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(54) **Chainsaw**

(57) The present invention relates to improvements in or relating to chainsaws. In particular, it relates to chainsaw braking mechanisms. We describe a chainsaw comprising a chain (35) carried by a chain bar (36) and driven by means of an electric motor (10) and including a run-down brake function and a kick-back brake function; characterised in that the electric motor (10) is an electronically commutated electric motor having at least three

coil windings (20), and at least one of the run-down and kick-back brake function is provided by means of a control circuit (44) comprising a brake switch (14) associated with each of said at least one of the run-down and kick-back brake and control means adapted to disconnect a driving voltage from each of said motor coil windings (20) except at least one of them and apply a controlled resistive connection across the each of said motor coil windings (20).

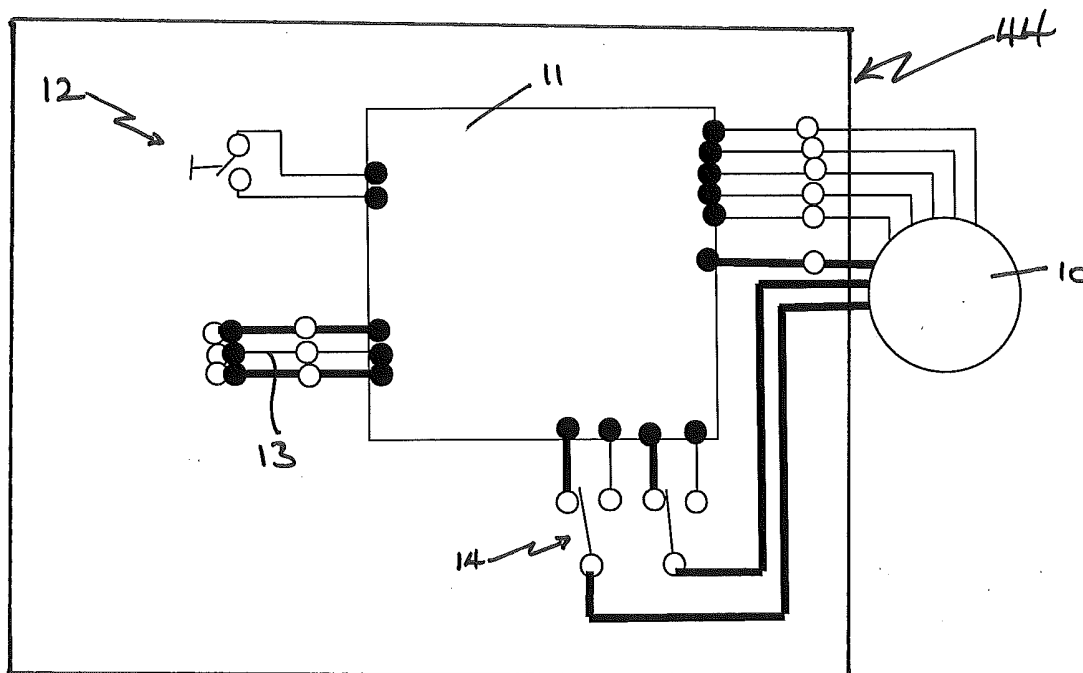


Figure 1

Description

[0001] The present invention relates to improvements in or relating to chainsaws. In particular, it relates to chain-saw braking mechanisms.

[0002] A chainsaw comprises a chain in which each or alternate links are provided with a cutting surface. The chain is carried on a chain bar and rotationally driven around the chain bar by means of an electric motor or a petrol engine rotating a chain sprocket. The chain bar is laterally adjustable with respect to the sprocket to enable adjustment of the tension of the chain.

[0003] A number of braking systems to arrest the rotation of the chain when power is removed are known. In normal use, current practice is to require the chain to stop within around 1 second after switch off of the power to the motor or the engine. Typically, such 'run-down' brakes include a metal strip wound around and urged by means of spring bias into contact with a brake disc mounted on the driveshaft of the engine or motor.

