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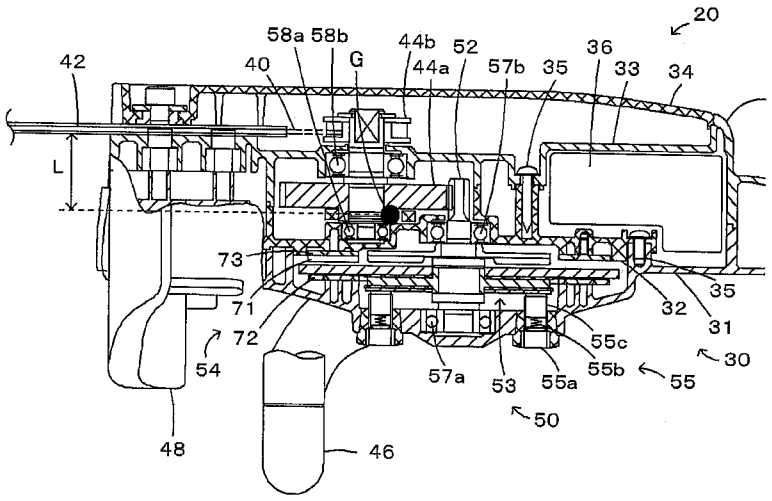
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(54) **Title**: CHAIN SAW

FIG. 4



(57) **Abstract**: A chain saw for cutting an object to be cut by rotating a saw chain, the chain saw including: a motor including, a rotor which rotates together with an output shaft, and a stator, wherein the motor has a flat shape, and wherein the axial direction of the output shaft is substantially perpendicular to a rotational plane of the saw chain.

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DESCRIPTION

CHAIN SAW

TECHNICAL FIELD

Aspects of the present invention relate to a chain saw for cutting trunks and branches of trees.

BACKGROUND ART

As this type of chain saws, there are known either gasoline-powered or electric-powered chain saws in general. As the latter type of the chain saws, there is a chain saw in which a motor is accommodated in a housing and a sprocket chain (a saw chain) is wound around a guide bar projecting from the housing, whereby the saw chain rotates along the guide bar by means of power from the motor (refer to JP-A-H08-250882, for example). As one example of such a known chain saw, an example of an external appearance of a chain saw 120 is shown in Fig. 10, and a top view of the chain saw 120 is shown in Fig. 11. Note that Fig. 11 is the top view which is partially sectional so that an interior thereof can partially be clarified for understanding. In this chain saw 120, as is shown in Figs. 10 and 11, a motor 150 is disposed within a housing 130 so that an output shaft 152 of the motor 150 is perpendicular to a rotational plane of a saw chain 140. Then, when power is outputted from the motor 150, the power is transmitted from the output shaft 152 to a spur gear 144a. A saw chain passive shaft 144b rotates together with the spur gear 144a as the spur gear 144a rotates, and the saw chain 140 receives the power from the saw chain passive shaft 144b and rotates along a side surface of a guide bar 142. When the motor

150 is disposed so that the output shaft 152 is perpendicular to the rotational plane of the saw chain 142 in the way described above, axial directions of the individual portions to which the power is transmitted can be made parallel to each other. Therefore, compared with a case in which the motor 150 is disposed so as to be parallel to the rotational plane of the saw chain 140, not only can the power transmission efficiency be increased but also vibrations and noise generated by the chain saw 120 can be reduced.

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

In the chain saw 120, however, as is shown in Figs. 10 and 11, the motor 150 projects largely in the direction which is perpendicular to the rotational plane of the saw chain 140, and a distance L defined between the rotational plane of the saw chain 140 and the center of gravity G of the chain saw 120 becomes long. When the distance L between the rotational plane of the saw chain 140 and the center of gravity G of the chain saw 120 becomes long so that they have to be spaced largely away from each other, a large force is necessary to maintain the weight balance when the chain saw 120 is operated, or the cutting point of the chain saw 120 is spaced away from the position of the gripping hand of the operator, the operability being thereby deteriorated. In addition, when the chain saw 120 is operated so that the rotational plane of the saw chain 140 becomes horizontal with respect to the ground as when the operator wants to cut an object to be cut horizontally, if the motor 150 projects largely from the rotational plane of

the saw chain 140, the view of the operator is interrupted by the motor 150.

The invention has been made in view of these situations, and an object thereof is to provide a chain saw which is smaller in size, which has a better weight balance and which is superior in operability.

MEANS FOR SOLVING THE PROBLEMS

According to an aspect of the invention, there is provided a chain saw for cutting an object to be cut by rotating a saw chain, the chain saw including: a motor including, a rotor which rotates together with an output shaft, and a stator, wherein the motor has a flat shape, and wherein the axial direction of the output shaft is substantially perpendicular to a rotational plane of the saw chain.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is an external side view showing an example of an external appearance of a chain saw according to an exemplary embodiment of the invention;

Fig. 2 is a top view of the chain saw;

Fig. 3 is an external rear view of the chain saw when the external appearance of the chain saw is seen from a rear side thereof;

Fig.4 is an enlarged view resulting of a portion surrounded by alternate long and short dash lines in Fig. 2;

Fig. 5 is an enlarged view of a portion near a rotor of a motor in Fig. 4;

Fig. 6 is an exploded view showing an example of a state in which an output shaft, a fan and the rotor are disassembled;

Fig. 7 is an explanatory diagram showing an example of a state in which the rotor is seen axially from the side of a commutator disk;

Fig. 8 is an explanatory diagram showing an example of a state in which a coil disk is seen axially;

Fig. 9 is a top view of a modified chain saw;

Fig. 10 is an external perspective view showing an example of an external appearance of a known chain saw; and

Fig. 11 is a top view of the known chain saw.

DETAILED DESCRIPTION

Fig. 1 is an external side view showing an example of an external appearance of a chain saw 20 according to an exemplary embodiment of the invention, Fig. 2 is a top view of the chain saw 20, and Fig. 3 is an external rear view of the chain saw 20 when the external appearance of the chain saw is seen from a rear side thereof. Note that in order to facilitate understanding of an interior construction of the chain saw 20, part of an internal section of the chain saw 20 is shown. In addition, in the following description, a cutting direction (an up-to-down direction in Figs. 1 and 3) of the chain saw 20 is referred to as a "vertical direction." A direction in which a saw chain 40 extends from a housing 30 of the chain saw 20 (a left-to-right direction in Figs. 1 and 2) is referred to as a "front-to-rear direction." A left-to-right direction in a state in which a rotational plane of the saw chain 40 is perpendicular to the ground (a down-to-up direction

in Fig. 2, a left-to-right direction in Fig. 3) is referred to simply as a "left-to-right direction."

