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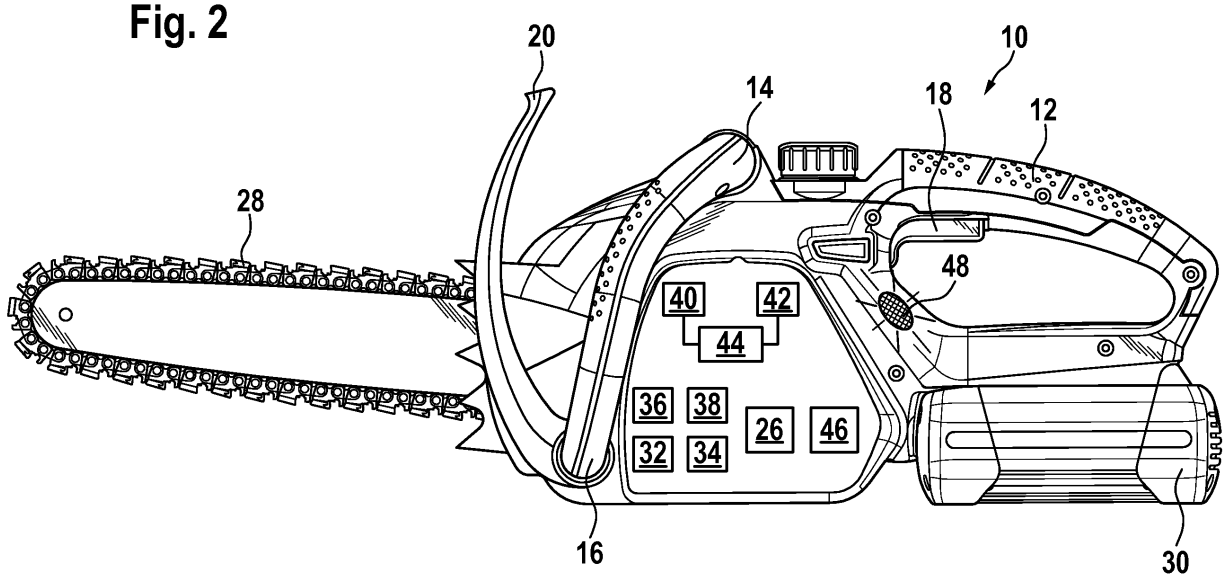
(54) Power tool and method for providing user feedback

(57) A power tool (10) having a user feedback system having a trigger (18) for activating the tool and a safety element (20) that is inactive in a first position and which is operable to stop the tool from functioning in a second position, wherein a user feedback signal (46,50) is provided when the trigger (18) is activated and the safety element (20) is in the second position.

Fig. 2



EP 2 286 970 A1

Description

PRIOR ART

[0001] The present invention relates to a system for providing feedback to a user of a power tool.

[0002] In particular it relates to a power tool having means for indicating to the user that a safety element is positioned so that the power tool is not operational and a method for communicating this information to the user.

[0003] US Patent No. 3,991,469 discloses a chain saw having a safety braking means comprising a swinging sensing arm that is positioned adjacent the user gripping handle specifically so that it will be engaged automatically under conditions of kickback. A flexible brake band has one end anchored to the tool housing and the other coupled with the swinging sensing arm, so that swinging of the safety arm brings the brake band into frictional braking relationship with the chain rotation means, thereby quickly stopping the chain. Once the brake means are engaged, biasing means retain the swinging arm in a forward "braking" position. This uncomplicated braking arrangement has been utilized for decades by numerous chain saw manufacturers, the feature commonly referred to as a "chain brake lever" or "kickback guard". While the operational manual often explains that the chain brake lever must be returned to its original position for the tool to resume operation, the operational manual may be discarded or otherwise not regarded, such that the user may become frustrated or confused and come to believe that the tool has malfunctioned. This is especially the case for electric-corded or battery-operated chainsaws as it can appear that the chain saw is completely inoperable. As a result, work plans may be disrupted and time may be wasted in unnecessarily bringing the tool to a repairman or returning the tool to the manufacturer or place of purchase.

