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(54) Title: CUTTING TOOL

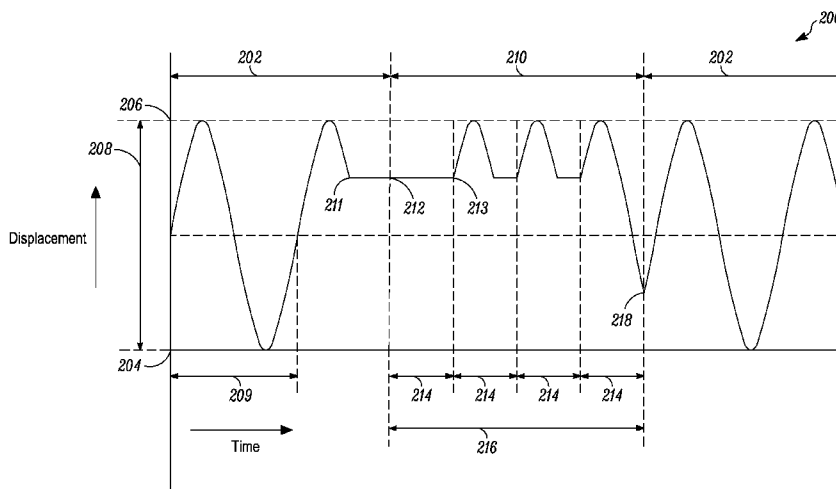


FIG. 2

(57) Abstract: The present invention discloses a cutting tool (100). The cutting tool (100) includes at least one cutting blade (106, 107) which is adapted to perform an oscillating movement. The cutting tool (100) also includes a prime mover (104, 302) to drive the at least one cutting blade (106, 107) such that an output direction of the prime mover (104, 302) is selectively reversible. Further, the output direction of the prime mover (104, 302) is periodically switched with a predetermined time period (214).

Title: Cutting tool

#### TECHNICAL FIELD

The present invention relates to a cutting tool. More particularly, it relates to a cutting tool with at least one oscillating cutting blade.

#### 5 BACKGROUND

Typically, a cutting tool like a hedge trimmer includes a motor, a pair of cutting blades, and a gearbox assembly. The cutting blades of the hedge trimmer are placed adjacent to each other in a superimposed relationship, such that the cutting blades are arranged to reciprocate relative to each other  
10 along a longitudinal axis. Each of the cutting blades has multiple cutting teeth which are aligned orthogonal to the longitudinal axis. In some cases, both the cutting blades may be driven by a motor. Alternatively, one of the cutting blades may be driven whereas the other blade may be stationary. The motor of the hedge trimmer is connected to a battery or another power supplying means to operate the cutting blades.  
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During operation, hedge trimmers may encounter a thick or hard branch which gets stuck between two cutting teeth. The operator may try to pull the branch trapped between two cutting teeth. This poses a safety concern as  
20 the operator puts his finger near the cutting blades. It is thus advisable to switch off the power to the cutting blades to remove the pressure of the moving blade on the branch before attempting to remove the stuck branch. Repeated encounters of a thick branch might force the operator to frequently turn the hedge trimmer off. This makes operating the hedge trimmer inconvenient.  
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Solutions to the above problem have been proposed by reversing the direction of the rotation of the motor, whenever the hedge trimmer is stuck.

Methods in the art use sensors and other necessary hardware to affect the change in the direction of the motor. This may increase the cost of the hedge trimmer. Also such systems may be complicated and make the hedge trimmer bulky.

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Therefore there is a need for a system that overcomes the aforementioned problems. An inexpensive and simplified system that enables convenient removal of branches stuck between the cutting teeth of a hedge trimmer is desired.

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#### SUMMARY

In view of the above, it is an objective to solve or at least reduce the problems discussed above. In particular, an objective is to provide an inexpensive and simplified system for reversing an output direction of a cutting tool.

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The objective is achieved with a novel cutting tool according to claim 1. The cutting tool includes at least one cutting blade which is adapted to perform an oscillating movement. The cutting tool also includes a prime mover to drive the at least one cutting blade such that an output direction of the prime mover is selectively reversible. Further, the output direction of the prime mover is periodically switched with a predetermined time period. Thus, a direction of oscillation of the cutting blade periodically changes. This may result in a continuous chopping action on an external body stuck between the cutting teeth and sever the body within a one or more predetermined time periods. Moreover, according to another aspect of the invention, the cutting blade moves at least a minimum distance within the predetermined time period. Thus, a gap between cutting teeth of the blades is maximum at least once within the predetermined time period. This enables a user to safely remove the body stuck between the cutting teeth if the body is not severed.

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According to another embodiment, the output direction of the prime mover is periodically switched during a switching mode. Further, preferably, a minimum time interval is provided between two consecutive switching modes.

- 5 According to another embodiment, the cutting tool includes an actuator, the actuator being configured to initiate the switching mode. Further, preferably, the switching mode initiates and continues for a first duration once the actuator is pressed. Alternatively, preferably, the switching mode initiates and continues when the actuator is kept pressed. Moreover, in another embodi-
- 10 ment, the switching mode terminates after a second duration. Additionally, according to another aspect, the first duration and the second duration are integral multiples of the predetermined time period. Thus, the present invention does not require sensors, or any other electronic equipment to sense a blockage and effect a reversal in the output direction. On the other hand,
- 15 user reverses the output direction whenever there is a blockage. Thus, this may simplify the construction and reduce the cost of the cutting tool.

- According to another embodiment, the switching mode is terminated if a current in the prime mover exceeds an upper limit. This safeguards various
- 20 components of the prime mover against damage. Further, according to another embodiment, the switching mode is terminated if the current in the prime mover is below a lower limit during the predetermined time period. If the current is below the lower limit, it indicates that any blockage if present has been removed, and the cutting blade can function normally. Alternatively,
- 25 according to another embodiment, the switching mode is terminated if a load in the prime mover exceeds an upper limit. Further, according to another embodiment, the switching mode is terminated if the load in the prime mover is below a lower limit during the predetermined time period.

- 30 According to another embodiment, the prime mover includes a gear system, the gear system being adapted to periodically switch the output direction of the prime mover. Further, according to another embodiment, the prime

mover includes an electric motor. Alternatively, according to another embodiment, the prime mover includes two electric motors, and freewheeling clutches are provided between the electric motors and the cutting blade such that each electric motor drives the cutting blade in a single direction. Further,  
5 according to another embodiment, each electric motor alternately drives the cutting blade during the predetermined time periods.

Preferably, the cutting tool is one of a hedge trimmer or a shrub shear.

10 Claim 9 discloses a method of operating a cutting tool. The cutting tool includes at least one cutting blade adapted to perform an oscillating movement. Further, a prime mover is provided to drive the at least one cutting blade, an output direction of the prime mover being selectively reversible. Moreover, the output direction of the prime mover is periodically switched or reversed  
15 with a predetermined time period (or switching or reversing period).

In a preferred embodiment of the method according to the invention a monitoring step is performed wherein the electrical current of or for the prime mover is monitored (or: measured, detected) during a defined monitoring  
20 time interval of or within the time period, wherein the monitored (or: measured, detected) current is compared with a predetermined threshold value (or: threshold current or level) and, when the monitored current is below the threshold value, the switching or reversing of the output direction of the  
25 prime mover is deferred or interrupted and/or the output direction of the prime mover is maintained or kept unchanged in a so called normal operation mode or one-directional mode.