As is shown in Figs. 1 to 3, a chain saw 20 of this exemplary embodiment includes a saw chain 40 which is a chain-like blade for cutting an object to be cut, a guide bar 42 round a circumferential edge of which the saw chain 40 is wound, a housing 30 which supports the guide bar 42, a motor 50 which is accommodated in the housing 30 for outputting power, a power transmission unit 44 which is also accommodated in the housing 30 for transmitting the power from the motor 50 to the saw chain 40, a handle 46 which is attached to the housing 30, a hand guard 48 for protecting a hand of the operator and a power supply cable 22 and a power supply plug 24 which can be connected to an exterior power supply for supplying electric power from the exterior power supply to the motor 50.

The saw chain 40 is a known saw chain which is made up of a plurality of mutually guidable cutting teeth which are connected to constitute a circular or oval blade. The saw chain 40 is wound round the circumferential edge of the guide bar 42 so as to rotate therealong. As is shown in Figs. 1 and 2, the guide bar 42 is mounted in the housing 30 so that part of the guide bar 42 is accommodated in the housing 30, while most of the guide bar 42 projects from the housing 30. The saw chain 40 is brought into engagement with a saw chain passive shaft 44b of the power transmission unit 44 at a position which is spaced away from a circumferential end of the guide bar 42 within the housing 30 and rotates in

association with rotation of the saw chain passive shaft 44b so as to slide along the periphery of the guide bar 42.

The housing 30 supports the saw chain 40 and the guide bar 42 and accommodates the motor 5 and the power transmission unit 44 in an interior thereof, forming an outer shell of the chain saw 20. A handle 30a is attached to a rear side of the housing 30. Fig. 4 shows an enlarged view of a portion of the chain saw 20 surrounded by alternate long and short dash lines in Fig. 2. The housing 30 is formed of a light and sturdy material (for example, a reinforced plastic). As is shown in Fig. 4, the housing 30 is made up of four support members such as a first support member 31 in which a plurality of vent openings 31a are formed for taking in outside air and which supports the motor 50 from the outside, a second support member 32 which support the motor 50 from the guide bar 42 side, a third support member 33 which supports the guide bar 42 from the motor 50 side and a fourth support member 34 which supports the guide bar 42 from an opposite side of a side where the motor 50 resides. These four support members 31 to 34 are disposed adjacent to each other and are connected to each other with screws (for example, a plurality of screws 35 in Fig. 4). In addition, the housing 30 also accommodates therein an oil supply mechanism, not shown, for supplying oil, an oil tank 36 for storing oil, and a power supply circuit, not shown, which electrically connects the power supply cable 24 with the motor 50. Additionally, as is shown in Fig. 1, an oil cap 36a is provided at an upper portion of the housing 30. The oil cap 36a communicates with the oil tank 36 and can be opened and closed by the

operator. A main switch 26 for switching on and off the motor 50 is provided to the handle 30a.

The motor 50 has a flat shape. The motor 50 is configured as a commutator motor which receives electric power and outputs power to an output shaft 52. The motor 50 includes the output shaft 52, a fan 56 which is connected to the output shaft 52 so as to rotate together with the output shaft 52, a rotor 53 which is also connected to the output shaft 52 so as to rotate together with the output shaft 52, and a stator 54 and a slider 55 which are supported on the housing 30. Fig. 5 shows an enlarged view of a portion near the rotor 53 of the motor 50 in Fig. 4, and Fig. 6 shows an example of a state in which the output shaft 52, the fan 56 and the rotor 53 are disassembled.

As is shown in Fig. 4, the output shaft 52, the fan 56 and the rotor 53 are supported by the housing 30 by a bearing 57a which is supported by the first support member 31 and a bearing 57b which is supported by the second support member 32. The output shaft 52 has a flange portion 52a which can support the fan 56 and the rotor 53. The fan 56 is attached to one end side of the flange portion 52a, and the rotor 53 is attached to the other end thereof, whereby the output shaft 52, the fan 56 and the rotor 53 are made to rotate together. The fan 56 is formed of, for example, an aluminum alloy or a reinforced plastic and has a plurality of blade portions 56a which extend towards the rotor 53 so that air is sent to the rotor 53 and the stator 54 when it rotates together with the output shaft 52.

As is shown in Figs. 5 and 6, the rotor 53 includes a flange 61, a commutator disk 62, a coil substrate 63 which is formed of four stacked coil disks 64 and a plurality of insulation plates 67, 68. The flange 61 is formed of, for example, an aluminum alloy, and has a hollow cylindrical shaft portion 61a and a disk-shaped flange portion 61b which extends from the shaft portion 61a. In the flange 61, an inner circumferential surface of the shaft portion 61a is fixedly fitted on an outer circumferential surface of the output shaft 52 so as not to rotate relative to each other. The commutator disk 62 is attached to one end side of the flange portion 62b via the insulation plate 67, and the coil substrate 63 is attached to the other end side of the flange portion 62b via the insulation plate 68.

The commutator disk 62 and the four coil disks 64 are each configured of a printed circuit board which is made up of an insulator substrate and a conductor pattern. Fig. 7 shows an example of a state in which the rotor 53 is seen in an axial direction from the commutator disk 62 side, and Fig. 8 shows an example of a state in which the coil disk 64 is seen in the axial direction. As is shown in Figs. 5 to 8, the commutator disk 62 and the four coil disks 64 are each formed into a disk shape with a hole opened in the center thereof so that the shaft portion 61a of the flange 61 is inserted therethrough.

