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STRING TRIMMER

Abstract

A string trimmer includes a handle unit including a handle unit housing that defines a grip portion and a battery receptacle. The string trimmer also includes a head unit including a rotatable trimmer head and a motor configured to rotate the trimmer head. The string trimmer further includes a shaft assembly extending along an axis between the handle unit and the head unit to couple the handle unit to the head unit. The string trimmer also includes a handle coupled to the shaft assembly between the handle unit and the head unit. The string trimmer also include a counterweight disposed within the housing between the grip portion and the battery receptacle, wherein the axis intersects the counterweight.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a divisional of prior-filed U.S. patent application Ser. No. 17/351,588 filed on Jun. 18, 2021, which claims priority to co-pending U.S. Provisional Patent Application No. 63/041,625, filed Jun. 19, 2020, the entire contents of each of which is hereby incorporated by reference.

FIELD OF THE DISCLOSURE

[0002] The present disclosure relates to outdoor tools, and more specifically to string trimmers.

BACKGROUND OF THE DISCLOSURE

[0003] Outdoor tools, such as string trimmers, may include an elongated shaft assembly extending between a handle unit and a head unit.

SUMMARY OF THE DISCLOSURE

[0004] The present disclosure provides, in one aspect, a string trimmer including a handle unit having a handle unit housing that defines a grip portion and a battery receptacle. The string trimmer also includes a head unit including a head unit housing, and electric motor, and a rotatable trimmer head. The string trimmer further includes a shaft assembly coupling the handle unit to the head unit. A circuit board assembly is supported within the head unit housing, the circuit board assembly including a heat sink and a circuit board that comprises a controller configured to control the electric motor.

[0005] The present disclosure provides, in another aspect, a string trimmer including a handle unit having a handle unit housing that defines a grip portion and a battery receptacle. The string trimmer also includes a head unit including a head unit housing and a rotatable trimmer head. The string trimmer further includes a shaft assembly coupling the handle unit to the head unit. The string trimmer also includes an electric motor supported within the head unit housing and configured to rotate the trimmer head, the electric motor including a rotor assembly, a stator assembly surrounding the rotor assembly, and a circuit board assembly coupled to an axial end of the stator assembly. The circuit board assembly includes a heat sink, a first circuit board located between the stator assembly and the heat sink, and a second circuit board located between the first circuit board and the stator assembly.

[0006] The present disclosure provides, in another aspect, a string trimmer including a handle unit having a housing that defines a grip portion and a battery receptacle. The string trimmer also includes a head unit including a rotatable trimmer head and a motor configured to rotate the trimmer head. The string trimmer further includes a shaft assembly extending along an axis between the handle unit and the head unit to couple the handle unit to the head unit. The string trimmer also includes a handle coupled to the shaft assembly between the handle unit and the head unit. The string trimmer further includes a counterweight disposed within the housing between the grip portion and the battery receptacle, wherein the axis intersects the counterweight.

[0007] The present disclosure provides, in another aspect, a string trimmer including a handle unit having a housing that defines a grip portion, a trigger assembly, and a mode selection shuttle switch movable between a first position and a second position. The string trimmer also includes a head unit including a rotatable trimmer head and a motor configured to rotate the trimmer head. The string trimmer further includes a shaft assembly coupling the handle unit to the head unit. When the mode selection shuttle switch is in the first position, the motor is configured to operate in a high speed mode corresponding to a first rotational speed of the trimmer head. When the mode selection

shuttle switch is in the second position, the motor is configured to operate in a low speed mode corresponding to a second rotational speed of the trimmer head less than the first rotational speed. [0008] Other features and aspects of the disclosure will become apparent by consideration of the following detailed description and accompanying drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a perspective view of an outdoor tool, such as a string trimmer, according to one embodiment.

[0010] FIG. 2 is a perspective view of a head unit of the string trimmer of FIG. 1.

[0011] FIG. 3 is a perspective view of portions of the string trimmer of FIG. 1.

[0012] FIG. 4 is a perspective view of a power head of the string trimmer of FIG. 1.

[0013] FIG. 5 is a perspective view of the power head of FIG. 4 with portions removed.

