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(11) **EP 1 466 666 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**13.10.2004 Bulletin 2004/42**

(51) Int Cl.7: **B02C 18/12, B02C 18/24**

(21) Application number: **04252071.8**

(22) Date of filing: **07.04.2004**

(84) Designated Contracting States:  
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR  
HU IE IT LI LU MC NL PL PT RO SE SI SK TR**  
Designated Extension States:  
**AL HR LT LV MK**

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(30) Priority: **07.04.2003 GB 0308012**

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(54) **Garden shredder**

(57) A garden shredder to shred garden material comprising a feeder for receiving said garden material, one or more blades for shredding said garden material received by said feeder, a series-type electric motor connected to move said one or more blades, and an electronic controller for controlling the electric motor, the electronic controller comprising an electronic circuit including means to sense the speed of rotation of the motor and means to control the speed of the motor to reduce the increase of the speed of rotation of the motor when the load applied to the motor by said one or more blades is reduced or removed. In this way, when there is no or only a small amount of garden material fed to the blades, the increase of the speed of rotation of the blades and hence the noise generated is reduced.

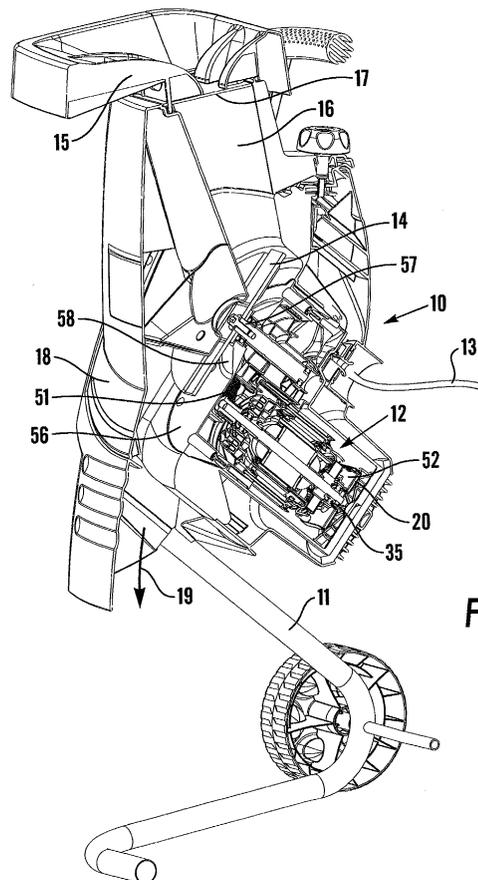


Fig.2

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## Description

[0001] The present invention relates to a garden shredder for shredding leaves, branches and the like driven by an electric motor.

## BACKGROUND OF THE INVENTION

[0002] Garden shredders are commonly used in gardens to shred garden material such as leaves, small branches and other material fed (usually manually) to the shredder via a feeder and discharging the shredded material (usually via a chute). They are typically driven by an electric motor, which in turn drives blades at a relatively high speed, (typically 3,000 rpm) which engage with the material to be shredded and shreds it as desired.

[0003] Such shredders are generally quite noisy and it is highly desirable to reduce the noise level of the shredder. The noise level of the shredder can increase when the load on the motor in the shredder reduces. For example when the shredder has completed the shredding of a branch, the motor will tend to speed up which increases the noise. This can be particularly troublesome as for most of the time the shredder is not under load.

[0004] This change of speed of the motor is not so great where the electric motor is an induction motor as the speed of rotation is set by the frequency of mains electricity applied to the motor. However, induction motors are not entirely suitable for use in shredders where the load can vary considerably due to their limited overload torque capacity. Thus, if the load increases significantly, induction motors can stall. It would be preferable to use a series type electric motor which has better speed/torque characteristics. When a sudden load is applied to a series electric motor, it slows down but will not generally stall since the torque continually increases. Thus for a situation where the load can vary considerably, a series type electric motor is preferred. Furthermore the same power can be provided for less weight than an induction motor because the series motor can be run at high speed and thus less material such as copper can be used in its construction. However the disadvantage of the series motors is that when the load is removed from the motor, the motor will speed up to a substantial extent causing it to be noisy.

[0005] There is an increasing desire to reduce noise, particularly in the garden environment to increase the gardener's enjoyment of the garden and reduce nuisance to other people.

[0006] To reduce the noise that the high running speed of the motor in that circumstance generates, it is desirable to try to maintain the unloaded motor at a speed similar to the motor when loaded.

[0007] Furthermore, the environment of a shredder is relatively rough and it is desirable to protect the components, particularly the electrical components as far as

possible to provide a long life.