Commutator conductor patterns are formed in an annular shape on an upper surface (a lower surface in Figs. 4 to 6) of the commutator disk 62,

and coil conductor patterns are formed in an annular shape each on an upper surface and a lower surface of the coil disk 64. Through holes 64a, 64b are provided in positions corresponding to inner circumferential and outer circumferential end portions of the conductor patterns so as to extend axially through the coil disk 64. Solder is filled in these through holes 64a, 64b so as to electrically connect together the conductor pattern formed on the upper surface and the conductor pattern formed on the lower surface of the coil disk 64. By this configuration, a plurality of coils 64c each having a U-like shape as seen in the axial direction are formed on the coil disk 64. Then, the four coil disks 64 are stacked one on another so that the conductor patterns formed thereon coincide with each other or are shifted by a predetermined angle from each other as seen in the axial direction, whereby the coil substrate 63 is formed. In addition, through holes 62a are provided in positions corresponding to outer circumferential end portions of the conductor patterns on the commutator disk 62 so as to extend axially through the commutator disk 62. Then, holes are also provided in the two insulation plates 67, 68 and the flange portion 61b of the flange 61 in positions corresponding to the through holes 62a so as to extend axially through the insulation plates 67, 68 and the flange portion 61b, and an insulation material is provided on an inner circumference of each hole. The commutator conductor patterns on the commutator disk 62 and the plurality of coils 64c of the coil disks 64 are electrically connected via solder filled in the through holes 62a and the holes or via connection pins fitted in the through holes 62a and the holes.

As is shown in Figs. 4 and 5, the stator 54 is made up of a magnet 71 which is a permanent magnet and a pair of yokes, that is, an upper yoke 72 and a lower yoke 73. The upper yoke 72 and the lower yoke 73 are each formed of a magnetic material such as iron and have an annular disk shape. The upper yoke 72 and the lower yoke 73 are fixed to the housing 30. The upper yoke 72 is screwed to the first support member 31 so as to face an upper surface (a lower surface in Figs. 4 and 5) of the rotor 53. Specifically, the upper yoke 72 is screwed to the first support member 31 so as to be disposed further radially outwards than the commutator disk 62 to thereby face the coils 64c of the coil disk 64. The lower yoke 73 is screwed to the second support member 32 so as to face a lower surface (an upper surface in Figs. 4 and 5) of the rotor 53. Specifically, the lower yoke 73 is screwed to the second support member 32 so as to face the coils 64c of the coil disk 64. The magnet 71 has a plurality of magnet poles which are aligned in a circumferential direction and is formed in an annular shape. The magnet 71 is secured to an upper surface (a lower surface in Figs. 4 and 5) of the lower yoke 73. By this configuration, the upper yoke 72 and the lower yoke 73 form a magnetic path which enables a magnetic flux generated by the magnet 71 to pass through the commutator disk 62 and the coil disks 64 in an axial direction of the output shaft 52. Note that the magnet 71 and the upper yoke 72 and the lower yoke 73 configure a magnetic flux generation portion of the invention.

The slider 55 is fixed to the first support member 31 of the housing 30 so as to slide on the upper surface (the lower surface in Figs. 4 and 5) of

the rotor 53 or precisely so as to slide on the commutator disk 62. The slider 55 includes a brush holder 55a which is fixed to the housing 30, a spring 55b and a brush 55c which is formed of a material having electric conductivity (for example, carbon), and the brush 55c is pressed against the rotor 53 by a biasing force of the spring 55c which is supported on the brush holder 55a. In addition, the slider 55 is connected to the power supply cable 24 via a power supply circuit, not shown, which is accommodated in the housing 30.

As is shown in Fig. 4, the power transmission unit 44 includes a spur gear 44a which is brought into engagement with the output shaft 52 of the motor 50 and a saw chain passive shaft 44b which rotates together with the spur gear 44a. The spur gear 44a and the saw chain passive shaft 44b are disposed so that their axes are parallel to the output shaft 52 of the motor 50 and are rotatably supported on the housing 30 by a bearing 58a which is fixed to the second support member 32 and a bearing 58b which is fixed to the third support member 33. As been described above, the saw chain 40 is in engagement with the saw chain passive shaft 44b, so that when the saw chain passive shaft 44 rotates, the saw chain 40 rotates while sliding along the circumferential edge of the guide bar 42 in association with rotation of the saw chain passive shaft 44b.

As is shown in Figs. 1 and 3, the handle 46 is formed into a single rod-like member and is bent in several positions along the length thereof so that the operator can grip and hold it. The handle 46 is attached to the

housing 30 at both ends thereof. As is shown in Figs. 1 and 3, the handle 46 has a first grip portion 46a which extends in the vertical direction (in the direction in which the chain saw 20 cuts an object to be cut) so that the operator can grip to hold it in a position which is spaced away from the housing 30 in the left-to-right direction (in the axial direction of the output shaft 52 of the motor 50) and a second grip portion 46b which extends in the left-to-right direction so that the operator can grip and hold the handle 46 in a position which is spaced away from the housing 30 in the vertical direction. The handle 46 is attached to a lower side of the first support member 31 of the housing 30 which covers the motor 50 from the outside at one end at a first grip portion 46a side and is attached to an upper side of the fourth support member 34 of the housing 30 which covers the guide bar 42 from the opposite side to the side where the motor 50 resides at the other end at a second grip portion 46b side of the handle 46. In addition, in the exemplary embodiment, the handle 46 is provided near the motor 50, and the first grip portion 46a of the handle 46 is provided so as to overlap with the motor 50 when seen in the axial direction of the output shaft 52 of the motor 50. With the handle 46 formed in the way described above, the operator holds the handle 30a of the housing 30 with one hand and holds the second grip portion 46b with the other hand so that he or she can implement a cutting operation easily with the rotational plane of the saw chain 40 oriented normal to the ground. In addition, the operator holds the handle 30a of the housing 30 with one hand and holds the first grip portion 46a with the other hand so that he or she can implement a cutting operation easily with the rotational plane of the saw chain 40 oriented parallel to the

ground. In addition, because the handle 46 is provided near the motor 50, the operator is allowed to hold the chain saw 20 in a position lying near the motor 50 which occupies a dominant portion of the total weight of the chain saw 20, this making the chain saw 20 easy to be held.

As is shown in Fig. 1 and the like, the hand guard 48 is attached to the housing 30 in a position lying closer to the saw chain 40 (further forwards) than the handle 46 so as to protect the hand of the operator with which the handle 46 is gripped. The hand guard 48 is attached to the housing so as to oscillate slightly, so that when the hand guard 48 is inclined towards the saw chain 40, a brake is applied so as to suppress the rotation of the saw chain 40, whereby the saw chain 40 is made to stop rotating momentarily. In this exemplary embodiment, the hand guard 48 is described as being provided only on a front side of the second grip portion 46b which is disposed near the rotational plane of the saw chain 40. However, a hand guard may be provided on a front side of the first grip portion 46a.