By means of the threshold value a state without clamping or jamming of the blades can be detected or recognized, since it can be assumed that no such  
30 jamming has occurred if the current drops below the threshold value. The threshold value is preferably chosen from an interval between 10 % and 50 %, preferably 10 % to 33 %, of the maximum current or initial current

peak which is reached immediately after a switching or reversing action of the output direction of the prime mover.

The defined measuring time interval is at least the last quarter, preferably at least the last third, of the time period of the switching or reversing or of the time interval between two potential switching or reversing actions of the output direction of the prime mover. Alternatively or in addition the defined measuring time interval corresponds to the difference between said time period or said time interval and a given waiting time interval, in particular 0.2 s. That way an initial peak of the current resulting from the load right after the reversing or switching will normally not be in the monitoring interval and, thus, not be detected. The monitoring time interval is in particular chosen from an interval between 0.05 s to 1 s, in particular between 0.2 s and 0.5 s.

In an alternative embodiment the monitoring step is performed by detecting the rotation of the motor and/or the movement of the prime mover or an oscillating blade. In this case the detection reveals that there is no interruption of the rotation of the motor or in the movement of the oscillating blade during the monitoring interval one can conclude that there is no jamming or blockage of the blades.

Preferably the monitoring takes place during a time interval (monitoring interval) immediately preceding the end of the predetermined time period (214) in which the output direction of the prime mover is periodically switched during a switching mode (210).

The method can comprise the following further steps:

- checking as a first condition whether a trigger switch is turned on and, if so, starting the prime mover reversing mode, i.e. periodically switching or reversing the output direction of the prime mover with the predetermined time period, in particular in the same direction the mover was stopped the last time,

- checking as a second condition whether a given maximum time limit for the reversing or switching mode, for instance 5 s, or a respective number of cycles, e.g. 15, is reached and if so stopping the prime mover is stopped and if not so, performing said monitoring step,
- 5 - checking again the second condition if in the monitoring step the current does not go below the threshold value or if there is the detection of a non-rotation of the motor and/or a non-movement of the prime mover or an oscillating blade,
- checking as a further condition whether the trigger switch is turned off  
10 and if so the prime mover is stopped and it is returned to the first condition and if not so normal operation mode is maintained, i.e. the prime mover is driven in the one direction.

Accordingly, by this method of operation a periodically switching of the direction of the prime mover is adjourned in the case that the operation current of  
15 the mover stays below a defined threshold, this being an indication that no hard branch or the like got stuck between two cutting teeth. Thus, a switch of the direction of the prime mover is not necessary and is intermitted.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will in the following be described in more detail with reference to the enclosed drawings, wherein:

- FIG. 1 illustrates a schematic view of a cutting tool, according to an  
25 embodiment of the present invention;
- FIG. 2 illustrates a plot of displacement of a cutting blade against time, according to an embodiment of the present invention;
- FIG. 3 illustrates a schematic view of the cutting tool, according to an alternative embodiment of the present invention;
- 30 FIG. 4 illustrates a plot of displacement of the cutting blade against time, according to another embodiment of the present invention;

FIG. 5 exemplary diagrams showing the change in current as drawn by the motor in normal mode and under blockage;

FIG. 6 shows a flowchart of a preferred mode of operation.

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#### DESCRIPTION OF EMBODIMENTS

The present invention will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, like numbers refer to like references.

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FIG. 1 shows a schematic view of a cutting tool 100, according to an embodiment of the present invention. The cutting tool 100 may be, for example, but not limited to, a hedge trimmer, a shrub shear, or the like. In addition, any suitable size, shape, or type of elements or materials could be used. As illustrated in FIG. 1, the cutting tool 100 includes a cutting unit 102 and a prime mover 104. The prime mover 104 may be housed inside a body, while the cutting unit 102 may be connected to a front portion of the body. The cutting tool 100 may include one or more handles to permit a user to grasp the cutting tool 100 during operation. Further, the cutting tool 100 may include a manually actuated trigger to activate or deactivate the prime mover 104.

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As illustrated in FIG. 1, the cutting unit 102 includes a cutting blade 106 (hereinafter referred to as "the blade 106") adapted to perform an oscillating movement and driven by the prime mover 104. The oscillating movement may be a linear oscillating movement or an angular oscillating movement about an axis. The blade 106 may have multiple cutting teeth which extend substan-

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tially perpendicular relative to a direction of linear oscillation of the blade 106. Alternatively, in case of angular oscillation, the cutting teeth may extend in a plane which is substantially perpendicular relative to the axis of oscillation. In addition to the blade 106, another blade 107 may be provided.

5 The blade 107 also includes multiple cutting teeth and disposed in a superimposed relationship with the blade 106. In an embodiment of the present invention, the blade 107 is stationary. In an alternative embodiment of the present invention, the blade 107 also oscillates with the blade 106. Cutting is performed by shearing action between the cutting teeth of the blades 106

10 and 107.

As illustrated in FIG. 1, the prime mover 104 includes an electric motor 108 (hereinafter referred to as "the motor 108"). The motor 108 may be an AC or DC motor within the scope of the present invention. The motor 108 may be

15 driven by a battery or directly from an external power source. In another embodiment of the present invention, the prime mover 104 may include two motors (explained in detail in conjunction with FIG. 3). Further, the motor 108 drives a transmission unit 110 which in turn imparts the oscillating movement to the blade 106. The transmission unit 110 may include any

20 combination of one or more gears, eccentric members, friction drive, belt-pulley drive, or the like within the scope of the present invention.

Moreover, as illustrated in FIG. 1, the transmission unit 110 includes a gear system 111 adapted to selectively switch an output direction of the prime

25 mover 104. However, the output direction of the prime mover 104 may be reversed by any other means, for example, an electronic circuit. The motor 108 may be a brushless DC motor whose direction is reversed by using a reversible drive circuit. Such a reversible drive circuit may be similar to the reversible drive circuit described in US Pat. 4,282,464 titled "Reversible drive

30 circuit for brushless DC motor", the disclosure of which is incorporated herein by reference. Alternatively, the motor 108 may be a brushed DC motor which may be reversed using a switch circuit, for example, the switch circuit de-

scribed in US Pat. 5,877,573 titled "D.C. motor and reversing circuit", the disclosure of which is incorporated herein by reference.

As illustrated in FIG. 1, an actuator 112 is provided to initiate a switching mode (explained in detail in conjunction with FIG. 2) of the cutting tool 100. The actuator 112 may be a manually actuated switch provided on the body of the cutting tool 100 for easy accessibility. Further, the switch may be provided in a recessed area to prevent accidental actuation. In an embodiment of the present invention, the actuator 112 may also act as a trigger for activation and deactivation of the prime mover 104. Further, the actuator 112 may be a toggle switch movable between three positions. The first position corresponds to an off state of the toggle switch. In the second position, the toggle switch may activate the prime mover 104 while in the third position the toggle switch may initiate the switching mode. In another embodiment of the present invention, the actuator 112 may be a push button switch that can be pressed into two different positions from an off position. The two positions may correspond to the activation of the prime mover 104 and the initiation of the switching mode respectively. Further, in an alternative embodiment of the present invention, a trigger for activating and deactivating the prime mover 104 may be separate from the actuator 112.