[0008] It is also preferable to provide a means of preventing the electrical motor being overloaded, to allow the electric motor to start in a controlled way without being overstressed, and from the safety point of view, provide a safe way of restarting the motor after it has stopped, for example, after a failure of the electric supply voltage to the shredder or because of overloading.

## 10 SUMMARY OF THE INVENTION

[0009] According to a first aspect, the present invention provides a garden shredder to shred garden material comprising a feeder for receiving said garden material, one or more blades for shredding said garden material received by said feeder, a series-type electric motor connected to move said one or more blades, and an electronic controller for controlling the electric motor, the electronic controller comprising an electronic circuit including means to sense the speed of rotation of the motor and means to control the speed of the motor to reduce the increase of the speed of rotation of the motor when the load applied to the motor by said one or more blades is reduced or removed.

20 [0010] In this way, when there is no or only a small amount of garden material fed to the blades, the increase of the speed of rotation of the motor and blades and hence the noise generated is reduced.

30 [0011] The control means preferably includes means to control the power to the electric motor. The power control means preferably comprises a triac or thyristor.

35 [0012] The control means preferably includes means to provide an electrical parameter which represents the target speed of rotation of the motor. The electrical parameter may be an electrical signal, which may be digital or analog, or may be an electrical value such as current or voltage. There may also be provided means for measuring the speed of the motor which provides an output which represents the speed of the motor. The output may be in the form of a digital or analog signal, or an optical or electrical value such as brightness or voltage or current. Means may be provided to turn this measured component into a parameter which may be compared with the parameter provided by the control means to control the speed of the motor.

45 [0013] The control means may also include means to detect an overload of the motor, said overload detecting means being connected to the control means to reduce the power to the electric motor. A start acceleration means may be provided to control the initial acceleration of the electric motor and thereby reduce the initial stress on the motor.

50 [0014] The control means may also include a stop/start control means having three positions, an off position in which any power applied to the stop/start control means is not passed to the motor of the shredder, a running position in which power is passed to the shredder if various parameters are met, and a start position in

which the shredder may be started.

**[0015]** The stop/start control means may include mechanical means requiring the stop/start control means to pass through the off position before returning to the start position if power to the shredder is interrupted.

**[0016]** The stop/start means includes electronic circuit means for providing DC power to some or all of the other electronic components in the electronic controller, said electronic circuit means being adapted so that, if power to the shredder is interrupted, said electronic circuit means interrupts the DC power to the other circuits and remains in that state until both power to the shredder is restored and a manually operated switch is operated.

This makes the operation of the shredder safer

**[0017]** The electronic controller may be provided in a housing surrounding a shaft of the motor, the housing including an aperture therethrough through which the shaft passes, whereby to facilitate measurement of the speed of rotation of the shaft.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0018]** A preferred embodiment of the invention will now be described by way of example with reference to accompanying drawings in which:-

Figure 1 is a perspective view of a shredder driven by an electric motor and incorporating a controller comprising a preferred embodiment of the invention,

Figure 2 is a part cross-sectional view of the shredder of Figure 1,

Figure 3 is a perspective view of an internal part of the shredder of Figure 1,

Figure 4 is a block diagram of the controller, and,

Figure 5 is a detailed circuit diagram of the controller for the electric motor.

#### **DESCRIPTION OF PREFERRED EMBODIMENT OF THE INVENTION**

**[0019]** Referring to Figure 1 and 2 there is shown in diagrammatic form a shredder for use in shredding garden material such as leaves or small branches in a garden. The shredder comprises a base unit 10 and legs 11 to space the base unit 10 from the ground. Mains AC electricity is provided by means of a cable (not shown) connected to a socket 13. A series type universal electric motor 12 drives either directly from the motor shaft or indirectly via a belt or gear arrangement a set of rotating blades 14 in a vertically orientated feeder 16, the

feeder 16 having an open upper end 17 incorporating a safety guard 15 for receiving the garden material to be shredded. A housing 18 surrounding the blades 14 incorporates an exit chute 19 to discharge shredded material.

**[0020]** As is well known, in use, leaves or small branches or twigs are manually fed into the open upper end 17 of the feeder 16 whilst the electric motor 12 is rotating the blades 14, and the leaves and branches are shredded and the shredded remains are discharged through the chute 19.

**[0021]** Figure 2 shows a vertical section through a preferred shredder of the invention. It will be noted that there is provided an electronic controller 20 which forms a generally flat rectangular plate like member 52 including a central aperture 53 through which or into which the shaft 54 of the electric motor 12 passes.

**[0022]** Figure 3 is a perspective view of some of the internal components of the shredder of Figure 1. The same reference numerals have been used as in Figures 1 and 2.