ADVANTAGES OF THE INVENTION

[0004] A power tool having a user feedback system is described which may be, for example, a chain saw. The power tool has a trigger for activating the tool and a safety element that is inactive in a first position and which is operable to stop the tool from functioning in a second position. The power tool overcomes the problems with the prior art by providing a user feedback signal when the trigger is activated and the safety element is in the second position. In this advantageous arrangement, the user is less likely to believe that the tool has malfunctioned.

[0005] The user feedback signal may be selected from a set including many different sensory modalities, including an audible signal, a visual signal, or a tactile signal. The tool takes advantage of the fact that users are able to respond to a variety of different senses. The user feedback signal may alternatively be provided as a combination of at least two sensory modalities. This has the advantage of providing feedback even to users may be less sensitive to audible, visual, or tactile stimuli. It is also clear that the more modalities are provided, the more salient the feedback signal will be to the user and quite possibly the more likely it will be understood.

[0006] If the feedback signal does not communicate what corrective actions are necessary, the feedback signal may create even more confusion for the user. Therefore it is advantageous if the user feedback signal provides descriptive information regarding actions that will restore tool functionality. In the case of a tactile feedback signal, this is not possible with the exception of a Morse code-type coding scheme that would not be interpretable by most users. Tactile feedback is therefore preferably not provided alone, but instead in combination with other sensory feedback, wherein the tactile feedback alerts the user and the other user feedback may provide descriptive information.

[0007] One way to make the signal more salient to the user is for the user feedback signal to increase in intensity for at least a period of time after being activated. Therefore a user with hearing loss, impaired vision or deficits in tactile sensation due to wearing gloves, for example, has a greater chance of receiving and responding to the user feedback signal.

[0008] In one described alternative, the user feedback signal is presented for a fixed period of time if the trigger remains activated and the safety element remains in the second position. This will preserve battery life for example, if there is no response to the user feedback signal, or if, for example, the trigger becomes activated during storage while the tool is inoperable. If the user is not attempting to operate the tool, he will be less likely to notice the user feedback signal, so it would be advantageous to terminate the signal after a period of time.

[0009] Greater efficiency for the power tool is achieved if it utilizes an electronically-commutated motor and is powered via a lithium ion-based battery pack. These features typically necessitate additional monitoring or control electronics. Ideally a microcontroller is provided within the power tool for determining whether to provide the user feedback signal. There are cost and design advantages if the same microcontroller that controls the user feedback system can also be used to monitor the operational state of a battery pack and/or control the timing of an electrically commutated motor.

[0010] Such a user feedback signal is most useful if the safety element is not provided with independent means for returning to the first position and therefore requires a distinct action from the user to return it from the second position to the first position, for example so as to overcome a defined operating load or bias..

[0011] The user feedback system is useful for safety elements that activate mechanical means, electrical means, or a combination of the two for stopping the tool from functioning. Any of these means may give the user the impression that the tool has malfunctioned and therefore it would be advantageous to provide a user feedback

signal as described herein.

[0012] The user feedback system is particularly well-suited for incorporation into a chain saw which has a cutting chain and a motor for driving the cutting chain. A chain saw is often configured with one or more safety elements for stopping the motor from driving the cutting chain.

[0013] A method for providing feedback to the user of a power tool is described, wherein the activity state of a trigger for activating the tool is determined, the position of a safety element that is inactive in a first position and is operable to stop the tool from functioning in a second position is determined, and a user feedback signal is provided only if the trigger is active and the safety element is in the second position. This method overcomes the problems with the prior art by providing direct user feedback signal rather than relying on information that is printed in an operation manual that may not be in the vicinity of the tool. This method is not complicated to implement and when utilized has the advantage that the user will be less likely to believe that the tool has malfunctioned.

DRAWINGS

[0014]

Figure 1 is a left side view of a chain saw in a first position.

Figure 2 is a left side view of a chain saw in a second position with the housing broken away to illustrate certain components of the saw schematically.

Figure 3 is a perspective view of a chain saw wherein the rear handle is shown broken away to illustrate certain components of the saw schematically.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] A power tool 10, in particular a hand-held chain saw, is provided with multiple user gripping surfaces including a rear handle 12 as well as a front handle 14 which is contiguous with a side handle 16 as shown in Fig. 1. A trigger 18 for activating tool 10 is integrated into rear handle 12 and a chain brake lever 20 is positioned immediately forward of front handle 14. When tool 10 is at rest and the safety system is engaged, chain brake lever 20 is in a first position shown in Fig. 1. When tool 10 is being operated, a user gripping front handle 14 will be likely to pivot chain brake lever 20 in direction 22 in the event of kickback condition so that lever 20 takes on the second position shown in Fig. 2.