[0004] An additional brake, a so-called 'kick-back' brake, is required to arrest the movement of the chain when a dangerous condition occurs, particularly those in which the teeth of the chain at the tip of the chain bar become stuck in the object being sawn. In such circumstances, continued rotation of the motor or engine causes the chainsaw to swing upwards or 'kick back', typically towards the user's face. As the chainsaw kicks back, a kick-back guard or switch positioned immediately forward of the first handgrip contacts the user's hand and is actuated, causing a braking member to act directly or indirectly upon the motor or engine driveshaft. However, the chainsaw body continues to have considerable rotational inertia and could still make contact with the user's face or other part of their body. Accordingly, a kick-back brake is required to stop the movement of the chain much more quickly than a run-down brake, typically in less than 0.15 seconds.

[0005] Typically, the same metal strip brake is used for both the run-down and kick-back brakes, with a much stronger compression spring being used for the kick-back actuation. An example of such a system is disclosed in our earlier patent application, GB 2413525 to which further reference should be made.

[0006] An alternative arrangement is also described in our earlier application EP1749626.

[0007] However, traditional mechanical chainsaw braking can be complicated, contribute substantially to increased product weight and is subject to deterioration through wear over time, leading to increased servicing costs. The present invention seeks to overcome these problems.

[0008] Accordingly, the present provides a chainsaw comprising a chain carried by a chain bar and driven by means of an electric motor and including a run-down brake function and a kick-back brake function; characterised in that the electric motor is an electronically commutated electric motor having at least three coil windings,

and at least one of the run-down and kick-back brake functions is provided by means of a control system comprising a brake switch associated with said run-down and kick-back brake and adapted to disconnect a driving voltage from each of said motor coil windings except at least one of them and apply a controlled resistive connection across the each of said motor coil windings.

[0009] Preferably, the at least one of said run-down and kick-brake functions is at least the kick-back brake function.

[0010] Preferably, the motor has three coil windings and the control means applies a controlled resistive connection across the windings.

[0011] Preferably, the motor drives the chain in a direct, gearless, construction.

[0012] The above and other aspects of the invention will now be described in further detail with reference, by way of example only, to the accompanying figures, in which:

Figure 1 is a schematic block wiring diagram for an embodiment of a chainsaw in accordance with the present invention;

Figure 2 is a schematic circuit diagram corresponding to the diagram of Figure 1 in a braking configuration; and

Figure 3 is an exploded perspective view of an embodiment of a chainsaw in accordance with the present invention.

[0013] The construction of a chainsaw is well-known and will not be described in detail here. The reader is referred to Figure 3 and to our earlier application US2002/0124421. The chainsaw includes a housing formed of two housing mouldings 30, 31 and additional cover elements as required. The housing houses a prime mover in the form of an electric motor. The housing includes a rear handle 32 in which is mounted lock-off switch assembly 33 to cause actuation of the motor in response to operation of electrical switch 12. Rear handle will, in use, be typically held by the user's right hand and mounted to the housing is a front handle 34 for the user's left hand.

[0014] The chainsaw includes a chain 35 carried by an elongate chain bar 36 having a rounded tip. Correct tensioning of the chain is achieved by means of an adjustment member 40 adjusted by means of a circular tensioning wheel 41 with clamping to retain it in position by means of clamping knob 42. Other methods of tensioning the chain and clamping the chain bar are well known. The chainsaw also includes a lubricating system including a lubricant reservoir 46 to ensure that the rapidly moving chain remains adequately lubricated.

[0015] The chainsaw has a kick-back actuator 43 which, in use, causes actuation of the kick-back brake by contact with the user's left hand or wrist in a kick-back situation.

[0016] In accordance with the present invention and with reference to Figure 1, the chainsaw uses an elec-

tronically-commutated (EC) fan-cooled motor (10) to provide sufficient speed and torque to enable direct drive of the chain, without the need for equivalent gears. The chainsaw comprises a control system 44 including a programmed control microprocessor (not shown) located on a PCB (11) which provides the means to manipulate the open-framed motor to soft start, increase available current when under high loads and electronically brake the motor and thus arrest movement of the chain under kick-back and run down conditions.

[0017] The control system further comprises a user accountable on/off switch (12), a battery connector (13) and a kick-back brake switch (14).

[0018] The motor armature component 52 uses a surface-mounted eight-pole high-performance magnet construction.