The power supply plug 22 and the power supply cable 22 are a known power supply plug and power supply cable, respectively, and are formed so as to supply electric power to the power supply circuit, not shown, disposed in the housing 30. In the exemplary embodiment, a domestic AC power supply is used as an exterior power supply for the chain saw 20. When the main switch 26 is triggered on by the operator with the power supply plug 22 inserted in such an AC power supply, electric power of the

AC power supply supplied from the power supply plug 22 and the power supply cable 24 is converted into a predetermined direct current voltage by the power supply circuit in the housing 30 so as to be supplied to the motor 50.

In the chain saw 20 of the exemplary embodiment which is configured as has been described heretofore, when the operator actuates the main switch while holding near the handle 30a of the housing 30 with one hand and the handle 46 with the other hand thereof, a predetermined voltage is applied to the slider 55 of the motor 50. The voltage applied to the slider 55 of the motor 50 is then applied to the coils 64c of the rotor 53 via the commutator disk 62. The magnetic flux generated by the stator 54 passes through the rotor 53 in the axial direction and a current flowing to the rotor 53 flows perpendicular to the magnetic flux and an axis of the output shaft 52. Therefore, a rotational force is generated about the output shaft 52, whereby the rotor 53 and the output shaft 52 rotate. Then, when the output shaft 52 of the motor 50 rotates, the spur gear 44 which is in engagement with the output shaft 52 rotates and the saw chain passive shaft 44b rotates which is fixed concentrically with the spur gear 44b. When the saw chain passive shaft 44b rotates, the saw chain 40 rotates while sliding on the circumferential edge of the guide bar 42. Then, the operator presses the rotating saw chain 40 against an object to be cut so as to cut the object.

In addition, when the hand of the operator cutting the object to be cut by employing the chain saw 20 slips or the chain saw 20 is swung back

(kicked back) towards the operator for some reason to thereby cause the hand guard 48 to be inclined towards the saw chain 40, the brake is applied to suppress the rotation of the saw chain 40, whereby the saw chain 40 is stopped rotating momentarily, so as to ensure the safety of the operator. Further, in the chain saw 20 of the exemplary embodiment, oil is automatically supplied to the guide bar 42 and the saw chain 40 from the oil tank 36 by the oil supply mechanism, not shown, in association with the rotation of the saw chain 40.

In the chain saw 20 of the exemplary embodiment that has been described heretofore, the motor 50 includes the rotor 53 which rotates together with the output shaft 52 and the stator 54 which is fixed to the housing 30. The rotor 53 has the disk-shaped coil disks 64 to each of which the plurality of coils 64c are arranged circumferentially about the output shaft 52 in a substantially annular shape when seen in the axial direction of the output shaft 52. The stator 54 has the magnet 71 which generates the magnetic flux which passes through the coil disks 64 in the axial direction of the output shaft 52, as well as the upper yoke 72 and the lower yoke 73. The axial direction of the output shaft 52 is perpendicular to the rotational plane of the saw chain 40. Thus, the axes of the members which transmit the power from the motor 50 to the saw chain 40 can be aligned parallel to each other. According to this configuration, compared with a configuration in which the axial direction of the output shaft 50 is disposed parallel to the rotational plane of the saw chain 40, not only can the power transmission efficiency be increased, but also noise and

vibrations generated from the chain saw 20 can be reduced to lower levels.

Additionally, the motor 50 of the exemplary embodiment includes the disk-shaped rotor 53 which is made up of the commutator disk 62, which is the printed circuit board, and the four coil disks 64. When compared with a motor having coils which are wound round a so-called core, the rotor 53 of the motor 50 is advantageous in that the rotor 53 is light in weight and is highly efficient in power transmission. In addition, the rotor 53 does not need a so-called coil end (in a coil which is wound round a so-called core, a bent portion protruding from the core), and therefore, the motor 50 can be made flat and small, and additionally, the coils 64c can be restrained from being heated. Further, the rotor 53 having the above configuration has a large heat dissipating area and a high cooling capability to cool the coils 64c. Therefore, for example, the vent openings 31a formed in the first support member 31 of the housing 30 can be omitted or can be made relatively small.

In the chain saw 20 configured in the way described heretofore, by using the motor 50 which is smaller and flatter than the known motor, a reduction in thickness in the left-to-right direction and a reduction in weight can be realized. In addition, in the chain saw 20 configured as has been described above, compared with the conventional chain saw 120, a distance L defined between the center of gravity G of the chain saw 20 and the rotational plane of the saw chain 40 can be reduced, thereby providing a good weight balance. Thus, the operator can easily balance the chain saw

20 while in use. In addition, the operator can put his or her hand and eyes of closer to the cutting point, thereby making it possible to increase the operability.

Further, the motor 50 is flatter than the known motor, and therefore, as is shown in Fig. 3, a distance W of a space defined between the first grip portion 46a of the handle 46 which extends in the vertical direction and the housing 30 can be increased, and a length L1 of the first grip portion 46a itself and a length L2 of the second grip portion 46b itself can be made longer. Thus, the chain saw 20 can be made easy to be held. In addition, in the chain saw 20 of the exemplary embodiment, the first grip portion 46a of the handle 46 is disposed so as to coincide with the motor in the superposed fashion as seen in the axial direction of the output shaft 52. Therefore, the operator is allowed to hold the chain saw 20 at the position lying near the motor 50 which occupies the dominant portion of the total weight of the chain saw 20, this making the chain saw 20 easy to be held. In addition, the motor 50 is flatter than the known motor, and therefore, the motor 50 does not project largely from the rotational plane of the saw chain 40. In particular, when the operator manipulates the chain saw 20 by holding the first grip portion 46a so that the rotational plane of the saw chain 40 is parallel to the ground, a wide view can be ensured for the operator.

In the chain saw 20 described above, the housing 30 is described as being configured of the four support members 31 to 34. However, the

housing 30 only needs to support the motor 50 and the power transmission unit 44 and the guide bar 42, and therefore, the housing 30 may be configured of one to three support members or five or more support members.

In the chain saw 20 described above, the handle 46 is described as being attached to the housing 30. However, the handle 46 may be formed integrally with the housing 30. In addition, the handle 46 is described as having the first grip portion 46a and the second grip portion 46b. However, in place of the handle 46, there may be provided a first handle having a first grip portion 46a which extends in the vertical direction in a position which is spaced away from the housing 30 in the left-to-right direction (in the axial direction of the output shaft 52 of the motor 50) so as to be gripped and held by the operator and a second handle having a second grip portion 46b which extends in the left-to-right direction in a position which is spaced away from the housing 30 in the vertical direction so as to be gripped and held by the operator. In addition, the first grip portion 46a of the handle 46 may be provided so as not to overlap with the motor 50 when seen in the axial direction of the output shaft 52 of the motor 50. Further, the handle 46 may not have either of the first and second grip portions 46a, 46b and may be formed into an arc-like shape or any other shapes.