FIG. 2 shows a plot 200 illustrating displacement of the blade 106 against time, according to an embodiment of the present invention. The variation of displacement with time of the blade 106 is shown to be substantially sinusoidal in nature purely for exemplary purposes, and the displacement may vary in any other manner with time within the scope of the present invention. Further, during a normal operational mode 202 of the cutting tool 100, the blade 106 is shown to oscillate between extreme positions 204 and 206. The extreme position 204 is assigned a zero value. A distance 208 between the extreme positions 204 and 206 is the range of oscillation of the blade 106. A gap between the cutting teeth of the blades 106 and 107 is also maximum at the extreme positions 204 and 206. Further, during normal operational mode

202 of the cutting tool 100, the blade 106 oscillates with a normal time period 209. In an embodiment of the present invention, the output direction of the prime mover 104 is always in a specific direction in the normal operational mode 202. For example, in case the motor 108 is a brushed DC motor, the specific direction may be same as a normal direction of rotation of the motor 108.

During operation, the blades 106 and 107 may become jammed when any large body (E.g., a branch) gets stuck between the cutting teeth of the blades 106 and 107. As shown in FIG. 2, the blades 106 and 107 get jammed at point 211. In such a case, the user may move the actuator 112 to initiate a switching mode 210 of the cutting tool 100. On initiation of the switching mode 210 at point 212, the output direction of the prime mover 104 does not change for a predetermined time period 214, and the blades 106 and 107 remain jammed. After the time period 214 is over, the gear system 111 reverses the output direction of the prime mover 104 at point 213. Consequently, the direction of oscillation changes at the point 213. Thus, as illustrated in FIG. 2, the direction of oscillation is periodically changed with the time period 214 during the switching mode 210. As illustrated in FIG. 2, there is both oscillating movement and blockage of the blades 106 and 107 during consecutive time periods 214 after the point 213. This occurs because the blade 106 oscillates in a different direction of oscillation until the blade 106 reaches the blockage position during a cycle. This continues until the blockage is removed due to the blocking body being severed by continuous chopping action of the blades 106 and 107. For example, as shown in FIG. 2, the blockage is removed after the blades 106 and 107 are jammed twice during the switching mode 210 after the point 213. Alternatively, the user may remove the body. In an embodiment of the present invention, the output direction of the prime mover 104, after the termination of the switching mode 210, is same as the direction at the start of the switching mode 210. Therefore, the output direction of the prime mover 104 after point 218 is same as the output direction of the prime mover 104 before the point 213. In case the

motor 108 is a brushed DC motor, the output direction of the prime mover 104, before the point 213 and after the point 218, may be same as the normal direction of rotation of the motor 108.

5 In an embodiment of the present invention, the time period 214 is at least half of the normal time period 209 such that the blade 106 moves at least the distance 208 within the time period 214. As a result, the cutting blade 206 moves through one of the extreme positions 204 or 206 within the time period 214. Thus, a gap between the cutting teeth of the blades 106 and 107 is  
10 maximum at least once within the time period 214. This enables the user to safely remove the body stuck between the cutting teeth if the body is not severed by the continuous chopping action of the blades 106 and 106. In various embodiments of the present invention, the time period 214 may be any value greater than half the normal time period 209 and may be equal to  
15 the normal time period 209. Further, the reversal in the output direction also reduces impact forces on the blades 106 and 107, and prevents transmission of impact forces to various components of the cutting tool 100, such as, the motor 108 and the transmission unit 110. The present invention also does not require sensors, or any other electronic equipment to sense a blockage and  
20 effect a reversal in the output direction. On the other hand, user reverses the output direction whenever there is a blockage. Thus, this may simplify the construction and reduce the cost of the cutting tool 100.

In an embodiment of the present invention, the user may switch off the  
25 prime mover 104 on detecting a jamming of the blades 106 and 107. Subsequently, the prime mover 104 is switched on in the switching mode 210. The output direction of the prime mover 104 during the first cycle of the switching mode 210 may be same as the output direction which was prior to the deactivation of the prime mover 104. Alternatively, the output direction of  
30 the prime mover 104 may be opposite to the output direction which was prior to the deactivation of the prime mover 104. After the blockage is removed, the prime mover 104 may operate in the normal operational mode 202. Alter-

natively, the user may switch off the prime mover 104 and switch on the prime mover 104 in the normal operational mode 202.

In an embodiment of the present invention, the switching mode 210 automatically continues for a first duration 216 after the actuator 112 is moved to the switching mode position and released. Thus, the cutting tool 100 operates in the normal operational mode 202 after the point 218. The first duration 216 is a predetermined duration such that various components of the prime mover 104 do not get overheated due to frequent reversal in the direction of output. Further, the first duration 216 is also an integral multiple of the time period 214 so that the blade 106 completes an oscillation cycle of the switching mode 210 before reverting back to the normal operational mode 202.

In an alternative embodiment of the present invention, the switching mode 210 continues as long the actuator 112 is retained in the switching mode position. When the user releases the actuator 112 from the switching mode position, the blade 106 completes the current oscillation cycle of the switching mode 210 before reverting back to the normal operation mode 202. However, in case the user keeps the actuator 112 in the switching mode position beyond a second duration, the switching mode 210 is automatically terminated. The second duration of the switching mode 210 is also an integral multiple of the time period 214. In an embodiment of the present invention, the second duration is equal to the first duration 216. Further, in another embodiment of the present invention, a minimum time interval is provided before another switching mode 210 can be initiated. The minimum time interval enables various components of the prime mover 104 to sufficiently cool down before another switching mode 210.

In an alternative embodiment of the present invention, a current limiter (not shown in the figures) may be provided to limit the current flowing in the motor 108. In case the current exceeds an upper limit, the switching mode 210

is terminated. Subsequently, the prime mover 104 may be switched off. In a further embodiment of the present invention, if the current is below a lower limit during any of the time periods 214, the switching mode 210 is terminated. If the current is below the lower limit, it indicates that the blockage is removed, and the blades 106 and 107 can function normally. In yet another embodiment of the present invention, a load limiter (not shown in the figures) may be provided to limit the load in the motor 108. In case the load exceeds an upper limit, the switching mode 210 is terminated. Moreover, if the load is below a lower limit during any of the time periods 214, the switching mode 210 is terminated.

In an embodiment of the present invention, the actuator 112 may be a conventional switch used for activating and deactivating the motor 108. In such case, the switching mode 210 is initiated on switching on the motor 108. Subsequently, the switching mode 210 is terminated if the current or load in the motor 108 is below a lower limit after a certain time period, preferably the time period 214, and the normal operational mode 202 is started.

In case, both the blades 106 and 107 oscillate, the oscillation of the blade 107 is displaced by about half of the normal time period 209 during the normal operational mode 202. During the switching mode 210, the oscillating direction of the blade 107 is also periodically reversed with a time period 214. Further, the oscillation of the blade 107 is also displaced by half of the time period 214.