**[0023]** It will be noted that Figure 3 is upside down with respect to the relevant components shown in Figures 1 and 2. Figure 3 shows a belt drive housing 56 and illustrates clearly the shape of the plate 52 on which the electronic controller 20 is mounted. Figure 3 also illustrates the protruding shaft 57 which protrudes from a conical housing 58, the protruding shaft 57 mounting, in use the blades 14.

**[0024]** Referring to Figure 4, the electronic controller 20 is illustrated in diagrammatic form. The electronic controller 20 is provided to control the speed of the series electric motor and in particular to reduce the increase in speed of the motor when a load is reduced. The power supply 20 which may be mains AC power, is applied to a stop/start control 22 which in turn passes power to a power control 23. The stop/start control 22 is also connected to a power supply failure control 24 which in turn is connected to a control logic 26. The control logic 26 is connected to receive inputs from a start acceleration setting means 27, a speed setting means 28 and an overload protection setting means 29. The power control 23 is connected to pass power to the motor 12, the motor 12 including a speed sensor 32 and a load sensor 33.

**[0025]** The speed sensor 32 comprises one or more magnets 35 mounted on the shaft 54 where it passes through the plate 52. This is particularly convenient as the part of the speed sensor 32 which detects the magnets may be mounted within the electronic controller 20 but adjacent to the rotating magnets 35 or other rotatable mounting driven by the motor 12, the magnets 35 rotating past an inductor L1 (illustrated in Figure 5). The speed sensor 32 and load sensor 33 are connected to the control logic 26.

**[0026]** The arrangement of Figure 4 is operated as follows. The power supply 21 is connected to the stop/start control 22. The stop/start control includes a mechanical

three-position manually operated switch, the three switch positions being "OFF", "RUNNING" and spring-loaded "START". When the switch is in the "START" position, it is spring loaded back to the "RUNNING" position. Thus to start the shredder, it is necessary to move the switch from the "OFF" position, through the "RUNNING" position to the third spring-loaded "START" position. Thereafter the switch may be left to return to the "RUNNING" position. In this "RUNNING" position, as long as other criteria are met, power is provided to the power control 23 and then to the motor 12 to operate the motor.

**[0027]** If for any reason the power is interrupted but then returns, the shredder will not restart without the stop/start control switch being once more switched to the "START" position to re-establish the run mode in the electronic circuitry.

**[0028]** Moreover the mechanical arrangement of the stop/start switch is such that restarting cannot be achieved without first returning the switch to the "OFF" position and then passing through the "RUNNING" position to the "START" position,

**[0029]** This provides a safety feature which is particularly important in the use of a shredder where there is not a hand control which has to be continuously held to maintain the motor running. In some circumstances there could be an element of danger if the motor is disconnected from the power supply (e.g. there is a failure of electrical supply voltage) and subsequently reconnected to the power supply with the switch in the "RUNNING" position and it is desirable to require further operations to be necessary to start the motor rotating.

**[0030]** The speed of rotation of the motor 12 is measured by the speed sensor 32 and a relevant electrical value passed to the control logic 26. The control logic 26 compares the electrical value derived from the speed measured by the speed sensor 32 with a signal or electrical value representing a pre-set speed from the speed setting means 28 and controls the power control 23 to maintain the speed of the motor 12. Thus as the load on the motor 12 changes, (e.g. suddenly decreases) the control logic 26 will control the power control 23 to maintain that speed at or about a predetermined value.

**[0031]** The start acceleration setting means 27 provides a signal or electrical value to the control logic 26 so that as the motor 12 is started, the acceleration of the motor 12 is controlled to a predetermined extent. This provides a smooth start which improves the life of the components of the motor and also enhances the quality perception of the shredder.

**[0032]** If the load applied to the motor increases too much, then the load sensor 33 senses that and passes an electrical value or a signal to the control logic 26, and as that measured value of load reaches the preset value set in the overload protection setting means 29, the control logic 26 controls the power controller 23 to reduce or cut the power to the motor 12. A time delay may be provided in the control logic 26 to allow higher overload

levels for limited short periods.

**[0033]** Figure 5 shows a detailed circuit diagram of the components set out in Figure 4. Not all of the components of Figure 5 will be specifically referred to, as the components are clearly set out in the circuit diagram in standard notation.

**[0034]** Thus, the power supply 21 is provided by mains power provided to the terminals J5 and J6, and the power control 23 is provided by a triac Q1. Thus, the power from the mains terminals J5, J6 is provided via the triac Q1 to motor terminals J1, J2 which are applied to the motor 12. The triac Q1 is controlled by a signal on line 25 from the control logic 26 (Q3) via a resistor R12. Triac Q1, as is well known, varies the speed of the motor by varying the power provided thereto by "chopping" the AC voltage waveform applied in accordance with the control signal on line 25.