[0014] FIG. 6 is a cross-sectional view of the power head of FIG. 4, taken along line 6-6 of FIG. 1.

[0015] FIG. 7 is a cross-sectional view of the head unit of FIG. 3, taken along line 6-6 of FIG. 1.

[0016] FIGS. 8 and 9 are perspective views of a motor assembly of the string trimmer of FIG. 1.

[0017] FIG. 10 is a cross-sectional view of the motor assembly of FIG. 8, taken along line 10-10 of FIG. 8.

[0018] FIGS. 11 and 12 are partially exploded perspective views of the motor assembly of FIG. 8.

[0019] Before any embodiments of the disclosure are explained in detail, it is to be understood that the disclosure is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The disclosure is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

DETAILED DESCRIPTION

[0020] FIG. 1 illustrates an embodiment of an outdoor tool, such as a string trimmer 10, including a handle unit 12 and a head unit 14 detachably coupled to the handle unit 12 by an elongated shaft assembly 16 that extends along an axis 18. The shaft assembly 16 includes a first shaft segment 20 affixed to the handle unit 12, a second shaft segment 22 affixed to the head unit 14, and a coupler 24 including substantially identical coupling members 24a, 24b (FIG. 3) operable to couple the shaft segments 20, 22. A coupler of this type is described and illustrated, for example, in U.S. Provisional Patent Application No. 62/637,793, filed Mar. 2, 2018, entitled “COUPLER FOR A TOOL”, and in corresponding U.S. patent application Ser. No. 16/280,799, filed Feb. 20, 2019, entitled “COUPLER FOR A TOOL”, each of which is incorporated herein by reference in its entirety. The string trimmer 10 also includes a handle 26 coupled to the first shaft segment 20 and configured to be grasped by a user to hold the string trimmer 10 during operation.

[0021] With reference to FIGS. 2 and 7, the head unit 14 includes a head housing assembly 28 comprising a gear case 30 coupled to the second shaft segment 22, and a motor case 32 coupled to the gear case 30. The head unit 14 also includes an electric motor 34 supported within the motor case 32, an output shaft 36 rotatably coupled to a motor shaft 37 of the electric motor 34, and a gear assembly 38 that couples the motor shaft 37 to the output shaft 36 to provide a gear reduction therebetween. The head unit 14 further includes a trimmer head 40 supported on the output shaft 36. A flexible line of string 42 made from a suitable material, e.g., a plastic material such as nylon, is wound within the trimmer head 40 and includes one or more end portions extending outward from the trimmer head 40. As the trimmer head 40 rotates with the output shaft 36, the string 42 serves as a cutting blade, for example, to cut grass, weeds, or other vegetation as desired. The head unit 14 also includes a shroud 44 that protects the user from airborne debris stirred up during

operation of the string trimmer **10**.

[0022] With reference to FIGS. **4-6**, the handle unit **12** includes a handle housing assembly **46**, which may be formed, as shown in the illustrated construction, of two clamshell housing halves **46a**, **46b** (FIG. **4**). Together, the housing halves **46a**, **46b** define a compartment **48** (FIG. **6**) containing a counterweight **50** and other internal components (e.g., wiring, etc.) of the handle unit **12**. The handle housing assembly **46** also includes a battery receptacle **52** configured to selectively mechanically and electrically connect to a rechargeable battery pack (not shown) for supplying power to the string trimmer **10**. The handle housing assembly **46** further defines a grip portion **56** (FIG. **4**) supporting a trigger assembly **58** operable to selectively electrically connect the power source (e.g., the battery pack) and the motor **34**.