[0019] The motor field component includes three coil windings (20) (Figure 2) each with an associated Hall Effect sensor. These provide a position signal to the microprocessor which is therefore able to control the current on the coils to deliver the required rotation at optimal efficiency, as is known for such motors. Additionally the same PCB is connected to a detachable battery pack (45) in the case of a cordless product. In preferred embodiments using Li-ion cells, the PCB additionally receives a temperature monitoring signal and is therefore also able to provide the necessary protection for the cells to avoid over temperature, over-current or over-discharge. The PCB also is connected to a simple low current switch (12) as the primary on/off signal. In normal running when this switch is opened the motor and chain are allowed to decelerate freely.

[0020] The rapid stop kick back brake activated by contact with the front hand guard actuates a high current capacity double change-over rocker switch (14) which disconnects the incoming coil driving voltage 15 (Figure 2) from two of the three motor coils and introduces a controlled resistive connection through braking resistors (21) directly across all three of them, as shown in Fig. 2.

[0021] By this means, the motor coils are enabled to provide a very rapid regenerative braking effect. The resistance value is selected to provide an upper limit to the regenerative current whilst ensuring the consequent braking performance stops the motor and the chain rapidly, typically in 0.15 seconds or less. This provides a very simple, low wear and high reliability brake construction, using one double-pole changeover switch only.

[0022] The use of this system with an EC motor enables both very high short term power peaks and consistently high efficiency over the operating range (above 85% over the main operating range of 3000-3400 RPM) even with a Li-ion battery-powered electrical supply. This is especially appropriate for cordless chainsaws where knots etc in the wood can cause momentary additional power requirements but where the maximum number of cuts for each battery charge is also a key factor.

[0023] Avoiding the additional complexity and loss of efficiency of gears or mechanical braking systems, the

motor field and armature components may be located directly into the housing mouldings as shown in Figure 3 so saving the complexity and weight of motor end support brackets. This is a further particular advantage of the present invention.

[0024] Even with this construction, some heat losses may occur both resistively in the field windings and within the solid state mosfet switching element on the control unit. An advantage of the direct drive and of the motor directly assembled in the housing is that both of these can be adequately cooled by a common axial fan 50 carried on motor shaft 51.

[0025] An additional advantage of the direct drive motor construction is that the motor is rotating at a significantly slower speed (typically 4000rpm @ no load) than is usual in an electric chainsaw (typically 23000rpm @ no load). This in turn means the product generates significantly less noise in use.

Claims

1. A chainsaw comprising a chainsaw housing comprising housing mouldings, the chainsaw further comprising a chain carried by a chain bar and driven by means of an electric motor (10) and including a run-down brake function and a kick-back brake function; **characterised in that** the electric motor (10) is an electronically commutated electric motor (10) having at least three coil windings (20), and at least one of the run-down and kick-back brake functions is provided by means of a chainsaw control system 44 comprising a brake switch (14) associated with said run-down and kick-back brake and adapted to disconnect a driving voltage from each of said motor coil windings (20) except at least one of them and apply a controlled resistive connection across the each of said motor coil windings.
2. A chainsaw as claimed in claim 1 wherein the at least one of said run-down and kick-brake functions is at least the kick-back brake function.
3. A chainsaw as claimed in claim 1 or claim 2 wherein the motor has three coil windings (20) and the control means applies a controlled resistive connection across each of said windings.
4. A chainsaw as claimed in any preceding claim in which the motor drives the chain in a direct, gearless, construction.
5. A chainsaw as claimed in any preceding claim wherein the field and armature components of the motor (10) are mounted directly to at least one of the housing mouldings.
6. A chainsaw as claimed in any preceding claim

wherein the motor (10) has a motor shaft and the motor shaft carries an axial fan.