[0016] Within tool housing 24 is a motor 26, which is preferably an electronically commutated brushless motor, for driving the rotation of cutting chain 28. Power is provided to motor 26 by a removable lithium ion-based battery pack 30, but power might alternatively be provided via an electrical cord for providing AC power or by a combustion engine powered by gasoline or other fuels.

[0017] Key components of an exemplary safety system are found within tool housing 24. Chain brake lever 20 is coupled via coupling means 32 to braking means 34 for rapidly halting the rotary drive, such that cutting chain 28 is stopped from rotating during, for example, conditions of kickback. Chain brake lever 20 is held in the first position by reversible latching means 36 which unlatch when a force acts on chain brake lever 20 generally in direction 22. Once the latch means are overcome, biasing means 38 accelerate the movement of chain brake lever 20 into the second position, this action activating braking means 34. By manually returning chain brake lever 20 to the first position, latching means 36 are restored and biasing means 38 are preloaded so that the safety system is reset. Coupling means 32, braking means 34, latching means 36, and biasing means 38 are shown schematically in Fig. 2 and are not described in detail since several alternatives for achieving this function are well-known by those skilled in the art. For example, one set of means including a flexible brake band, a latch lever, and a spring is disclosed in EP 1 066 933 A1. The user feedback system described herein will be applicable to any safety system requiring a distinct action from the user to return a safety element to an operative position, for example to overcome a defined operating load or bias. In other configurations, chain brake lever 20 may be retained in its second position without ongoing bias from biasing means. There may be, for example, altemative braking means, such as the wrap-sprung clutch arrangement associated with actuation of the chain brake lever in EP 1 749 626 A1.

[0018] Tool 10 is provided with electronics for ascertaining certain aspects of its functional state. Micro switches 40 and 42 are coupled with chain brake lever 20 and trigger 18, respectively. These switches are connected to a microcontroller 44 which assesses the status of each micro switch. The same microcontroller 44 can preferably also be used for controlling the timing of electronically commutated motor 26 and/or still more additional functions such as monitoring the voltage or temperature state of battery pack 30.

[0019] When microcontroller 44 determines that chain brake lever 20 is in the second position and trigger 18 is depressed (the position shown in Fig. 2), it sends a signal to one or more output devices for providing user feedback. The output device may be an audio device 46 as in Fig. 2. Audio device 46 incorporates a speaker 48 and may provide user feedback with an alarm signal, such as a tone or buzzer, which may be repeated or provided consistently. Alternatively audio device 46 may be comparable to a conventional MP3-player and further include sufficient memory to store an audio message data file which when played by audio device 46 informs the user that chain brake lever 20 needs to be returned to the first position in order to further operate tool 10. Preferably audio device 46 is configured to simply repeat the audible signal as long as microcontroller 44 determines that the

operational states of chain brake lever 20 and trigger 18 have not changed.

[0020] Alternatively audio device 46 could be configured to increase the intensity of the audio signal or message over a defined period of time until it reaches a maximum volume. In other configurations, audio device 46 could be configured to play the audio signal or message only a certain number of times or for a fixed period of time before ceasing to provide further signals or messages even when microcontroller 44 has determined that there is no change in the operational states of chain brake lever 20 and trigger 18.

[0021] Two additional categories of output devices are illustrated in Fig. 3. Each of the output devices described herein can work in isolation or in combination with one, two or more additional output devices. The first category uses the visual modality to provide feedback to the user. For example, display device 50 could be simply a plastic panel that is lit by a light source under the prescribed conditions. It could be a simple device such as a monochrome numerical-type LCD display typical of a digital watch. It could be a relatively complicated device such as a color LCD display capable of displaying motion video. The user feedback message could be simply a text message informing the user that chain brake lever 20 needs to be returned to the first position in order to further operate tool 10. More preferably it could be a combination of text and visual messages depicting chain brake lever 20 along with indications of how it should be returned to its first position in order to operate tool 10.