**[0035]** We will now tie the components of Figure 4 to the components of Figure 5.

**[0036]** It will be understood that capacitor C13, resistor R1 and diode D1 provide a DC supply on line 34 for the control logic 26.

**[0037]** Thus the supply failure control 24 of Figure 4 comprises resistors R17, R11, R19, diode D2, transistors Q4, Q2 and the terminals J3 and J4. If the power is interrupted and then restored, Q4 will be first to turn on, holding Q2 off. D2 will then hold the DC supply below the operating threshold of the control logic Q3, keeping the motor off.

**[0038]** Operating the start control 22 shorts terminals J3/J4 holding off Q4 permitting Q2 to turn on. Q2 now holds Q4 permanently off permitting the DC supply to rise to its design value allowing the control logic Q3 to operate normally.

**[0039]** The control logic 26 of Figure 4 is provided by the integrated circuit Q3 of Figure 5.

**[0040]** The speed sensor 32 of Figure 4 is provided *inter alia* by the inductor L1, resistor R5, capacitor C4, and frequency-to-voltage converter 38 inside the controller Q3. L1 is an inductor which picks up the varying magnetic field as magnets driven by the motor rotate past it and with resistor R5 and capacitor C4 provides on terminal 8 a voltage whose frequency is proportional to the rotation of the motor. The frequency-to-voltage converter 38 converts that into a voltage which is applied to one input of a comparator 39. The other input of the comparator 39 is from terminal 11 which receives a voltage from the speed setting means 28, comprising resistors R13, R14, R15 and capacitor C10. These components comprise, effectively, a potentiometer. The comparator 39 thereby provides a signal to a phase controller 41 which controls the speed of the motor in accordance with the signal received from the comparator 39. The phase controller 41 passes pulses on line 25 to the triac Q1, the phase of the pulses controlling the triac Q1 to control the speed of the motor.

**[0041]** If there is some kind of failure in the inductor L1 detecting the movement of the magnets 35 on the

shaft (for example if the inductor fails or the magnets detach), then the speed control sensor will not be operational. This is detected by passing pulses from the frequency-to-voltage converter 38 to a tachometer 43 which, if no pulses are detected, cuts off the triac Q1 pulses after a delay determined by C12 and R16.

**[0042]** The output of the comparator 39 is also connected to an overload means 42 which, if an overload is detected, as will be described hereafter, reduces the output of comparator 39 causing the phase controller 41 to reduce the phase angle of the trigger pulses passed on line 25 to the triac Q1 and hence the spread of rotation of the motor.

**[0043]** The load current detected by R8, via R10 is integrated by C9. Should the voltage across C9 exceed an internally set threshold load limiting is turned on. This reduces the output of the comparator 39 reducing the phase angle of the trigger pulses generated by the phase controller 41.

**[0044]** The start acceleration setting means 27 of Figure 4 comprises a soft start means 46 and transistor Q10 and capacitor C3 of Figure 5. The value of the capacitor C3 sets the operation of the soft start means 46 by applying a signal to the gate of Q10 which controls the output signal from comparator 39 so that during the initial stages of operation the output signal of comparator 39 is ramped which causes the phase angle of the trigger pulses fed to line 25 by phase controller 41 to increase in a smooth manner to control the initial acceleration of the motor 12 to build up speed smoothly.

**[0045]** We have therefore now provided a shredder using a series type electric motor with an electronic speed control which limits the "off load" speed and therefore the noise made by the product when it is running and not actually shredding. This is a significant part of the running time for shredders and therefore contributes significantly to reducing overall nuisance.

**[0046]** The electronic controller also provides "soft start" effects so that the shredder builds up speed smoothly when turned on. This enhances the quality of the shredder as well as reducing stresses in the drive and increasing product life.

**[0047]** The electronic control also incorporates a "zero voltage switch off" which means that if there is a loss of power supply, the shredder will not start up again when the power returns. This is usually provided by a relay type switch which can be unreliable.

**[0048]** The invention is not restricted to the detail of the foregoing example.

**[0049]** For example, although we have described the speed sensor 32 as incorporating magnets and an inductor to pick up the rotation of the magnet, other arrangements may be used such as an optical sensor. A typical arrangement might comprise a slotted disc mounted to the motor shaft whereby light passes through the slots as the slots pass between a light source and a light detector. In that way a digital signal relating to the speed of rotation of the motor may be

readily provided.

