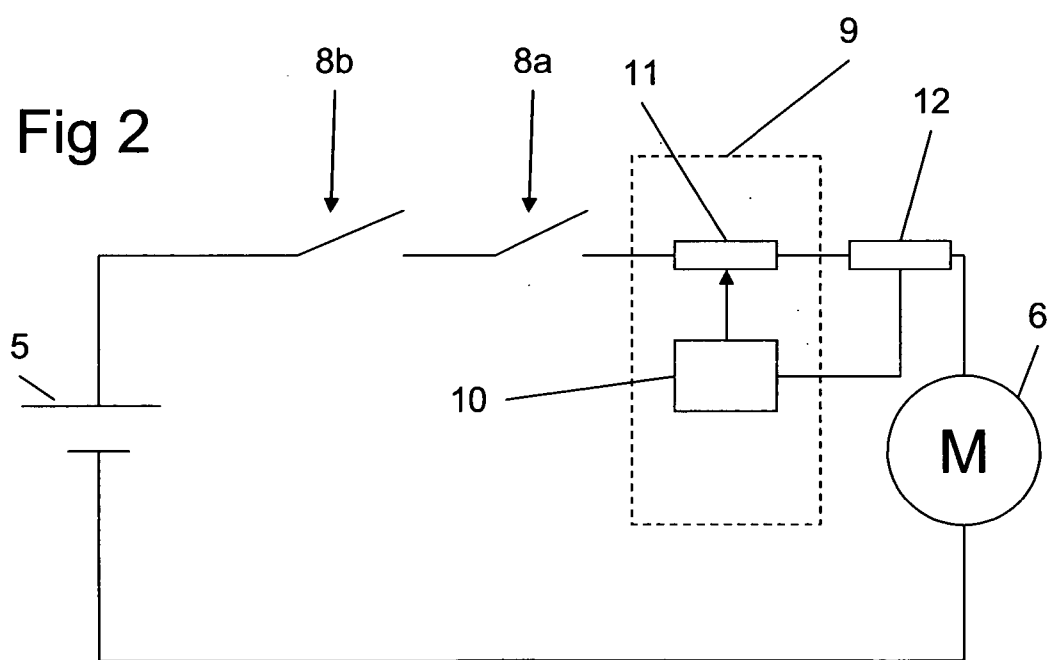


Fig 2

POWER TOOLS

[0001] This invention relates to power tools, particularly electric power tools such as, but not limited to, battery operated power tools including chain saws or hedge trimmers.

[0002] Power tools, and in particular battery-operated electric power tools such as hedge trimmers and chainsaws are well known in the prior art. They will typically comprise a battery arranged to power a motor, the motor being coupled to a working element in order to drive that working element. A control element is provided in order to control the level of power supplied to the motor; this may be a simple on/off control or may provide discrete control over the voltage or current supplied to the motor. For a chainsaw, the working element is an endless chain carrying a plurality of bladed teeth, whereas for a hedge trimmer the working element is generally a pair of reciprocating blades.

[0003] Particularly for battery-operated products, it is useful to be able to provide feedback to a user on how efficiently they are using the power tool. Batteries hold a limited amount of charge, and efficient use increases the time between charges. Also, efficient use of the power tool will reduce the heat dissipated in the battery and the rest of the tool, thus improving the life of the battery and potentially the other systems.

[0004] According to a first aspect of the invention, there is provided a power tool comprising a working element, a motor arranged to drive the working element and a controller arranged to control the speed at which the motor drives the working element, in which there is provided a sensor for at least one factor indicative of the efficiency with which the power tool is being operated, the controller being arranged to vary the speed at which the motor drives the working element should the factor indicate that the power tool is being operated in a sub-optimal manner.

[0005] As such, this provides feedback to a user through the speed at which the working element is driven. By controlling the motor to run at a modified speed, the user is encouraged to operate the tool in a more efficient manner.

[0006] The controller will preferably be arranged to reduce the speed at which the motor drives the working element in the event of the power tool being used in a sub-optimal manner. Alternatively, the controller can be arranged to cyclically vary the speed, so as to provide vibrations to the user, or could even increase the speed.

[0007] In the preferred embodiment, the at least one factor comprises the pressure which the user applies the working element to a subject to be worked. As such, the power tool may therefore guide the user as to the efficient pressure to be applied.

[0008] Inexperienced users are particularly liable to use their power tools in an inefficient manner. Most tools will have a speed at which they are most efficient. Inexperienced users, particularly with chain saws, are liable to put too much pressure on the working element; since the cutting chain in a chain saw is more or less self-feeding, increased pressure will generally lead to a loss of efficiency.

[0009] The sensor may comprise a pressure sensor, arranged to measure the pressure applied using the working element. However, in the case where the tool is an electric power tool and the motor is an electric motor, the sensor may comprise a current sensor arranged to measure the current flowing through the motor. An increase in current may therefore indicate that too much pressure is being applied, and so the motor is working in a sub-optimal state. As such, the

controller may be arranged to vary, and typically reduce, the speed at which the motor drives the working element when the current measured by the current sensor exceeds a limit.