[0022] In a manner comparable to audio device 46, display device 50 can alternatively be configured to present these visual messages in a manner that increases in intensity over a defined period of time, for example by increasing the brightness of the device. Alternatively the display device could cause the signal to flash on and off in order to better grab the attention of the user. In other configurations, display device 50 could be configured to display the visual message only for a predetermined period of time even when microcontroller 44 has determined that there is no change in the operational states of chain brake lever 20 and trigger 18.

[0023] Speaker 48 or display device 50 might be positioned anywhere on the tool although they are preferably positioned in a direction facing the expected position of the user when the user is attempting to operate tool 10.

[0024] When a user is operating tool 10, it is expected that the user is in contact with handles 12 and 14. Therefore either of these would be possible positions for providing tactile feedback to the user. A tactile output device 52 is schematically shown positioned within handle 12 in Fig. 3. It may be for example a vibrating element such as the type used in a conventional video game controller with "force feedback". Under the conditions previously described, tactile output device 52 can be configured to provide a consistent tactile stimulus or one that is increasing in intensity for a period of time. It may also be configured to provide the tactile stimulus only for a defined period of time even when microcontroller 44 has determined that there is no change in the operational states of chain brake lever 20 and trigger 18.

[0025] A tool 10 provided with the features described herein can be the basis for implementing a method for providing feedback to the user of a power tool. First, the position of trigger 18 is determined via input from micro switch 42 to microcontroller 44 and the position of chain brake lever 20 is comparably determined via micro switch 40. Then a user feedback signal is provided by one or more of audio device 44, display device 50, and tactile device 52 if trigger 18 is depressed and chain brake lever 20 is in the second position.

[0026] Although the device and methods described herein applied in the illustrated examples to a chain saw, they may be also applied to any sorts of power tool, including drills, saws or grinders, whether hand-held or not, that incorporate a safety system that renders the power tool non-operational without certain actions taken by the user. For example, benchtop tools such a table saw may be provided with a safety system for rapidly applying brakes or retracting a saw blade to avoid injury. Brakes comprise just one example of a safety system. The invention is useful for any sort of power tool that, for example, cuts off power to the motor as part of a safety system.

Claims

1. A power tool having a user feedback system comprising:

   a trigger (18) for activating the tool; and
   a safety element (20) that is inactive in a first position and which is operable to stop the tool from functioning in a second position;
   characterized in that a user feedback signal is provided when the trigger (18) is activated and the safety element (20) is in the second position.

2. A power tool according to claim 1, **characterized in that** the user feedback signal is an audible signal.

3. A power tool according to any one of the preceding claims, **characterized in that** the user feedback signal is a visual signal.

4. A power tool according to any one of the preceding claims, **characterized in that** the user feedback signal is a combination of at least two signals selected from the group comprising an audible signal, a visual signal, and a tactile signal.

5. A power tool according to any one of the preceding claims, **characterized in that** the user feedback signal provides descriptive information regarding actions that will restore tool functionality.

6. A power tool according to any one of the preceding claims, **characterized in that** the user feedback signal increases in intensity for at least a period of time after being activated.

7. A power tool according to any one of the preceding claims, **characterized in that** the user feedback signal is presented for a fixed period of time if the trigger (18) remains activated and the safety element (20) remains in the second position.

8. A power tool according to any one of the preceding claims, **characterized in that** the power tool further comprises an electronically commutated motor (26).

9. A power tool according to any one of the preceding claims, **characterized in that** the power tool further comprises a lithium ion-based battery pack (30).

10. A power tool according to claim 1, **characterized in that** the power tool further comprises a microcontroller (44) for determining whether to provide a user feedback signal.

11. A power tool according to claim 10, **characterized in that** said microcontroller (44) also monitors the operational state of a battery pack (30) or controls the timing of an electronically commutated motor (26).

12. A power tool according to any one of the preceding claims, **characterized in that** a load or bias must be overcome to move the safety element (20) from the second position to the first position.

13. A power tool according to any one of the preceding claims, **characterized in that** the power tool further comprises a cutting chain (28) and a motor (26) for driving the cutting chain (28), wherein the safety element (20) in the second position stops the motor (26) from driving the cutting chain (28).