FIG. 3 illustrates the cutting tool 100, according to another embodiment of the present invention. As illustrated in FIG. 3, the prime mover 302 includes two motors 304A and 304B, and corresponding freewheeling clutches 306A and 306B which form part of the transmission unit 308. Thus, each of the freewheeling clutches 306A and 306B is provided between the motors 304A and 304B respectively, such that each of the motors 304A and 304B drives the blade 106 in a single direction. During normal operational mode 202 of

the blade 106, any one of the motors 304A and 304B may drive the blade 106. In a case, the motor 304A drives the blade 106 during the operational mode 202. When the switching mode 210 is initiated, the driving of the blade 106 is switched to the motor 304B which moves the blade 106 in the opposite direction via the freewheeling clutch 306B. After the time period 214, the driving of the blade 106 is switched to the motor 304A. Thus, each of the motors 304A and 304B alternatively drives the blade 106 during the time periods 214.

FIG. 4 illustrates a plot 400 illustrating displacement of the blade 106 against time, according to another embodiment of the present invention. The plot 400 illustrates the cutting tool 100 which operates solely in the switching mode. The cutting tool 100 may be of a similar construction as the embodiment illustrated in FIG. 3. Thus, the output direction of the prime mover 302 changes after each time period 402. Further, as illustrated in FIG. 4, the blades 106 and 107 get jammed at point 404. After being blocked in that cycle, the blade 106 again oscillates as the output direction of the prime mover 302 changes in the next cycle. However, the blades 106 and 107 get jammed after reaching the blockage position during the cycle. Subsequently, the blockage is removed after the blades 106 and 107 are jammed thrice. In an embodiment of the present invention, the output direction of the prime mover 302 during the first cycle may be same as the output direction which was prior to the deactivation of the prime mover 302. Alternatively, the output direction of the prime mover 302 may be opposite to the output direction which was prior to the deactivation of the prime mover 302.

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A preferred method according to the invention is described in the following using the flowchart according to FIG 5.

When looking at the electrical input current of the motor 108 over time there is a rise of the current at each point in time when a switch of the output direction of the prime mover 104, 302 takes place. The electrical current takes a maximum or initial peak immediately after a switch operation took place

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because the blades must be accelerated into the opposite direction. Then, if no jamming of the blades or other load occurs, the current drops significantly to a normal steady current until another switch of the output direction takes place (as sketched for example with Figure 5a)). The starting time for the starting current rising to the initial peak and dropping again to a normal current takes a typical value, e.g. about 0.2 s, so after this starting time one can assume that the current is at its normal value and outside of its initial maximum caused by the power needed for acceleration, again assuming free blades (no load) or normal cutting situation without any jamming or blockage of the blades. However, when a jamming or blocking of the blades or other load occurs, the current does hardly drop after its initial peak, but stays basically at the maximum level or slightly below the initial peak as the motor continues to take up maximum load since the mover tries to move the blades with full power (as sketched for example with Figure 5b)).

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The characteristics of the variations of the current over time as sketched with Figures 5 a) and b) is for exemplary purposes only and will obviously vary with the specific layout of the cutting tool dependent on the type of motor and/or gear box used or when using battery as an alternative to the use of the mains supply as the power source to drive the cutting tool.

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This observation is used as a starting point for the special method according to FIG 6.

25 The first condition to be checked is whether the trigger switch such as the actuator 112 is turned on. In a preferred embodiment the actuator 112 may also act as the trigger for activation and deactivation of the prime mover. If so ("YES") the drive of the motor is started in reversing mode, preferably in the same direction the motor stopped or was switched off the last time.

30 Therefore, in the present case, periodical switching takes place with a given frequency  $f$  or a given time period  $T$  wherein  $f = 1/T$ , for example  $f = 3\text{Hz}$

and  $T = 1/3$  s. That means that a switching operation, i.e. a change of the direction of the prime mover, takes place each 0.33 s.

Now it is checked in a second condition whether a given time limit of for instance 5 s or a respective number of cycles, e.g. 15 at a frequency of 3 Hz (3 cycles per s), is reached. If so ("YES") the drive of the motor is stopped since otherwise the reversing mode leads to an overload.

If not ("NO"), however, the monitoring step is performed.

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In case the current flow with the motor is monitored it is advantageous to wait for a given time interval sufficient for the start-up peak to vanish or cease, i.e. a waiting time interval starting after a switching operation, for instance a time interval of 0,2 s. In case the monitoring is based on another mechanical or electrical parameter of the cutting tool there might be no need to wait with the monitoring.

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In case of monitoring the current flow with the motor the rest of the time period following the start up peak, here  $0.13 \text{ s} = 0.33 \text{ s} - 0.2 \text{ s}$ , is used to monitoring a third condition that is whether the current has dropped or gone below a threshold value as a defined level of the current ("Is the current lower than a defined level"). Alternatively, instead of directly monitoring the current flow with the motor one could also monitor the current flow at another location within the electric or electronic control circuitry or determine in an analogous manner the load of the motor.

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Alternative or in addition to monitoring the current flow (or its above described alternatives) one could monitor the rotation of the motor and/or the movement of the prime mover or an oscillating blade. In this case the detection reveals that there is no interruption of the rotation of the motor or in the movement of the oscillating blade during the monitoring step one can conclude that there is no jamming or blockage of the blades.

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Preferably the monitoring takes place during a time interval (monitoring interval) immediately preceding the end of the predetermined time period (214) in which the output direction of the prime mover is periodically  
5 switched during a switching mode (210). In case the current drawn by the motor is monitored it is of advantage if this time interval does not overlap with the initial current peak that occurs when switching the prime mover into an alternate output direction (as described above).

10 As long as this third condition is not the case ("NO") the algorithm returns to the second condition.

If, however, if during the monitoring interval it is detected that the current goes below the threshold value or defined value of the current (third condition = "YES") or there is no non-rotation of the motor or no non-movement  
15 of the prime mover or oscillating blade it can be concluded that there is no jamming or blockage of the blades. Thus the drive of the motor is continued in the actual or present direction and is not reversed any more, i.e. driven in normal, one-directional operation. The reversing mode will thus be aborted.  
20 As mentioned above, it is of advantage if the monitoring step monitors a time interval immediately preceding the end of the time period (214) with which the prime mover (104, 302) is periodically switched.

The threshold current or value is preferably chosen to be approximately in  
25 the area between one half ( $1/2$ ) and one third ( $1/3$ ) of the maximum current or initial peak value of the current mentioned above and occurring immediately after a switching operation or can be in absolute terms about 15 A.

Other values in relative or absolute terms are of course also possible subject to specific embodiments.

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Therefore, if no clamping or jamming of the blades of the cutting tool 100 occurs within the monitoring time interval, e.g. 0.13 s, after the waiting time

interval, e.g. 0.2 s, the motor current should fall below the threshold value and no reversing switching operation occurs any more, i.e. the actual direction is maintained and, further on, a normal operation mode without reversing takes place or is performed.

5

If, on the other hand, a clamping or jamming of the blades occurs within the monitoring time interval, which is detected by the current not dropping below the threshold value in this monitoring time interval (or by detecting the non-rotation of the motor or the non-movement of the oscillation blade during the  
10 monitoring step), the reversing mode is continued until either the 5s or 15 cycles are completed or a drop of the current below the threshold value is detected within the monitoring time period of the next time period or cycle, i.e. the jamming or clamping was resolved or ceased.