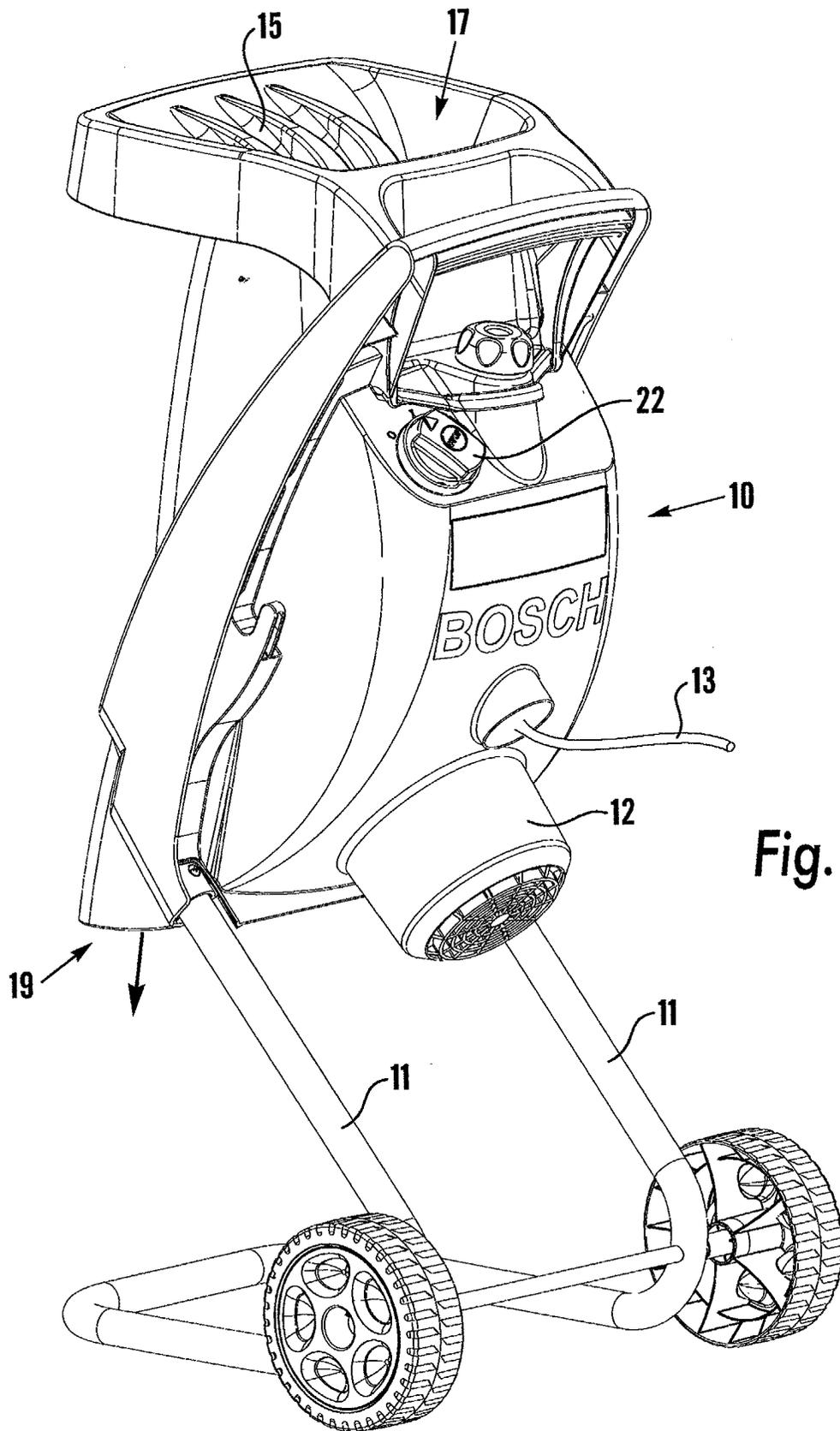
**[0050]** In another arrangement, the speed may be sensed not by direct means, but by a signal analysis system which analyses the electrical signal at some point in the electronic controller, to detect any regular changes in the signal, voltage or current value which reflects the speed of rotation of the motor. For example, if the motor includes a commutator, then the commutator tends to provide "spikes" of electrical voltage or current which may be readily detected.

## Claims

1. A garden shredder to shred garden material comprising a feeder for receiving said garden material, one or more blades for shredding said garden material received by said feeder, a series-type electric motor connected to move said one or more blades, and an electronic controller for controlling the electric motor, the electronic controller comprising an electronic circuit including means to sense the speed of rotation of the motor and means to control the speed of the motor to reduce the increase of the speed of rotation of the motor when the load applied to the motor by said one or more blades is reduced or removed.
2. A garden shredder as claimed in claim 1 in which the control means includes means to control the power to the electric motor.
3. A garden shredder as claimed in claim 1 or 2 in which the power control means comprises a triac or thyristor.
4. A garden shredder as claimed in claim 1, 2 or 3 in which the control means includes means to provide an electrical parameter which represents a target speed of rotation of the motor.
5. A garden shredder as claimed in claim 4 in which the electrical parameter comprises a digital or analog electrical signal.
6. A garden shredder as claimed in claim 4 in which the electrical parameter comprises an electrical value of current or voltage.
7. A garden shredder as claimed in any of claims 1 to 6 further comprising means for measuring the speed of the motor which provides an output which represents the speed of the motor.
8. A garden shredder as claimed in claim 7 in which the output is in the form of a digital or analog signal
9. A garden shredder as claimed in claim 7 in which

the output is in the form of an optical or electrical value.