[0023] With reference to FIGS. **5** and **6**, the counterweight **50**, in the illustrated embodiment, may comprise a generally cylindrically shaped body and can be formed from any suitable material, e.g., metals, plastics, composites, ceramics, or other materials. Since the motor **34** is located within the head unit **14** (FIG. **7**), the counterweight **50** serves to counterbalance or offset the weight of the motor **34**, so that the string trimmer **10** is generally balanced about the handle **26**. The counterweight **50** is positioned within the handle housing assembly **46** at an end region adjacent the battery receptacle **52**, and between the battery receptacle **52** and the grip portion **56**. As such, the counterweight **50** generates a moment about the grip portion **56** and the handle **26** to at least partially offset the moments generated by the weight of the head unit **14** about the grip portion **56** and the handle **26**. In the illustrated embodiment, the counterweight **50** is positioned generally in-line with the shaft assembly **16**, and the counterweight **50** is intersected by the axis **18**. By positioning the counterweight **50** in-line with the axis **18** of the shaft assembly **16**, the illustrated embodiment prevents the counterweight **50** from acting as an eccentric mass and introducing additional undesired vibrations when the string trimmer **10** is vibrating radially about the axis **18**.

[0024] With reference to FIG. **5**, in the illustrated construction, the trigger assembly **58** may include a “2-motion” trigger assembly **58** with a trigger **60** on one side of the grip portion **56** and a (“shark fin”) lock-off member **62** on an opposite side of the grip portion **56**. The trigger **60** is operable to actuate a microswitch **64** to selectively activate and deactivate the motor **34** during operation of the string trimmer **10**. The lock-off member **62** selectively prevents operation of the trigger **60**. Specifically, the lock-off member **62** is pivotable to selectively lock and unlock the trigger **60**. In operation, the user first presses the lock-off member **62**, thereby freeing the trigger **60**, and then presses the trigger **60** to activate the motor **34**. If the user attempts to press the trigger **60** without first pressing the lock-off member **62**, the trigger **60** is prevented from actuating due to engagement with the lock-off member **62**.

[0025] FIGS. **8-12** illustrate the motor **34**, which includes a rotor assembly **66** affixed to the motor shaft **37**, a stator assembly **68** surrounding the rotor assembly **66**, a fan **70** coupled to the rotor assembly **66**, and a printed circuit board (PCB) assembly **72** coupled to the stator assembly **68**. The PCB assembly **72** is coupled to a first end **74** (FIG. **11**) of the stator assembly **68**, and the fan **70** is located adjacent a second end **76** of the stator assembly **68** opposite the first end **74**. The motor shaft **37** is rotatably supported by a first bearing **78** that resides in a first bearing pocket **80** formed in the motor case **32**, and is further supported by a second bearing **82** that resides in a second bearing pocket **84** formed in the gear case **30**.

[0026] With reference to FIGS. **10-12**, the stator assembly **68** includes an annular stator core **86** that defines inwardly extending poles **88**, a molded insulator member **90** affixed to the stator core **86**, and coils **92** that are wound about the poles **88**. The insulator member **90** defines, in the illustrated embodiment, four threaded bosses **94** (FIG. **11**) that receive threaded fasteners **96** to secure the PCB assembly **72** to the stator assembly **68**. In other embodiments (not shown), in lieu of the threaded bosses, the insulator member **90** may instead include other mounting features (e.g., snap hooks, etc.) for securing the PCB assembly **72** to the stator assembly **68** (e.g., by interference fit or snap fit).

[0027] The PCB assembly 72 includes a first PCB 98, a heat sink 100 coupled to a first side 102 of the first PCB 98, and a second PCB 104 coupled to a second side 106 of the first PCB 98 opposite the first side 102. Thus arranged, the second PCB 104 is positioned between the stator assembly 68 and the first PCB 98, and the first PCB 98 is positioned between the second PCB 104 and the heat sink 100.

[0028] In the illustrated embodiment, the first PCB 98 comprises a power supply that supplies power to the coils 92, and also comprises a controller 98a that controls operation of the motor 34. The second PCB 104 comprises a Hall effect board that senses an angular position of the rotor assembly 66. The heat sink 100 includes a radial wall 108 that contacts the first PCB 98 to draw away heat therefrom, and also includes axially extending cooling flanges 110 that protrude from an outer circumferential edge of the radial wall 108 and extend generally toward the stator assembly 68. The cooling flanges 110 increase a thermal surface area and mass of the heat sink 100 to improve heat dissipation from the PCB assembly 72.