15 As a fourth condition it is then checked whether the trigger switch is turned off (again). If "YES", the drive of the motor is stopped and it is returned to the first condition, i.e. checking whether the trigger switch is switched on. If "NO", normal operation in one direction is maintained.

20 It can be seen that a core of this concept is – as explained – to check if the current is lower than a threshold value or if there is no non-rotation of the motor or no non-movement of the prime mover or an oscillating blade during a monitoring time interval (which is usually a second part of a time period or cycle), and if so, to have the prime mover continue to run in the same direc-  
25 tion (normal operation).

It is obvious to the one skilled in the art that he can modify the above described method without departing from the core of this concept that the second condition (that is the check if a given time limit has lapsed which allows  
30 to reduce the risk of overload) is only optional and could be disregarded. In this case one obviously runs the risk of overloading the motor or the motor's control electronics.

In a preferred exemplary embodiment the actuator 112 that initiates the switching mode 210 is identical with the trigger that is activating and deactivating the movement of the prime mover if the cutting tool. This means that immediately after the activation of the cutting tool the tool will find itself in the switching or reversing mode 210. According to the aforementioned method the monitoring step would immediately after the start of the cutting tool detect whether or not there is a jamming or blockage of the blades. If so, the cutting tool would work in the switching or reversing mode trying to cease the jamming or blockage. If not, the cutting tool would automatically end the switching mode and change to normal operation. It is of advantage if in a non-blockage situation the detection during the monitoring step works that fast that the switching mode could automatically be ended already within the first predetermined time period after activation of the cutting tool. In this case the user would not even recognize the change from the switching mode into the normal working mode of the cutting tool.

In an embodiment of the present invention, the cutting tool 100 may include a single motor which always oscillates in the switching mode. A reversing mechanism may be provided to periodically change the output direction of the motor. Examples of such a reversing mechanism may include the one described in US Pat. 4,315,170 (the '170 patent) titled "Reversible electric motor", the disclosure of which is incorporated herein by reference. The reversing mechanism disclosed in the '170 patent reverses the direction of a DC motor. In a further embodiment of the present invention, a mechanical drive may be provided with a unidirectional motor for periodically changing the output direction. Such a mechanical drive may similar to the reversible drive described in US Pat. 4,708,291 titled "Oscillating Sprinkler", the disclosure of which is incorporated herein by reference.

30

In the drawings and specification, there have been disclosed preferred embodiments and examples of the invention and, although specific terms are

employed, they are used in a generic and descriptive sense only and not for the purpose of limitation, the scope of the invention being set forth in the following claims.

CLAIMS

1. A cutting tool (100) comprising:  
at least one cutting blade (106, 107), wherein the cutting blade (106,  
107) is adapted to perform an oscillating movement; and  
a prime mover (104, 302) to drive the at least one cutting blade (106,  
5 107), wherein an output direction of the prime mover (104, 302) is se-  
lectively reversible;  
characterized in that,  
the output direction of the prime mover (104, 302) is periodically  
switched with a predetermined time period (214).
- 10
2. A cutting tool (100) according to claim 1, wherein the cutting blade  
(106, 107) moves at least a minimum distance (208) within the prede-  
termined time period (214).
- 15
3. A cutting tool (100) according to claim 1, wherein the output direction  
of the prime mover (104, 302) is periodically switched during a switch-  
ing mode (210).
- 20
4. A cutting tool (100) according to claim 3, wherein a minimum time in-  
terval is provided between two consecutive switching modes (210)  
and/or wherein the cutting tool (100) comprises an actuator (112), the  
actuator (112) being configured to initiate the switching mode (210)  
wherein in particular the switching mode (210) initiates and continues  
for a first duration (216) once the actuator (112) is moved to a switch-  
25 ing mode position and/or wherein in particular the switching mode  
(210) initiates and continues when the actuator (112) is retained in a  
switching mode position and/or wherein the switching mode (210) ter-  
minates after a second duration.

5. A cutting tool (100) according to claim 4, wherein the first duration (216) and the second duration are integral multiples of the predetermined time period (214).
- 5 6. A cutting tool (100) according to claim 3, wherein the switching mode (210) is terminated if a current in the prime mover (104, 302) exceeds an upper limit or if a current in the prime mover (104, 302) is below a lower limit during the predetermined time period (214) or if a load in the prime mover (104, 302) exceeds an upper limit or if a load in the prime mover (104, 302) is below a lower limit during the predetermined time period (214).
- 10
7. A cutting tool (100) according to claim 1, wherein the prime mover (104, 302) comprises a gear system (111), the gear system (111) being adapted to periodically switch the output direction of the prime mover (104, 302) and/or wherein the prime mover (104, 302) comprises an electric motor (108) or wherein the prime mover (104, 302) comprises two electric motors (304A, 304B), and wherein freewheeling clutches (306A, 306B) are provided between the electric motors (304A, 304B) and the cutting blade (106, 107) such that each electric motor (304A, 304B) drives the cutting blade (106, 107) in a single direction, wherein preferably each electric motor (304A, 304B) alternately drives the cutting blade (106, 107) during the predetermined time periods (214).
- 15
- 20
- 25
8. A cutting tool (100) according to any of the preceding claims, wherein the cutting tool (100) is one of a hedge trimmer or a shrub shear.
9. A method of operating a cutting tool (100) comprising at least one cutting blade (106, 107) adapted to perform an oscillating movement, the method comprising:
- 30

providing a prime mover (104, 302) to drive the at least one cutting blade (106, 107), wherein an output direction of the prime mover (104, 302) is selectively reversible;

characterized in

5 periodically switching or reversing the output direction of the prime mover (104, 302) with a predetermined time period (214).

10. A method according to claim 9, wherein in a monitoring step the rotation of the motor and/or the movement of the prime mover or an oscillating blade is monitored during a defined monitoring time interval of  
10 the time period (214) and, when there is no interruption in the rotation of the motor or in the movement of the oscillating blade during the monitoring step the switching or reversing of the output direction of the prime mover (104, 302) is deferred or interrupted and/or the out-  
15 put direction of the prime mover (104, 302) is maintained in a normal or one-directional operation mode.

11. A method according to claim 9 or 10, wherein in a monitoring step the electrical current of or for the prime mover (104, 302) is monitored  
20 during a defined monitoring time interval of the time period (214), wherein the monitored current is compared with a predetermined threshold value and, when the monitored current is below the threshold value, the switching or reversing of the output direction of the  
25 prime mover (104, 302) is deferred or interrupted and/or the output direction of the prime mover (104, 302) is maintained in a normal or one-directional operation mode.

12. A method according to claim 11, wherein the defined measuring time interval is at least the last quarter, preferably at least the last third, of  
30 the time period or the time interval between two potential switching or reversing actions of the output direction of the prime mover (104, 302) and/or wherein the defined measuring time interval corresponds to the

5 difference between said time period or said time interval and a given waiting time interval, in particular 0.2 s and/or wherein the predetermined time period of the periodical switching or reversing is chosen from an interval between 0.05 s to 1 s, in particular between 0.2 s and 0.5 s.