In the chain saw 20 described above, the rotor 53 of the motor 50 is described as being configured of the coil substrate 63 in which the four coil disks 64 are stacked one on another. However, only one coil disk 64 may

be provided or any other number than four of coil disks 64 may be stacked one on another so as to form a coil substrate. In addition, in place of the commutator disk 62, a coil/commutator disk may be used on which commutator conductor patterns are formed on an inner circumferential side and coil conductor patterns are formed on an outer circumferential side. Further, the commutator disk 62 and the coil disk 64 of the exemplary embodiment are configured of the printed circuit boards. However, they may be configured of thin coils which are arranged in a disk-like fashion.

In the chain saw 20 descried above, the stator 54 of the motor 50 is described as being made up of the magnet 71 and the upper yoke 72 and the lower yoke 73. However, the stator 54 only needs to be able to generate a magnetic flux which passes through the coil substrate 63 of the rotor 53 in the axial direction of the output shaft 52, and therefore, the stator 54 may be made up of a plurality of permanent magnets, electromagnets or coils only.

In the chain saw 20 described above, the motor 50 is described as including the rotor 53 having the coil disks 64 and the stator 54 having the magnet 71. However, the motor 50 may be a brush less motor which includes a stator having a coil disk and a rotor which generates a magnetic flux which passes through the coil disk in an axial direction of an output shaft.

In the chain saw 20 described above, the fan 56 is described as being attached to the output shaft 52, however, the output shaft 52 does not have

to have such a fan.

In the chain saw 20 described above, the motor 50 is described as being driven by the electric power supplied thereto via the power supply cable 22 and the power supply plug 24. However, the motor 50 may be driven by a battery. The battery is desirably disposed so as to be aligned with the motor 50 and the handle 30a into a substantially straight-line fashion. Thus, as is shown in a chain saw 20B according to a modified example shown in Fig. 9, a battery 28 may be attached to a rear end portion of a handle 30a. By adopting this configuration, even with the battery 28 so attached, a distance L between the center of gravity G of the chain saw 20B and a rotational plane of a saw chain 40 can be made small, thereby making it possible to increase the operability of the chain saw 20B.

According to an aspect of the invention, there is provided a chain saw which is smaller in size, which has the better weight balance and which is superior in operability.

While the exemplary embodiment of the invention has been described heretofore, the invention is not limited to the exemplary embodiment, and needless to say, the invention can be modified variously without departing from the spirit and scope of the invention.

The present invention provides illustrative, non-limiting aspects as follows:

According to a first aspect, there is provided a chain saw for cutting

an object to be cut by rotating a saw chain, the chain saw including: a motor including, a rotor which rotates together with an output shaft, and a stator, wherein the motor has a flat shape, and wherein the axial direction of the output shaft is substantially perpendicular to a rotational plane of the saw chain.

According to a second aspect, there is provided the chain saw according to the first aspect, wherein one of the rotor and the stator has a disk-shaped coil disk to which a plurality of coils are arranged circumferentially about the output shaft in a substantially annular shape when seen in an axial direction of the output shaft, and wherein another of the rotor and the stator has a magnetic flux generating portion for generating a magnetic flux which passes through the coil disk in the axial direction of the output shaft.

According to a third aspect, there is provided the chain saw according to the second aspect, wherein the coil disk is configured of a printed circuit board on which a conductor pattern of the coil is formed.

According to a fourth aspect, there is provided the chain saw according to the second aspect or the third aspect, wherein the magnetic flux generating portion includes a magnet.

According to a fifth aspect, there is provided the chain saw according to any of the second to fourth aspects, further including: a housing which accommodates the motor; and a handle having a grip portion which can be gripped by an operator at a position spaced away from the housing in the axial direction of the output shaft of the motor and is attached to the housing.

According to a sixth aspect, there is provided the chain saw according to the fifth aspect, wherein the grip portion is provided so as to overlap with the motor when seen in the axial direction of the output shaft of the motor.

According to a seventh aspect, there is provided the chain saw according to the fifth or sixth aspect, wherein the handle further includes a second grip portion which extends in a direction parallel to the axial direction of the output shaft of the motor and can be gripped by the operator.

According to an eighth aspect there is provided the chain saw according to any of the fifth to seventh aspects, further including: a hand guard which is provided on a side of the handle which faces the saw chain so as to project the hand of the operator.

This application claims priority from Japanese Patent Application No. 2010-212879 filed on September 22, 2010, the entire contents of which are incorporated herein by reference.

Industrial Applicability

According to an aspect of the invention, there is provided a chain saw which is smaller in size, which has the better weight balance and which is superior in operability.

CLAIMS

[Claim 1]

A chain saw for cutting an object to be cut by rotating a saw chain, the chain saw comprising:

a motor including,

a rotor which rotates together with an output shaft, and

a stator,

wherein the motor has a flat shape, and

wherein the axial direction of the output shaft is substantially perpendicular to a rotational plane of the saw chain.

[Claim 2]

The chain saw according to claim 1,

wherein one of the rotor and the stator has a disk-shaped coil disk to which a plurality of coils are arranged circumferentially about the output shaft in a substantially annular shape when seen in an axial direction of the output shaft, and

wherein another of the rotor and the stator has a magnetic flux generating portion for generating a magnetic flux which passes through the coil disk in the axial direction of the output shaft.

[Claim 3]

The chain saw according to claim 2,

wherein the coil disk is configured of a printed circuit board on which a conductor pattern of the coil is formed.

[Claim 4]

The chain saw according to claim 2 or 3,

wherein the magnetic flux generating portion includes a magnet.

[Claim 5]

The chain saw according to any of claims 2 to 4, further comprising:

a housing which accommodates the motor; and

a handle having a grip portion which can be gripped by an operator at a position spaced away from the housing in the axial direction of the output shaft of the motor and is attached to the housing.

[Claim 6]

The chain saw according to claim 5,

wherein the grip portion is provided so as to overlap with the motor when seen in the axial direction of the output shaft of the motor.