[0029] In many typical electric-powered string trimmers, the electronics (e.g., such as the motor power supply and control circuit boards) are located within the handle unit rather than within the head unit as done with the string trimmer 10. Since the PCB assembly 72 of the illustrated string trimmer 10 is provided in the head unit 14, the PCB assembly 72 is directly exposed to an airflow generated by the fan 70 of the motor 34. This advantageously improves heat dissipation from the PCB assembly 72 and may eliminate a need for an auxiliary cooling mechanism for the PCB assembly 72. In addition, the stacked arrangement of the first PCB 98, the heat sink 100, and the second PCB 104 described above provides a compact configuration for positioning the electronics close to the motor 34 and in direct contact with the airflow generated by the fan 70.

[0030] With reference to FIG. 4, the string trimmer 10 includes a mode change shuttle switch 112 located proximate the grip portion 56 and proximate the trigger assembly 58. The mode change shuttle switch 112 is provided sufficiently close to the trigger assembly 58 such that the user may switch between operating modes with one hand, while simultaneously gripping the grip portion 56 and/or operating the trigger assembly 58. In the illustrated embodiment, the mode change shuttle switch 112 is located on a same side of the handle unit 12 as the lock-off member 62, while the trigger 60 is located on an opposite side of the handle unit 12. The mode change shuttle switch 112 is also located forward of the lock-off member 62, i.e., between the lock-off member 62 and the handle 26. The mode change shuttle switch 112 is electrically connected to the first PCB 98, and in particular the controller 98a that controls operation of the motor 34. When the mode change shuttle switch 112 is in a first position, the controller places the string trimmer 10 in a high speed mode. When the mode change shuttle switch 112 is in a second position, the controller 98a places the string trimmer 10 in a low speed mode. The high speed mode corresponds to a relatively fast rotational speed for the trimmer head 40, and the low speed mode corresponds to a relatively slow rotational speed for the trimmer head 40. The controller 98a may receive a logic high or logic low signal from the shuttle switch 112 and selects the low speed mode or the high speed mode based on the signal from the shuttle switch 112.

[0031] In operation of the string trimmer 10, the user holds the string trimmer 10 by grasping the grip portion 56 with one hand and by grasping the handle 26 with the other hand, and points the head unit 14 toward the area that is to be trimmed. To begin trimming, the user first presses the lock-off member 62, thereby freeing the trigger 60, and then presses the trigger 60 to activate the motor 34. To switch the string trimmer 10 between the high speed and low speed modes, the user slides the shuttle switch 112 between the first position and the second position.

[0032] Various features of the disclosure are set forth in the following claims.

Claims

1. A string trimmer comprising: a handle unit including a housing that defines a grip portion and a battery receptacle; a head unit including a rotatable trimmer head and a motor configured to rotate the trimmer head; a shaft assembly extending along an axis between the handle unit and the head unit to couple the handle unit to the head unit; a handle coupled to the shaft assembly between the handle unit and the head unit; and a counterweight disposed within the housing between the grip portion and the battery receptacle, wherein the axis intersects the counterweight.
 2. The string trimmer of claim 1, wherein the counterweight comprises a cylindrically shaped body.
 3. The string trimmer of claim 1, wherein the grip portion supports a trigger assembly that includes a trigger and a lock-off member, the trigger being operable to selectively activate the motor and the lock-off member being configured to selectively prevent actuation of the trigger, and wherein the trigger is located on a first side of the grip portion and the lock-off member is located on a second side of the grip portion opposite the first side.
 4. The string trimmer of claim 1, wherein the motor comprises an electric motor including a rotor assembly, a stator assembly surrounding the rotor assembly, and a circuit board assembly coupled to an axial end of the stator assembly.
 5. The string trimmer of claim 4, wherein the circuit board assembly includes a heat sink, a first circuit board located between the stator assembly and the heat sink, and a second circuit board located between the first circuit board and the stator assembly.
 6. The string trimmer of claim 5, wherein the first circuit board comprises a controller configured to control operation of the electric motor, and wherein the second circuit board is configured to detect an angular position of the rotor assembly.
 7. The string trimmer of claim 6, wherein the electric motor further includes a plurality of coils, and wherein the first circuit board further comprises a power supply configured to supply power to the coils.
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