- 10 13. A method according to claim 11 or 12, wherein the threshold value of the current is chosen from an interval between 10 % and 50 %, preferably 10 % to 33 %, of the maximum current or initial current peak which is reached immediately after a switching or reversing action of the output direction of the prime mover (104, 302).
- 15 14. A method according to any of claims 11 to 13, comprising at least one of the following steps:
- 20 - as a first condition it is checked whether a trigger switch (112) is turned on and, if so, the prime mover is started in reversing mode, i.e. the output direction of the prime mover (104, 302) is periodically switched or reversed with a predetermined time period (214), in particular in the same direction the mover was stopped the last time
  - 25 - as a second condition it is checked whether a given maximum time limit, for instance 5 s, or a respective number of cycles, e.g. 15, is reached and if so the prime mover is stopped and if not so, said monitoring step is performed,
  - if in the monitoring step the current does not go below the threshold value the second condition is checked again,
  - 30 - as a further condition it is checked whether the trigger switch (112) is turned off and if so the prime mover is stopped and it is returned to the first condition and if not so normal operation mode is maintained.
- 30 15. A method according to any of claims 10 to 14, where during the monitoring step a time interval (monitoring interval) is monitored that im-

mediately precedes the end of the time period (214) with which the prime mover (104, 302) is periodically switched.