14. A method for providing feedback to the user of a power tool comprising the following steps:

first, determining the activity state of a trigger (18) for activating the tool; and
determining the position of a safety element (20) that is inactive in a first position and is operable to stop the tool from functioning in a second position; then
second, providing a user feedback signal only if the trigger (18) is active and the safety element (20) is in the second position.

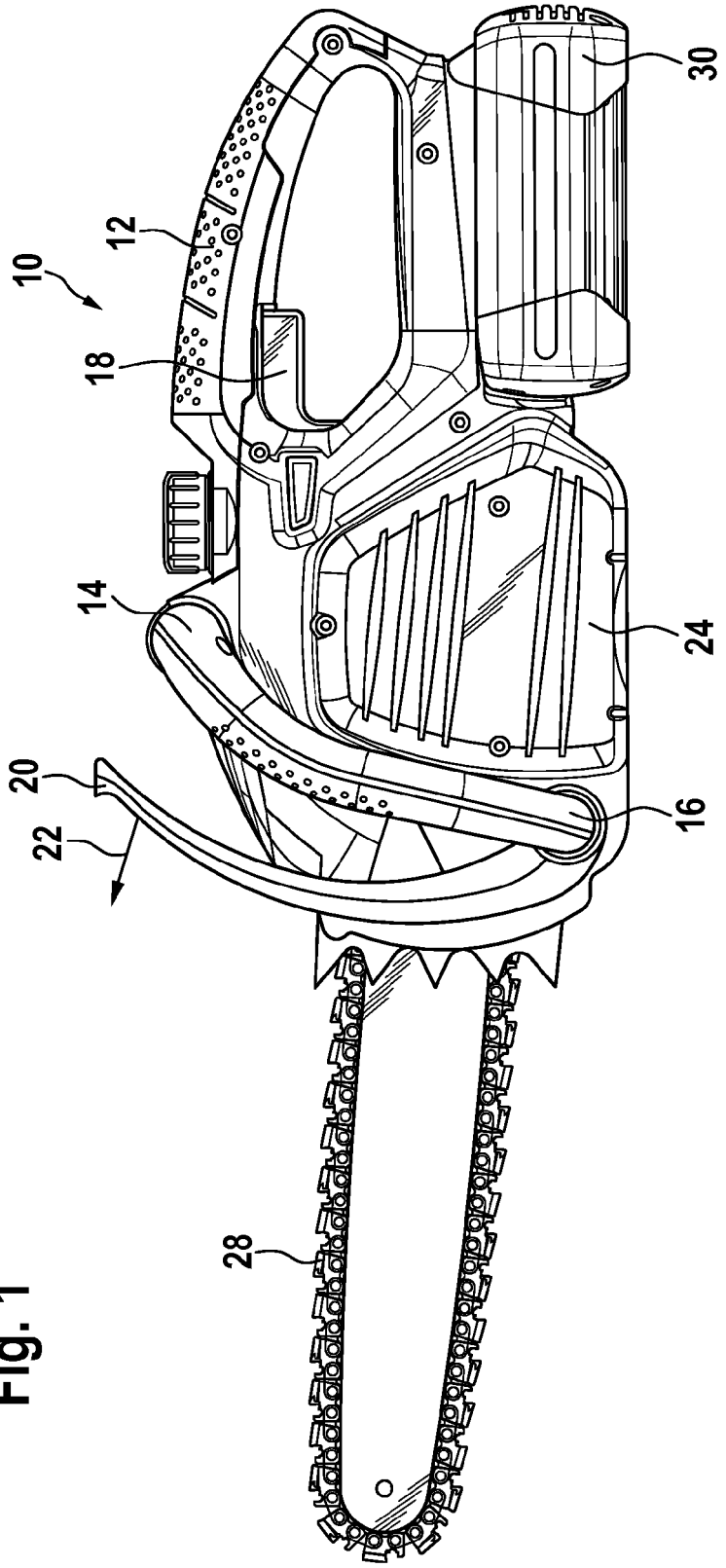


Fig. 1

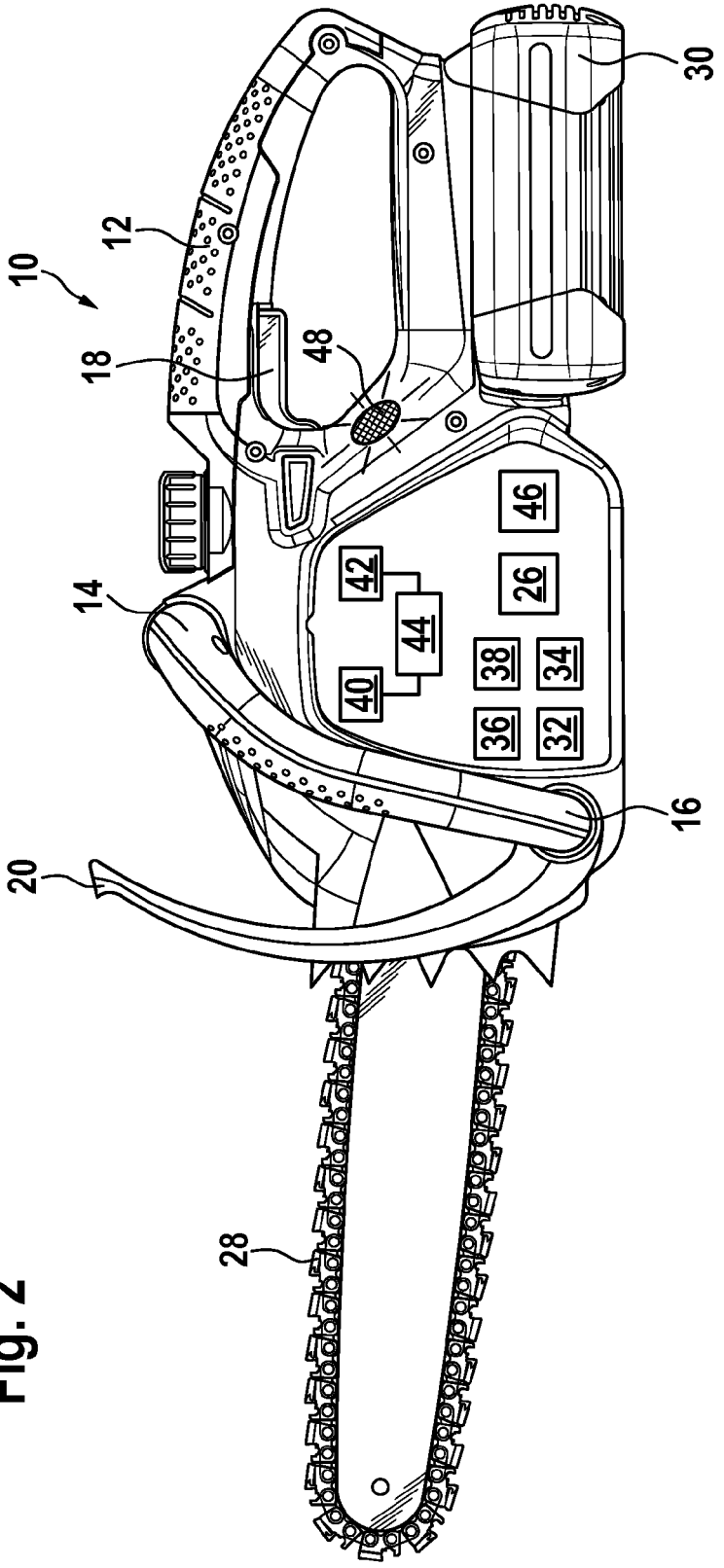


Fig. 2

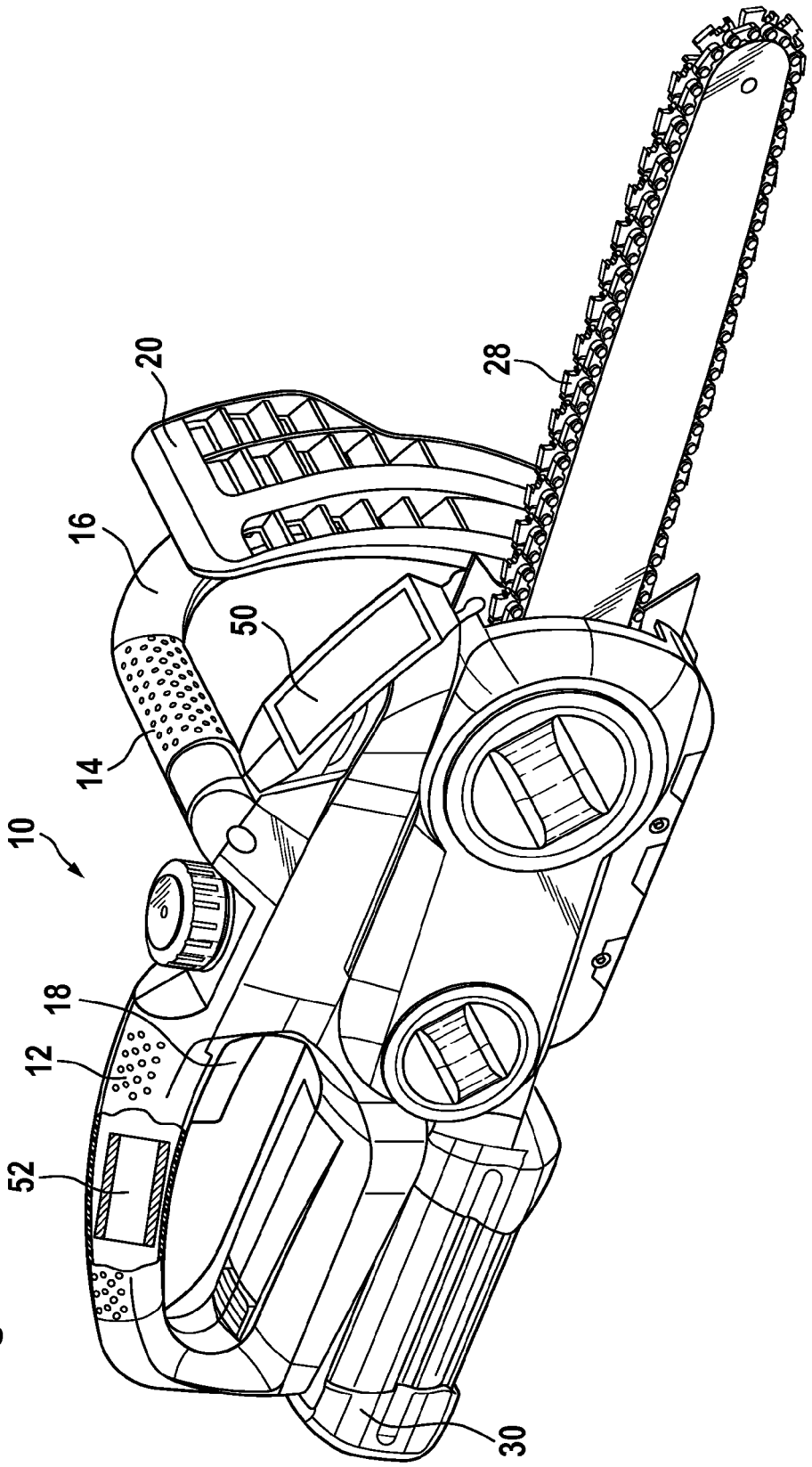


Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 09 16 8086

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
The Hague	3 May 2010	Huggins, Jonathan

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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EPO FORM 1503 03.82 (P04C01)

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EUROPEAN SEARCH REPORT

Application Number
EP 09 16 8086

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
The Hague	3 May 2010	Huggins, Jonathan

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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Application Number
EP 09 16 8086

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☒ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

1-6, 10-14

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 09 16 8086

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-5, 10-12, 14

   A power tool having a user feedback system where the user feedback is an audible signal.

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2. claim: 6

   A power tool having a user feedback system where the user feedback signal increases in intensity for at least a period of time after being activated

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3. claim: 7

   A power tool having a user feedback system where the user feedback signal is presented for a fixed period of time if the trigger (18) remains activated and the safety element (20) remains in the second position.

   ---

4. claim: 8

   A power tool having a user feedback system where the power tool further comprises an electronically commutated motor

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5. claim: 9

   A power tool having a user feedback system where the power tool further comprises a lithium ion-based battery pack

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6. claim: 13

   A power tool having a user feedback system where the power tool further comprises a cutting chain and a motor for driving the cutting chain, wherein the safety element in the second position stops the motor from driving the cutting chain

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 16 8086

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REFERENCES CITED IN THE DESCRIPTION

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