[Claim 7]

The chain saw according to claim 5 or 6,

wherein the handle further includes a second grip portion which extends in a direction parallel to the axial direction of the output shaft of the motor and can be gripped by the operator.

[Claim 8]

The chain saw according to any of claims 5 to 7, further comprising:

a hand guard which is provided on a side of the handle which faces the saw chain so as to project the hand of the operator.

FIG. 1

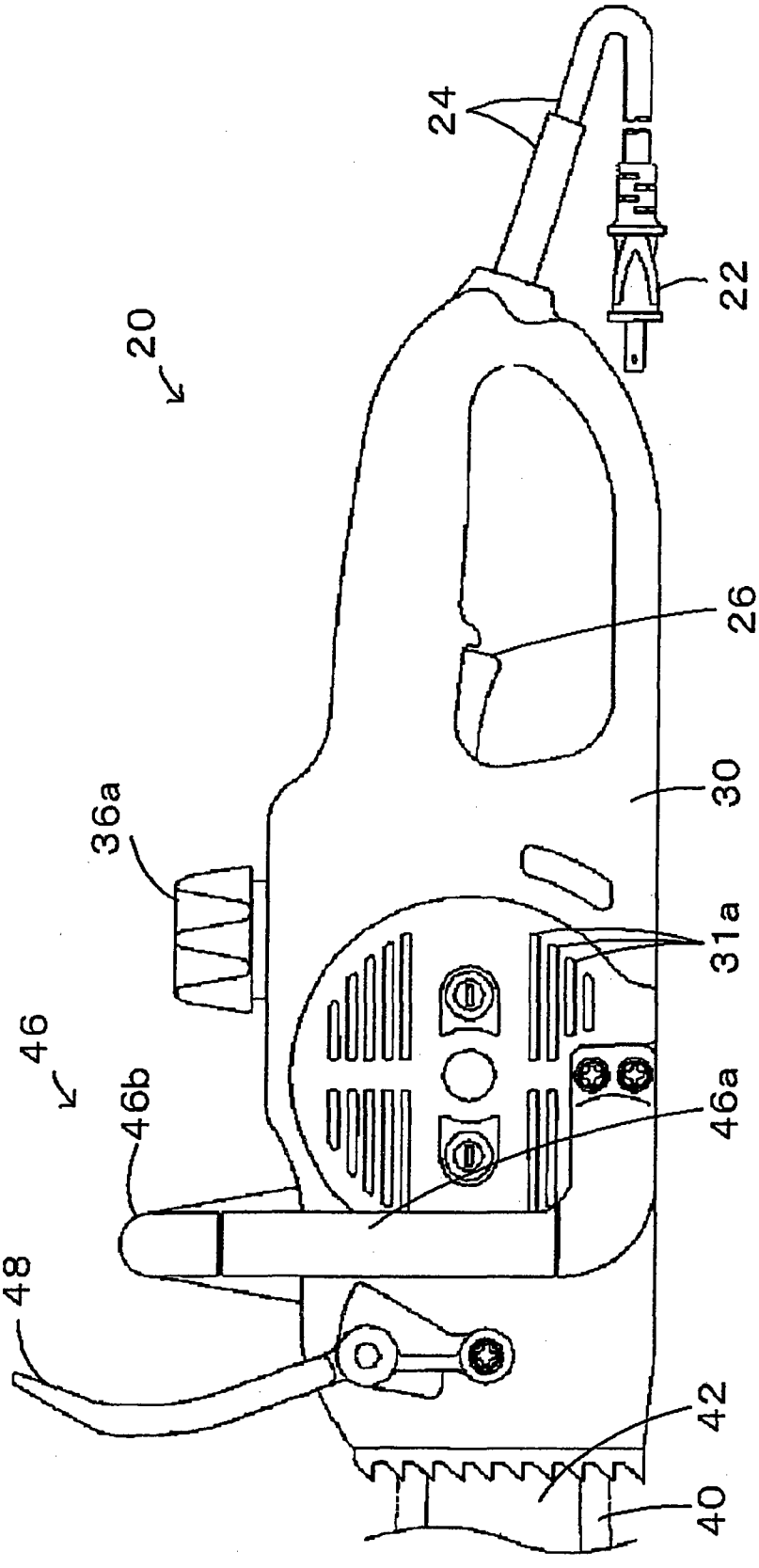


FIG. 2