[0010] The tool may comprise a power sensor, such as a current integration unit, which integrates the flow of current over time; this provides a convenient indication of the power flowing through the motor; if excessive power is being consumed, then this is an indication that the motor or any battery may be overheating.

[0011] Additionally or alternatively, the sensor may comprise at least one of a load sensor, arranged to sense, as a factor, the load on the working element as it works the subject to be worked; a speed sensor, arranged to sense as a factor the speed at which the motor or the working element is working; or a temperature sensor for sensing the temperature of part of the tool, such as the motor or a battery of the tool.

[0012] With an electric power tool where the motor is an electric motor, the controller may comprise a variable power control element having an input and an output, in which the controller is arranged so that, if the factor as measured by the sensor is indicative of a sub-optimal operation of the power tool, the power control element reduces the power that is transmitted from the input to the output. For example, the power control element may comprise a controllable variable resistance, whereby the controller increases the resistance of the controllable variable resistance should a sub-optimal operation be determined, for example by the current through the motor exceeding the limit.

[0013] As such, the power tool may comprise a source of electric power, a speed selector operable by a user of the power tool and operative to take electric power from the source and output an electric signal indicative of a speed at which the user desires to operate the power tool, the output of the speed selector being coupled to the input of the power control element. The speed selector may allow the selection a plurality of discrete different speeds, such as two different speeds providing simple on/off control, or may provide a continuous range of speeds, preferably including zero speed. The controller will then provide feedback based upon the user's desired speed.

[0014] The power tool may be a trimmer, such as a hedge trimmer, where the working element comprises at least one, but preferably two reciprocating blades. In the preferred embodiment, the power tool is a chain saw, where the working element comprises an endless chain carrying a plurality of cutting teeth, driven around the length of the endless chain by the motor.

[0015] Typically, the power tool will be battery-operated electric power tool, in which the motor is an electric motor, and in which the source of electricity for the motor is an electric battery.

[0016] According to a second aspect of the invention, there is provided a method of operating a power tool comprising a working element, a motor arranged to drive the working element and a control element by means of which a user indicates a desired speed, the method comprising sensing at least one factor indicative of the efficiency with which the power tool is being operated, the power tool varying the speed at which the motor drives the working element from the desired speed should the factor indicate that the power tool is being operated in a sub-optimal manner.

[0017] As such, this provides feedback to a user through the speed at which the working element is driven. By controlling

the motor to run at a modified speed, the user is encouraged to operate the tool in a more efficient manner.

[0018] The step of varying the speed will preferably comprise reducing the speed at which the motor drives the working element. Alternatively, that step may comprise cyclically varying the speed, so as to provide vibrations to the user, or could even comprise increasing the speed.

[0019] In the preferred embodiment, the at least one factor comprises the pressure which the user applies the working element to a subject to be worked.

[0020] The pressure may be sensed using a pressure sensor. However, in the case where the tool is an electric power tool and the motor is an electric motor, the pressure may be sensed by measuring the current flowing through the motor. An increase in current may therefore indicate that too much pressure is being applied, and so the motor is working in a sub-optimal state. As such, the method may comprise varying, and typically reducing, the speed at which the motor drives the working element when the current measured exceeds a limit.

[0021] The factors may comprise, additionally or alternatively, at least one of: the load on the working element as it works the subject to be worked, the speed at which the motor or the working element is working, the temperature of a battery of the tool, the temperature of the motor (so that it can be established that the tool is not overheating), the current drawn by the motor, the integral of the current drawn by the motor, or the power consumed by the motor (the latter two factors being indicative of the energy consumption of the motor, and so potentially can indicate that the tool may be overheating).

[0022] The power tool may be a trimmer, such as a hedge trimmer, where the working element comprises at least one, but preferably two reciprocating blades. In the preferred embodiment, the power tool is a chain saw, where the working element comprises an endless chain carrying a plurality of cutting teeth, driven around the length of the endless chain by the motor.

[0023] Typically, the power tool will be a battery-operated electric power tool, in which the motor is an electric motor, and in which the source of electricity for the motor is an electric battery.

[0024] There now follows, by way of example only, an embodiment of the present invention, described with reference to the accompanying drawings, in which:

[0025] FIG. 1 shows a side elevation of a chainsaw according to a first embodiment of the invention; and

[0026] FIG. 2 shows a circuit diagram of the electric circuit controlling the chainsaw of FIG. 1.

[0027] A chainsaw according to an embodiment of the invention is shown in the accompanying drawings. It comprises a housing 1 supporting a cutting element 2. The cutting element comprises an elongate support 3 over which an endless loop of cutting chain 4 runs. The cutting chain has cutting elements on each link.