7. A chainsaw as claimed claim 6 wherein the chainsaw control circuit is mounted within the chainsaw housing such that the axial fan applies, in use, a cooling air flow to the control circuit. 5
8. A chainsaw as claimed in any preceding claim further comprising a battery unit comprising a rechargeable battery to supply power to the electric motor (10), wherein the battery unit includes a battery-control circuit to control charging and discharging of the battery and the battery-control circuit is provided within the chainsaw control circuit. 10 15

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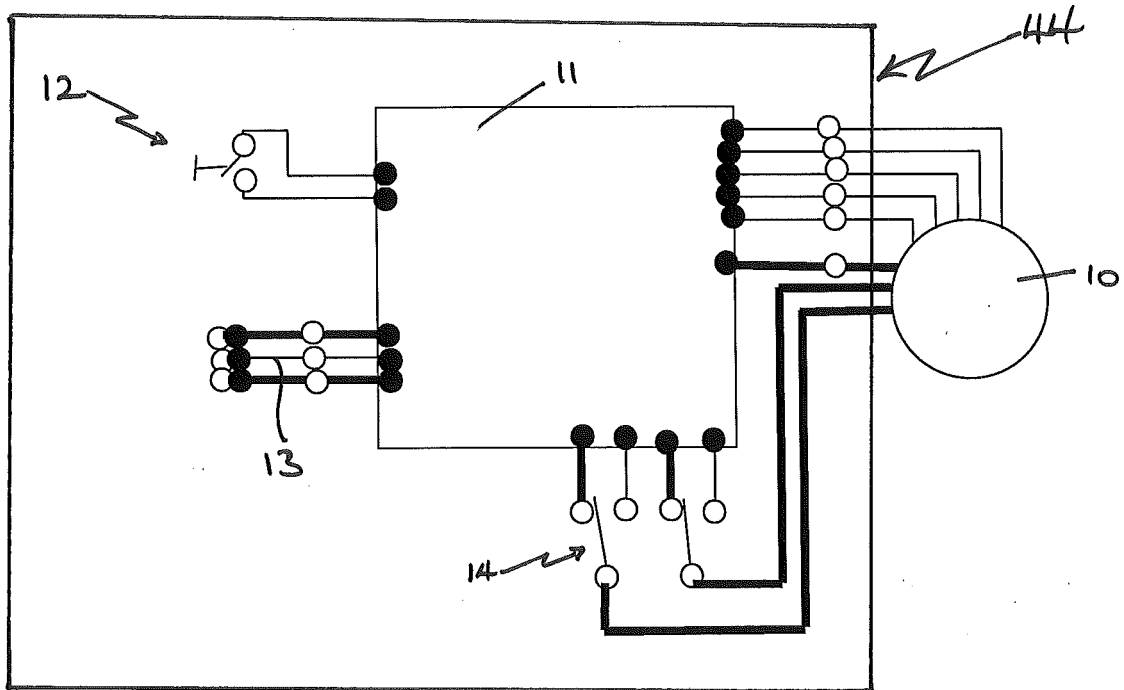