10. A garden shredder as claimed in claim 9 in which the output is in the form of an optical value of brightness. 5
11. A garden shredder as claimed in claim 9 in which the output is in the form of electrical voltage or current. 10
12. A garden shredder as claimed in claim 5 and any of claim 7 to 11 in which means is provided to turn the measured component into a parameter which may be compared with the parameter provided by the control means to control the speed of the motor. 15
13. A garden shredder as claimed in any of claims 1 to 12 in which the control means includes means to detect an overload of the motor, said overload detecting means being connected to the control means to reduce the power to the electric motor. 20
14. A garden shredder as claimed in any of claims 1 to 13 in which a start acceleration means is provided to control the initial acceleration of the electric motor. 25
15. A garden shredder as claimed in any of claims 1 to 14 in which the control means includes a stop/start control means having three positions, an off position in which any power applied to the stop/start control means is not passed to the motor of the shredder, a running position in which power is passed to the shredder if various parameters are met, and a start position in which the shredder may be started. 30  
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16. A garden shredder as claimed in claim 15 in which the stop/start means includes electronic circuit means for providing DC power to some or all of the other electronic components in the electronic controller, said electronic circuit means being adapted so that, if power to the shredder is interrupted, said electronic circuit means interrupts the DC power to the other circuits and remains in that state until both power to the shredder is restored and a manually operated switch is operated. 40  
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17. A garden shredder as claimed in any of claims 1 to 16 in which the electronic controller is provided in a housing surrounding a shaft of the motor, the housing including an aperture through which the shaft passes, whereby to facilitate measurement of the speed of rotation of the shaft. 50  
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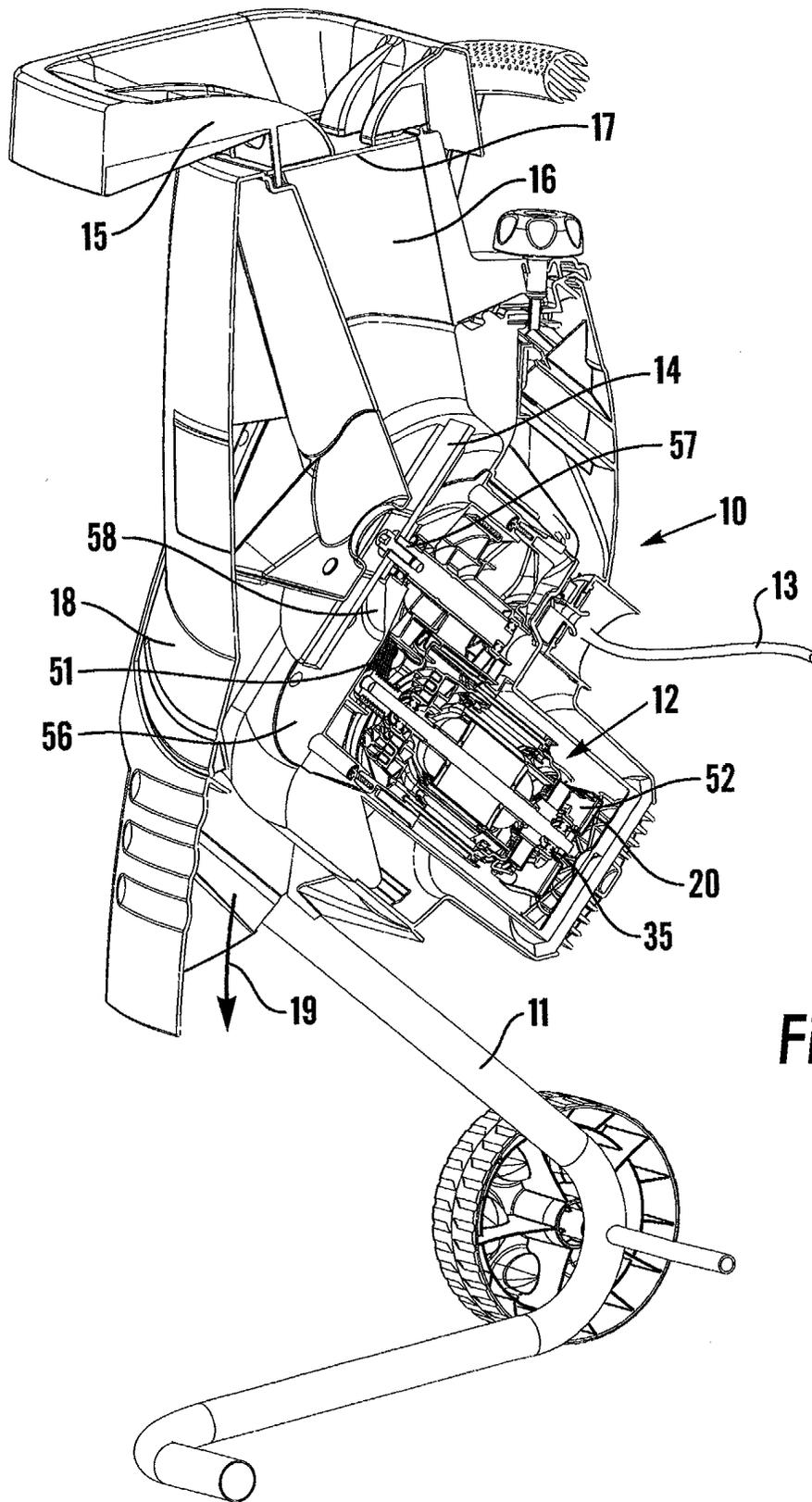
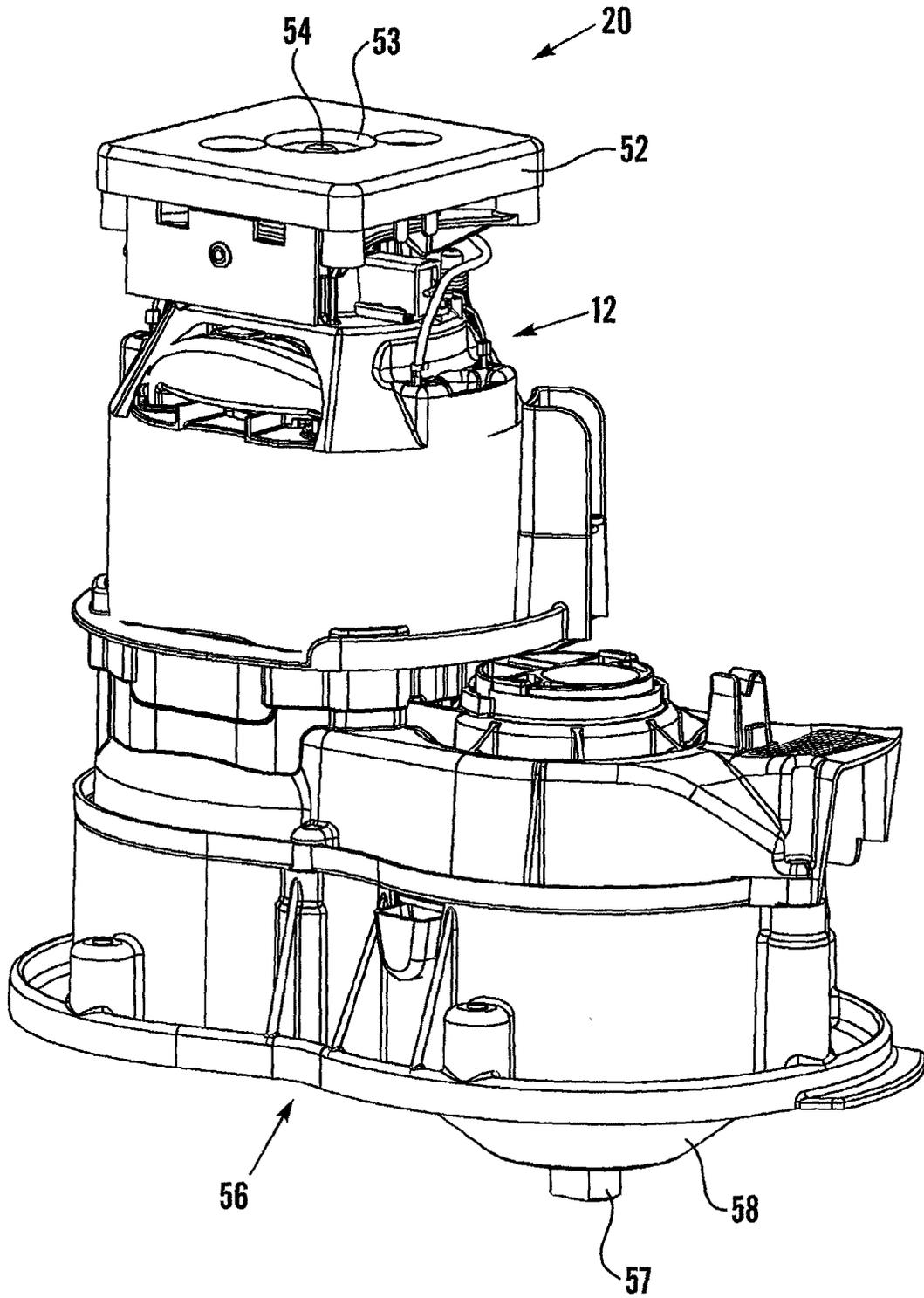
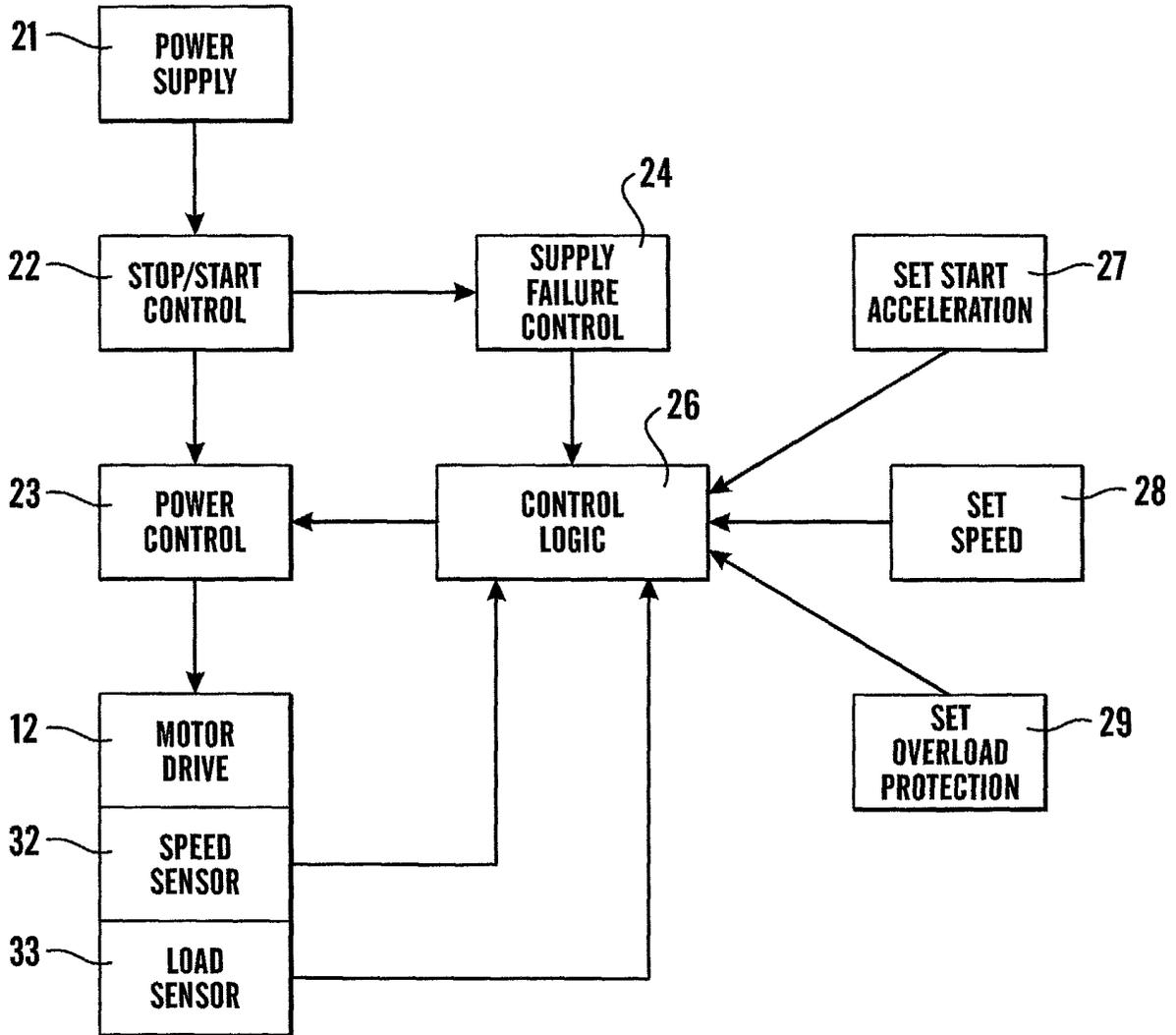


Fig.2



**Fig.3**

**SPEED CONTROL BLOCK DIAGRAM**



**Fig.4**