[0028] In order to drive the cutting chain 4, a battery 5 and a motor 6 (both shown in FIG. 2) are provided in the housing 1. The motor 6 acts to rotate a drive wheel 7 and so drive the chain 4 around the support 3 when current is supplied to it by the battery 5.

[0029] The main control a user has over the operation of the chainsaw is by the use of the control element main switch 8, which forms a control element. The user must squeeze both

parts 8a, 8b of the main switch in order to allow current to flow from the battery 5 to the motor 6 and so drive the cutting chain 3 to cut.

[0030] However, in order to provide feedback to a user of the chainsaw 1, a feedback controller 9 is provided. This comprises a control circuit 10 and a variable resistance 11 controlled by the control circuit 10. The control circuit 10 takes as an input the output of a current sensor 12, provided in series with the motor; the output indicates the current flowing through the motor 6.

[0031] As long as the current stays within predetermined normal limits, then the control circuit 10 will set the variable resistance 11 to its minimum value, which will not noticeably affect the flow of power from the battery to the motor; the chain 4 will therefore be driven at full speed.

[0032] However, should the user whilst using the chainsaw press too hard with the chainsaw on the object to be cut, the load on the motor 6 will greatly increase, thus increasing the current flowing through motor and so the current sensor 12. Once the current reaches a predetermined limit, the control circuit 10 will command the variable resistance 11 to a higher setting, which will restrict the power flowing to the motor 6, thus reducing the speed at which the chain 4 is driven. This can be easily perceived by a user, who should take it as a signal to press less hard. Once the current reduces to an appropriate level, the variable resistance will be reduced back to the minimum level, allowing the user to proceed as normal.

[0033] Multiple increasing levels of resistance can be provided, successively slowing the chain down further as the current increases. Alternatively, the variable resistance can either be off (resistance substantially zero if current in normal range) or on (resistance fully applied if current over limit).

[0034] The current sensor may comprise an integration unit, whereby the integral of the current flowing through the motor 6, typically over a window in time, can be measured. This gives a measure of the energy or power consumed by the motor 6, and so can be used to indicate if excessive power consumption leading to a potential overheating situation could occur. If such a situation occurs, then the variable resistance 11 can be used to reduce the current flow to the motor, and hence reduce the speed of the motor 6 to allow it to cool down.

[0035] Accordingly, this embodiment of the invention will teach a user to operate their chainsaw more efficiently, leading in an improvement in work done per watt-hour consumed.

1. A power tool comprising a working element, a motor arranged to drive the working element and a controller arranged to control the speed at which the motor drives the working element, in which there is provided a sensor for at least one factor indicative of the efficiency with which the power tool is being operated, the controller being arranged to vary the speed at which the motor drives the working element, so as to provide feedback through said speed to the user, should the factor indicate that the power tool is being operated in a sub-optimal manner.

2. The power tool of claim 1, in which the controller is arranged to reduce the speed at which the motor drives the working element in the event of the power tool being used in a sub-optimal manner.

3. The power tool of claim 1, in which the controller is arranged to cyclically vary the speed, so as to provide vibrations to the user, in the event of the power tool being used in a sub-optimal manner.

4. The power tool of claim 1, in which the at least one factor comprises the pressure which the user applies the working element to a subject to be worked.

5. The power tool of claim 1, in which the tool is an electric power tool and the motor is an electric motor and in which the sensor comprises a current sensor arranged to measure the current flowing through the motor.

6. The power tool of claim 5, in which the controller is arranged to reduce the speed at which the motor drives the working element when the current measured by the current sensor exceeds a limit.

7. The power tool of claim 1, being an electric power tool where the motor is an electric motor, in which the controller comprises a variable power control element having an input and an output, in which the controller is arranged so that, if the factor as measured by the sensor is indicative of a sub-optimal operation of the power tool, the power control element reduces the power that is transmitted from the input to the output.

8. The power tool of claim 7, in which the power tool comprises a source of electric power, a speed selector operable by a user of the power tool and operative to take electric power from the source and output an electric signal indicative of a speed at which the user desires to operate the power tool, the output of the speed selector being coupled to the input of the power control element.

9. A method of operating a power tool comprising a working element, a motor arranged to drive the working element and a control element via which a user indicates a desired speed, the method comprising sensing at least one factor indicative of the efficiency with which the power tool is being operated, the power tool varying the speed at which the motor drives the working element from the desired speed should the factor indicate that the power tool is being operated in a sub-optimal manner, thereby providing feedback to the user through the speed at which the working element is being driven.

10. The method of claim 9, in which the step of varying the speed comprises reducing the speed at which the motor drives the working element.

11. The method of claim 9, in which the at least one factor comprises the pressure which the user applies the working element to a subject to be worked, the load on the working element as it works the subject to be worked or the speed at which the motor or the working element is working; the temperature of a battery of the tool; the temperature of the motor; the current drawn by the motor, the integral of the current drawn by the motor, or the power consumed by the motor.

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