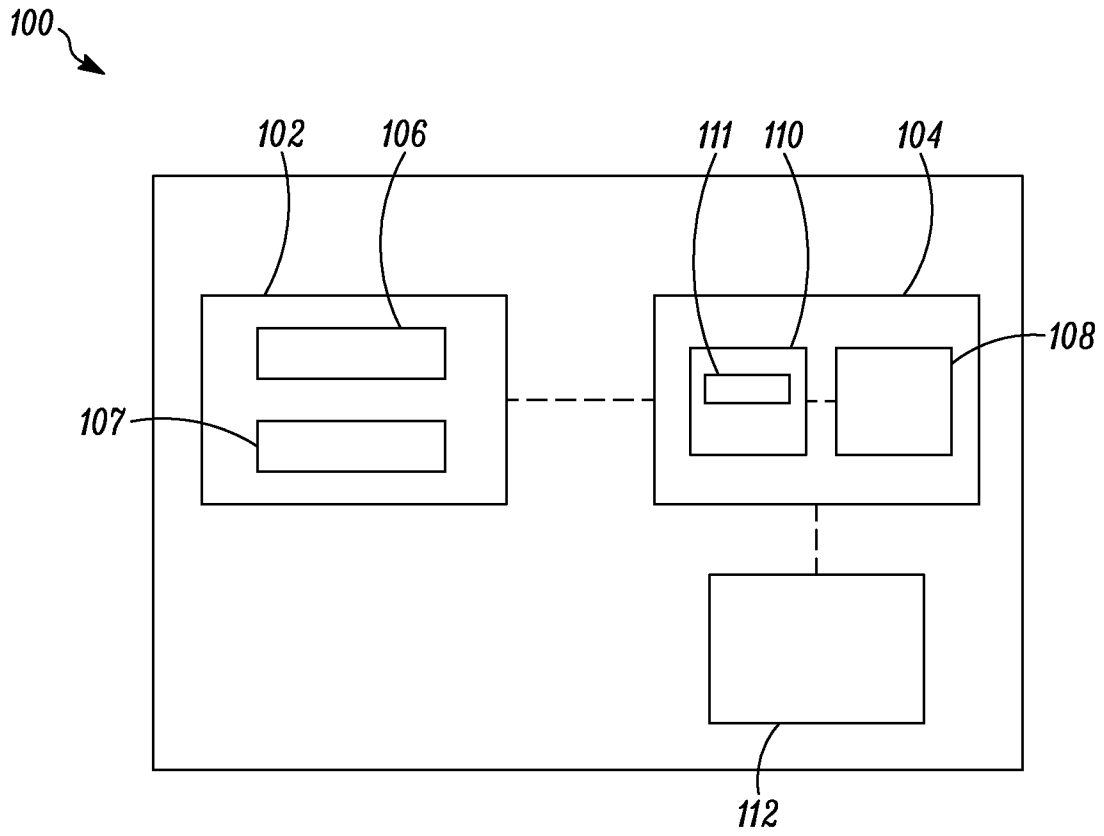


FIG. 1

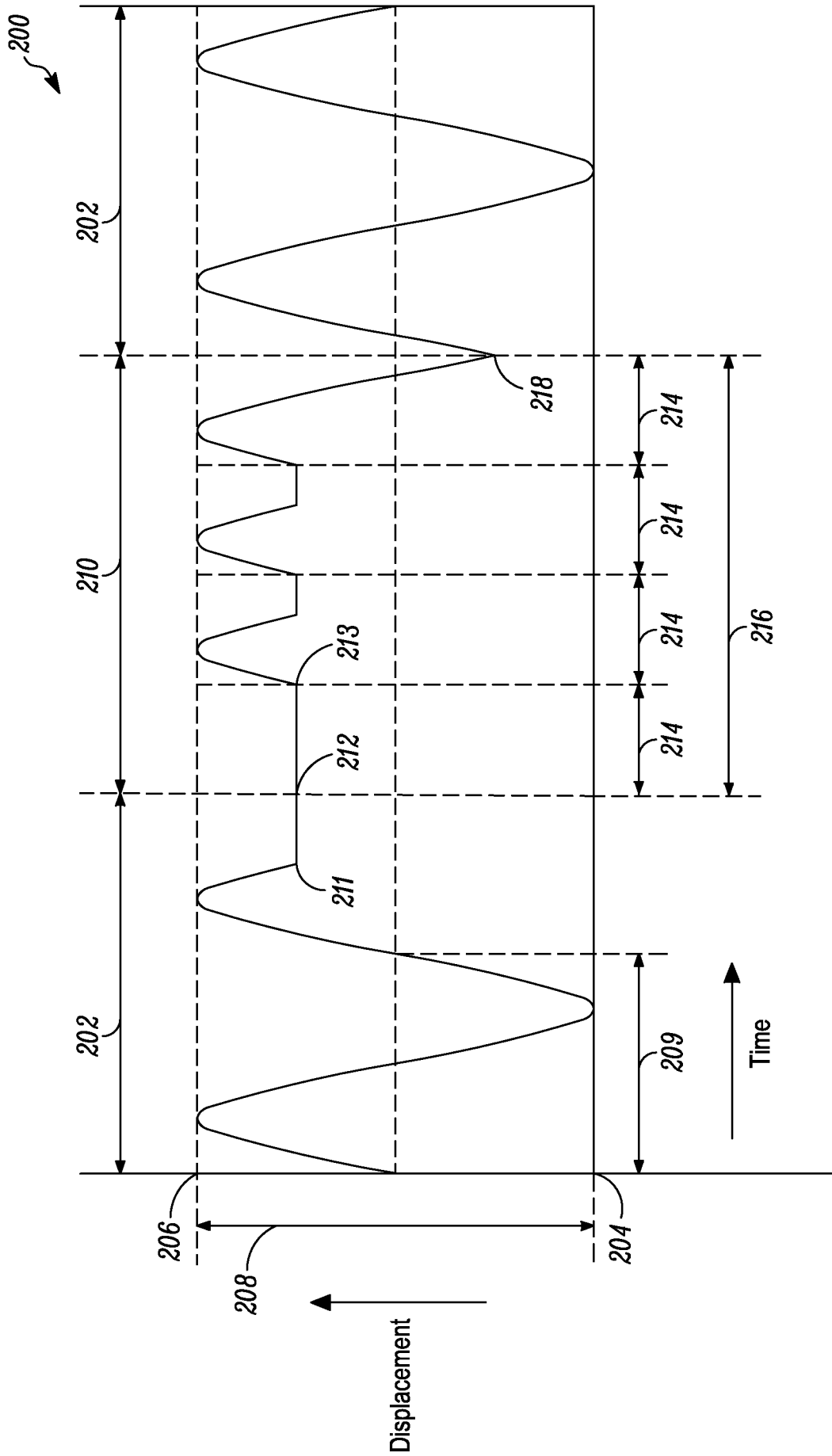


FIG. 2

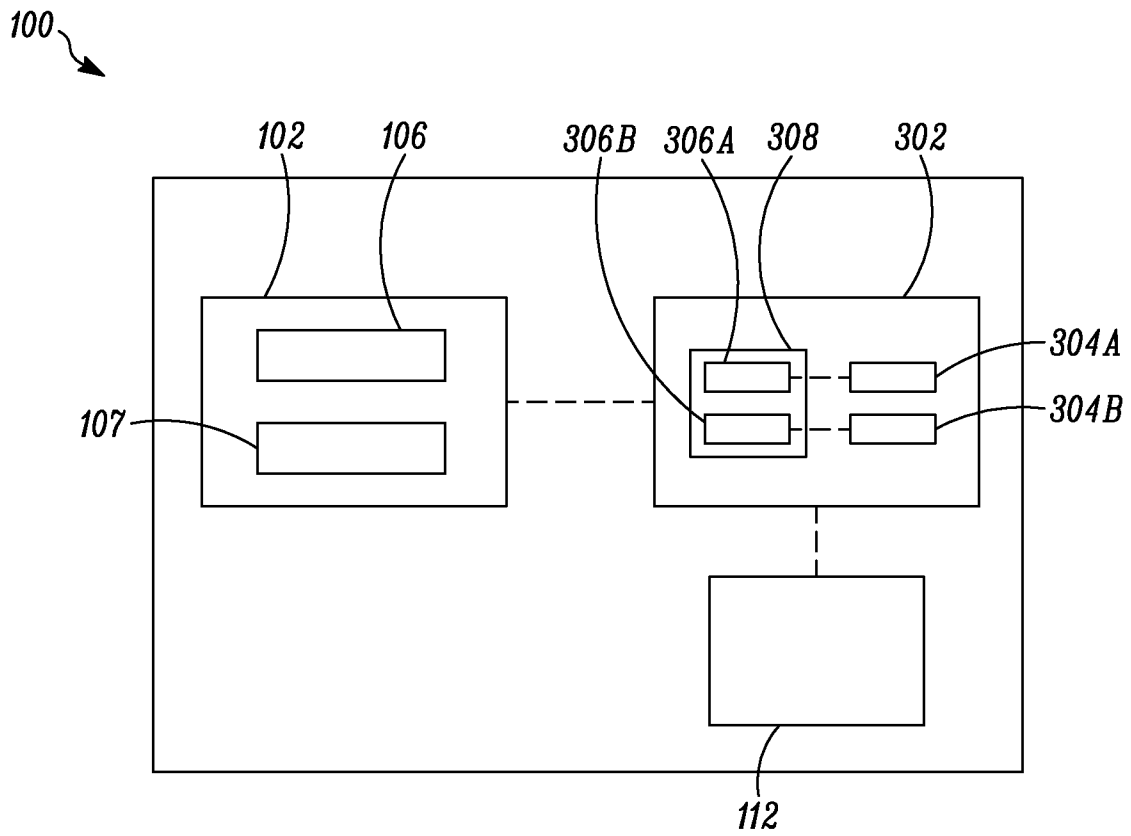


FIG. 3

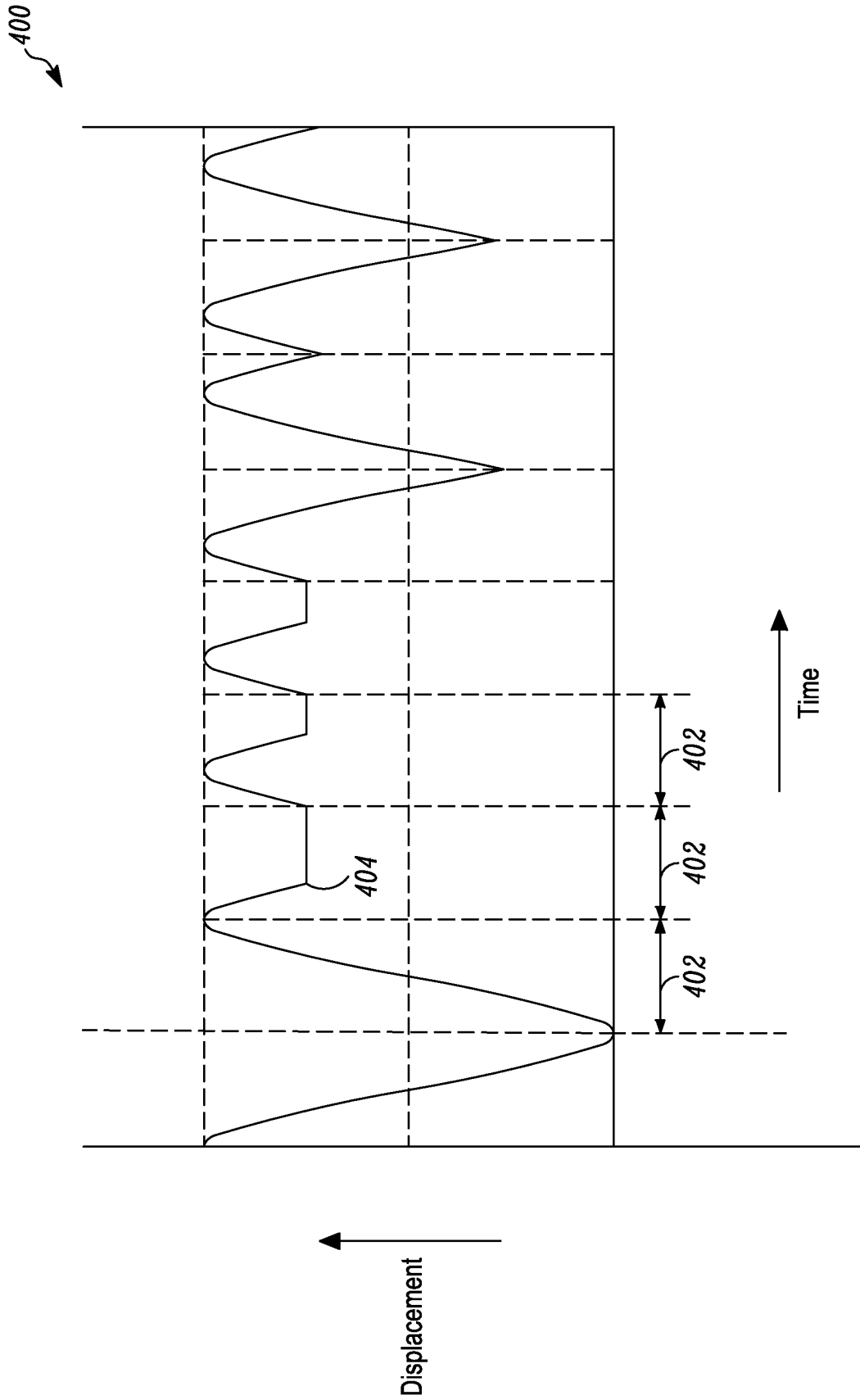


FIG. 4

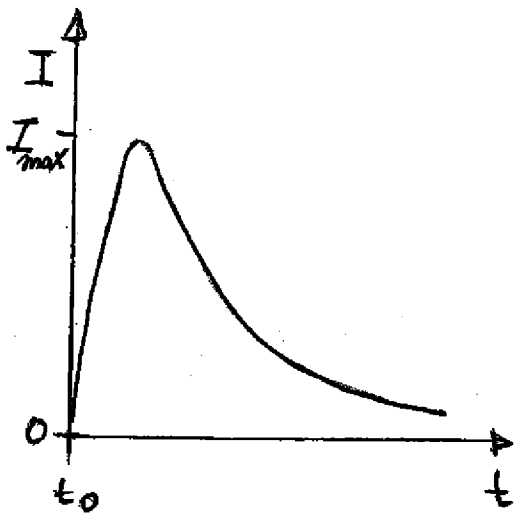


Fig. 5a)

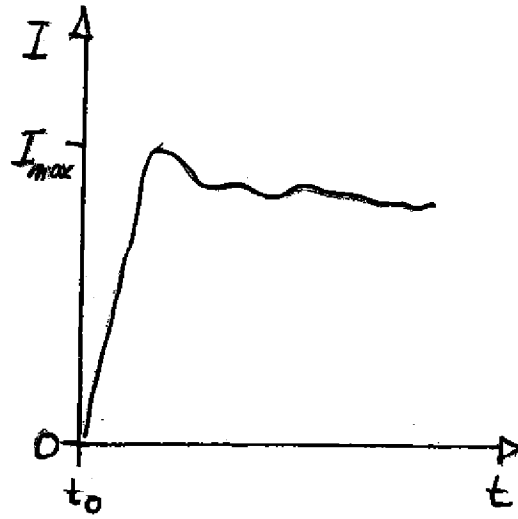


Fig. 5b)

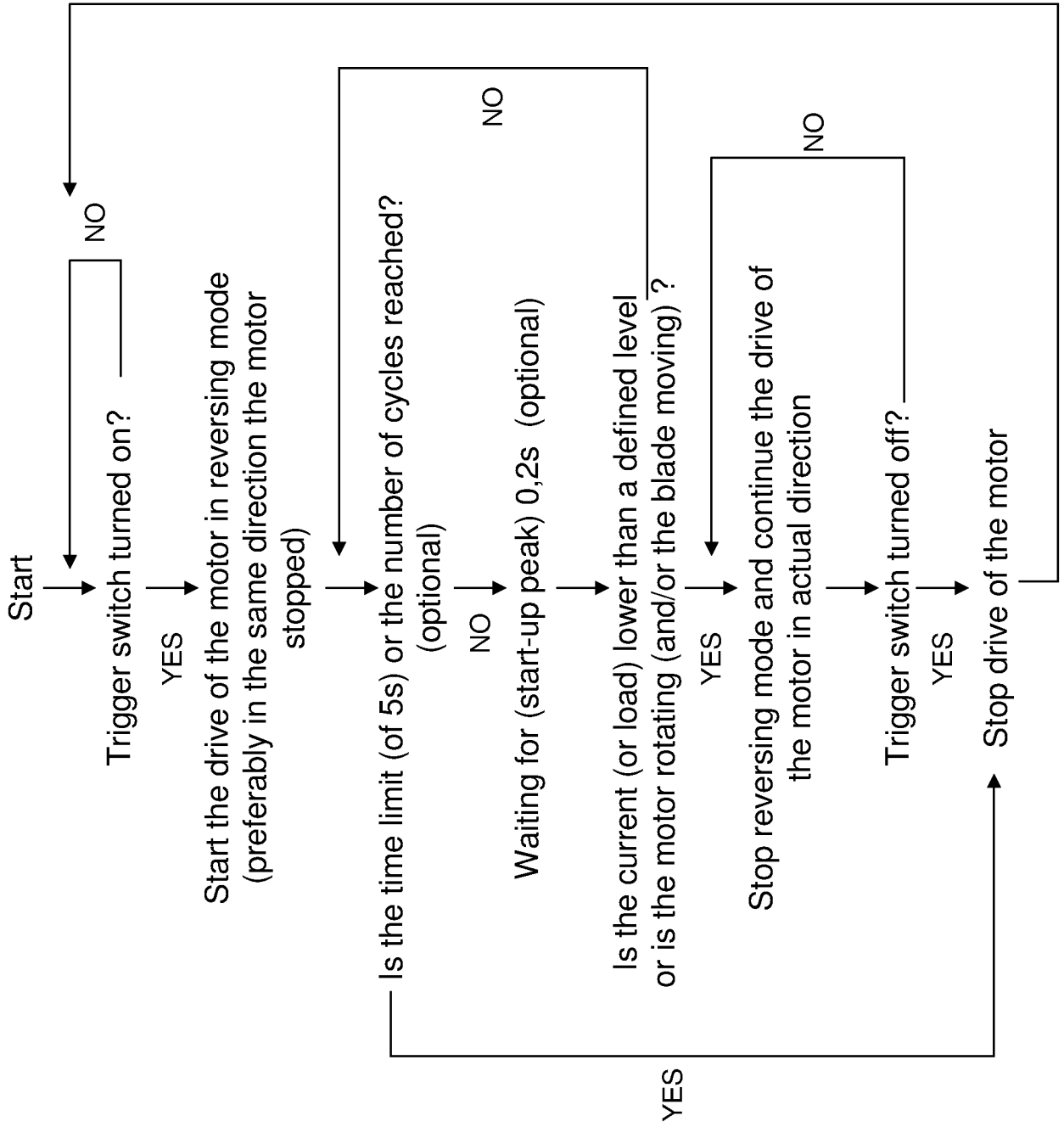


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2011/064176

A. CLASSIFICATION OF SUBJECT MATTER  
INV. A01G3/053  
ADD.  
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED  
Minimum documentation searched (classification system followed by classification symbols)  
A01G  
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)  
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 027 767 A1 (BOSCH GMBH ROBERT [DE]) 25 February 2009 (2009-02-25) paragraphs [0009] - [0011] -----	1-15
X	EP 2 198 690 A1 (PELLENC SA [FR]) 23 June 2010 (2010-06-23) paragraph [0028] -----	1,9

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search  
1 March 2012

Date of mailing of the international search report  
08/03/2012

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2011/064176

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