Figure 1

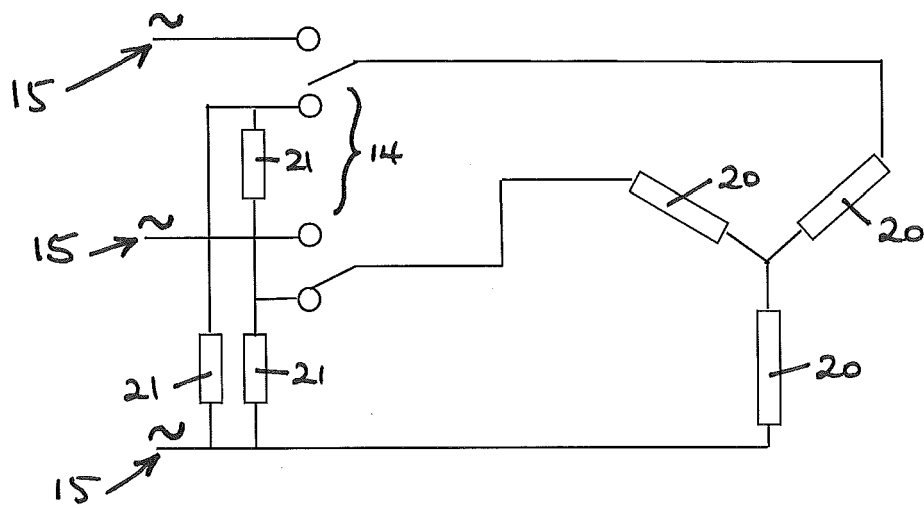


Figure 2

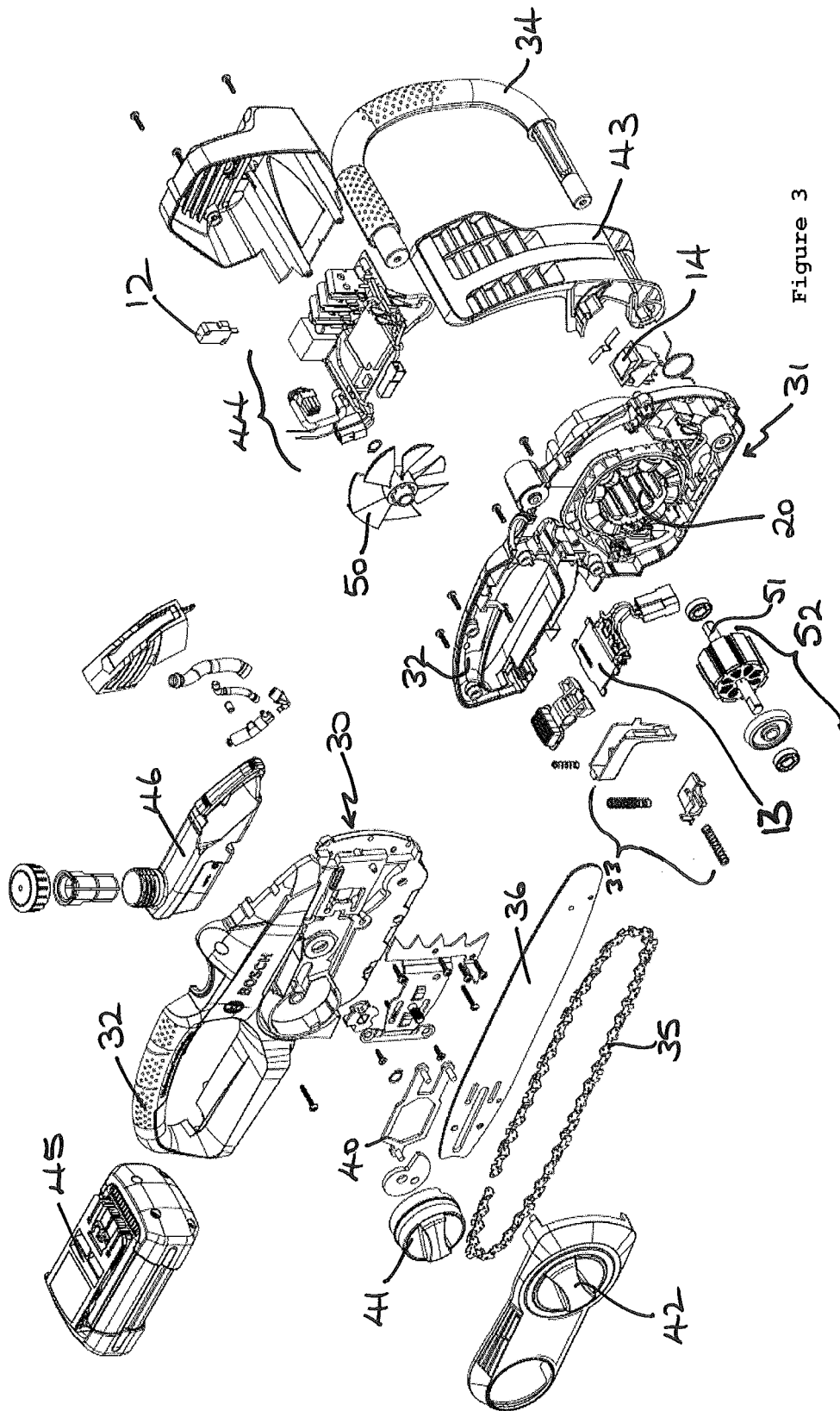


Figure 3



EUROPEAN SEARCH REPORT

Application Number
EP 10 19 5647

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A	US 2007/240892 A1 (BROTTO DANIELE C [US] ET AL) 18 October 2007 (2007-10-18) * paragraph [0011]; figure 14 * -----	5-8	TECHNICAL FIELDS SEARCHED (IPC) B27B
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 21 April 2011	Examiner Popma, Ronald
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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21-04-2011

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