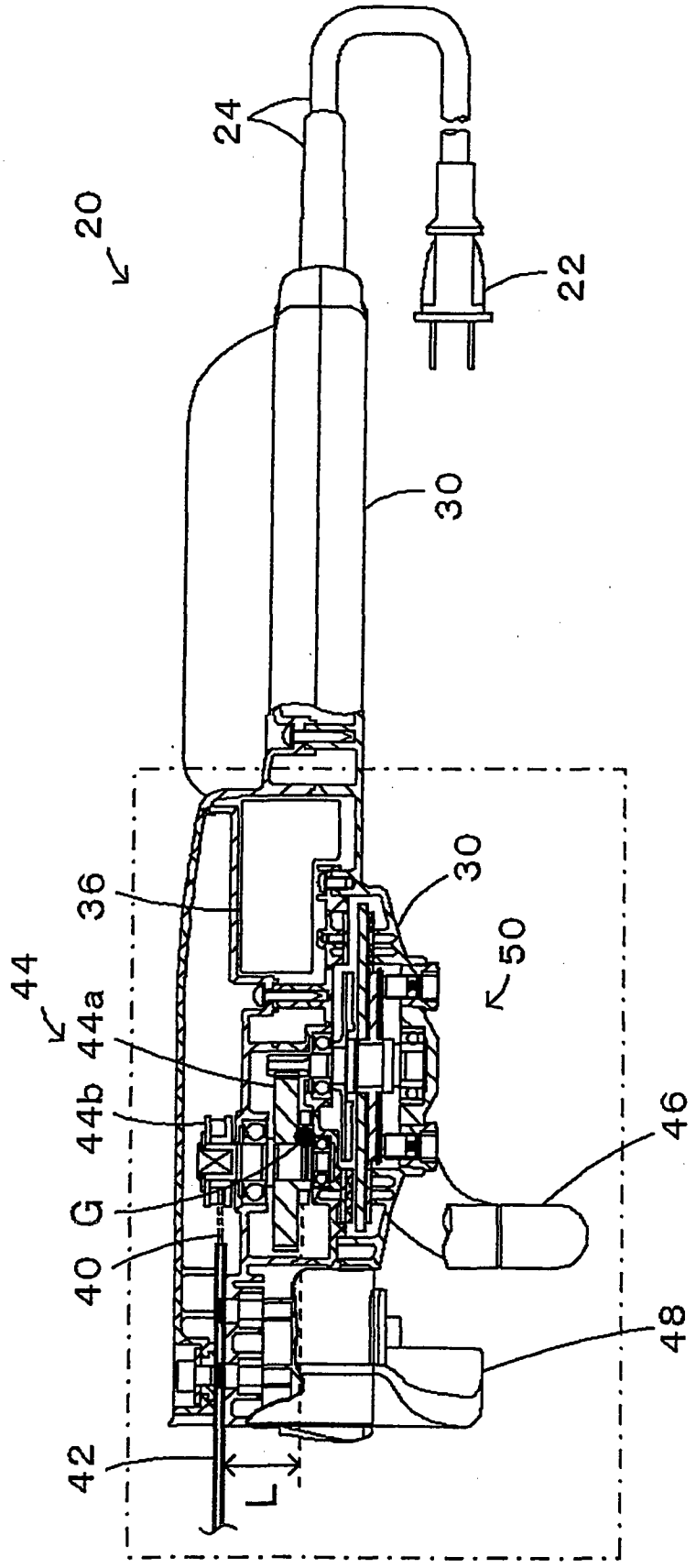


FIG. 3

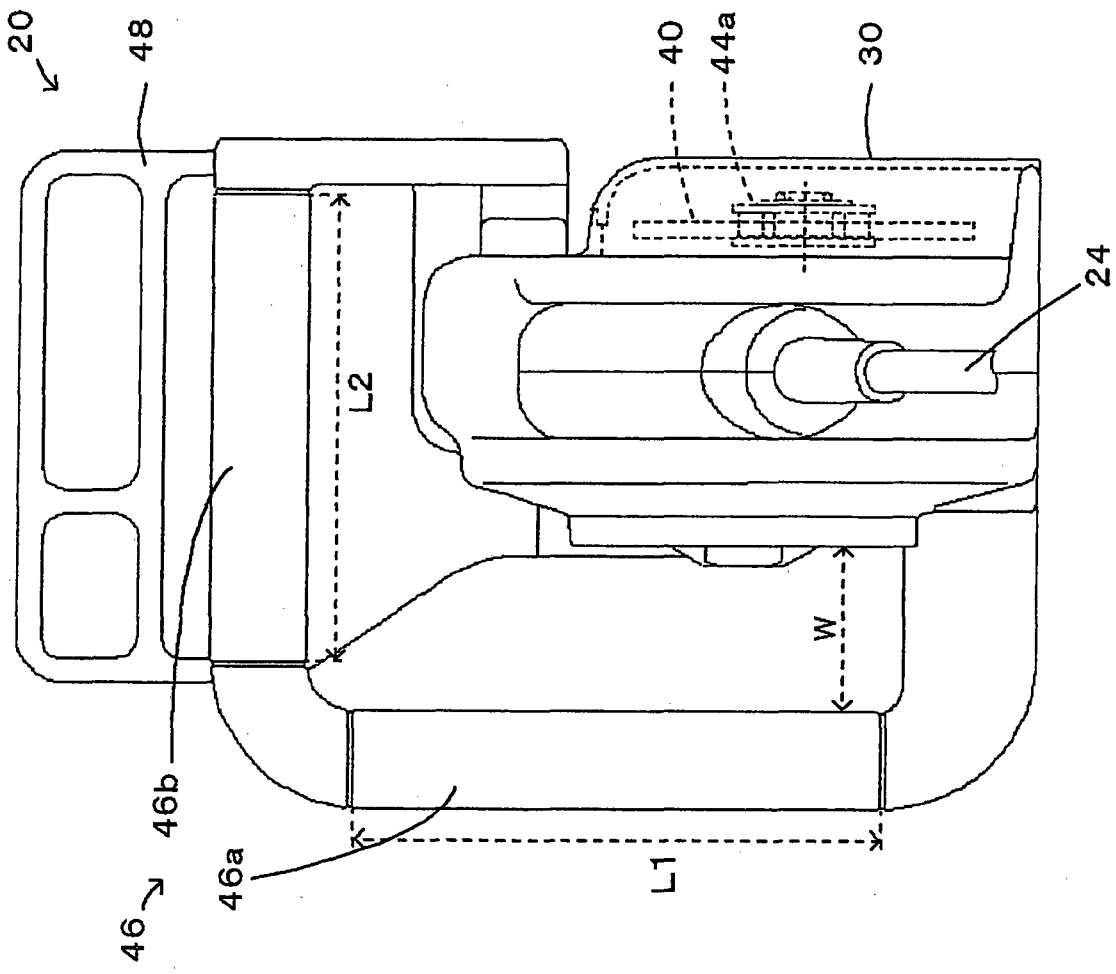


FIG. 4

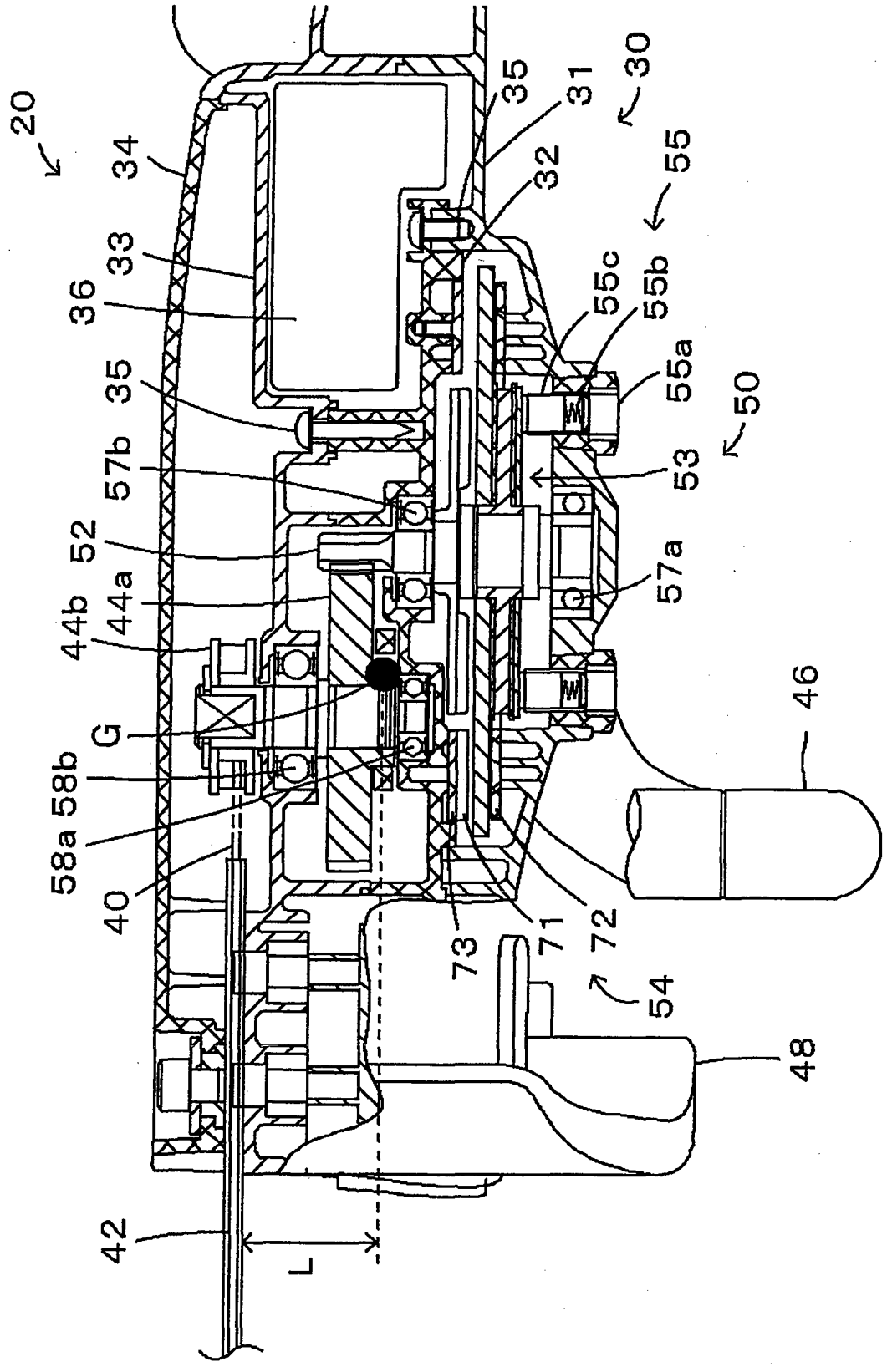

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FIG. 5

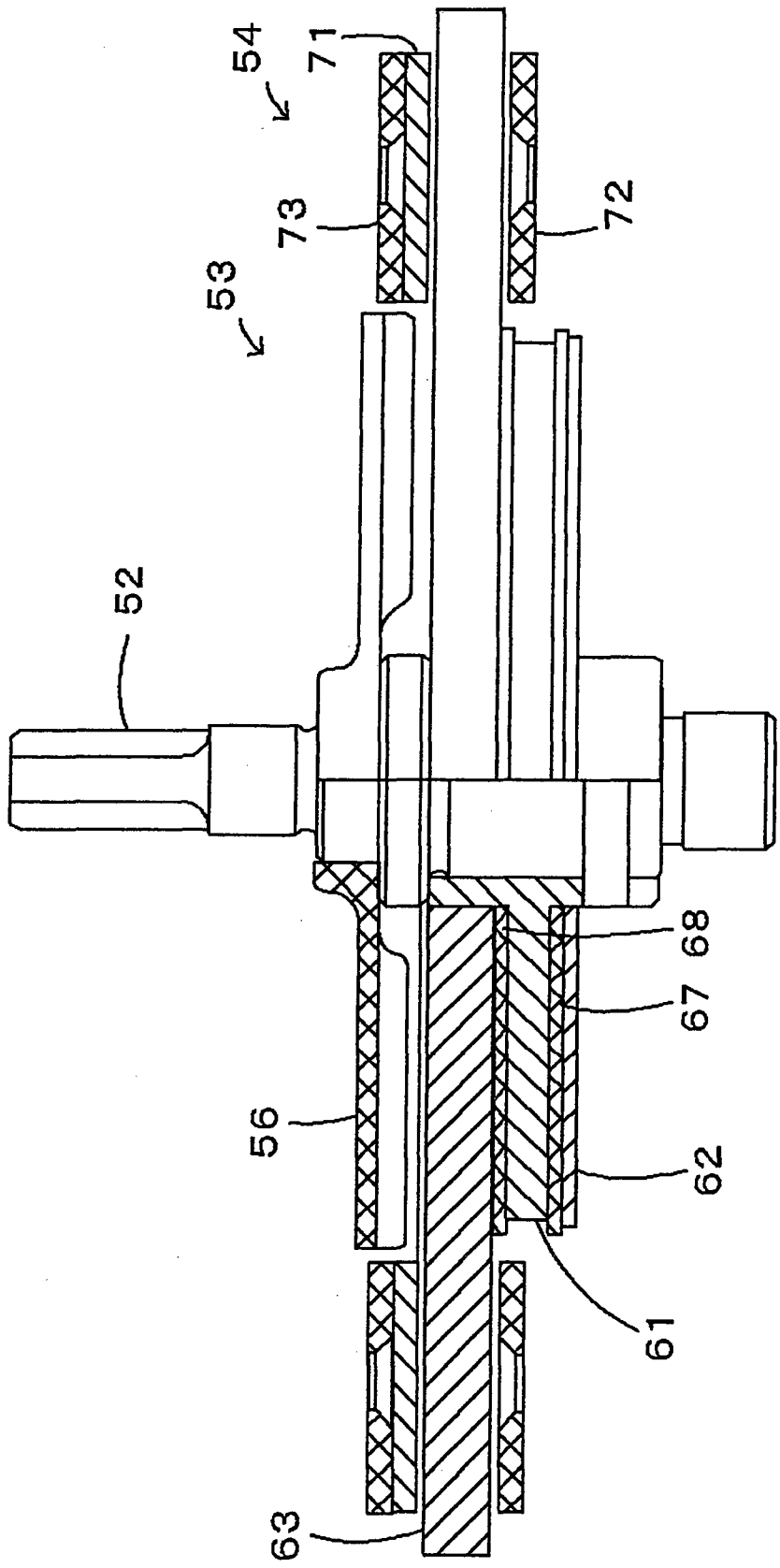


FIG. 6

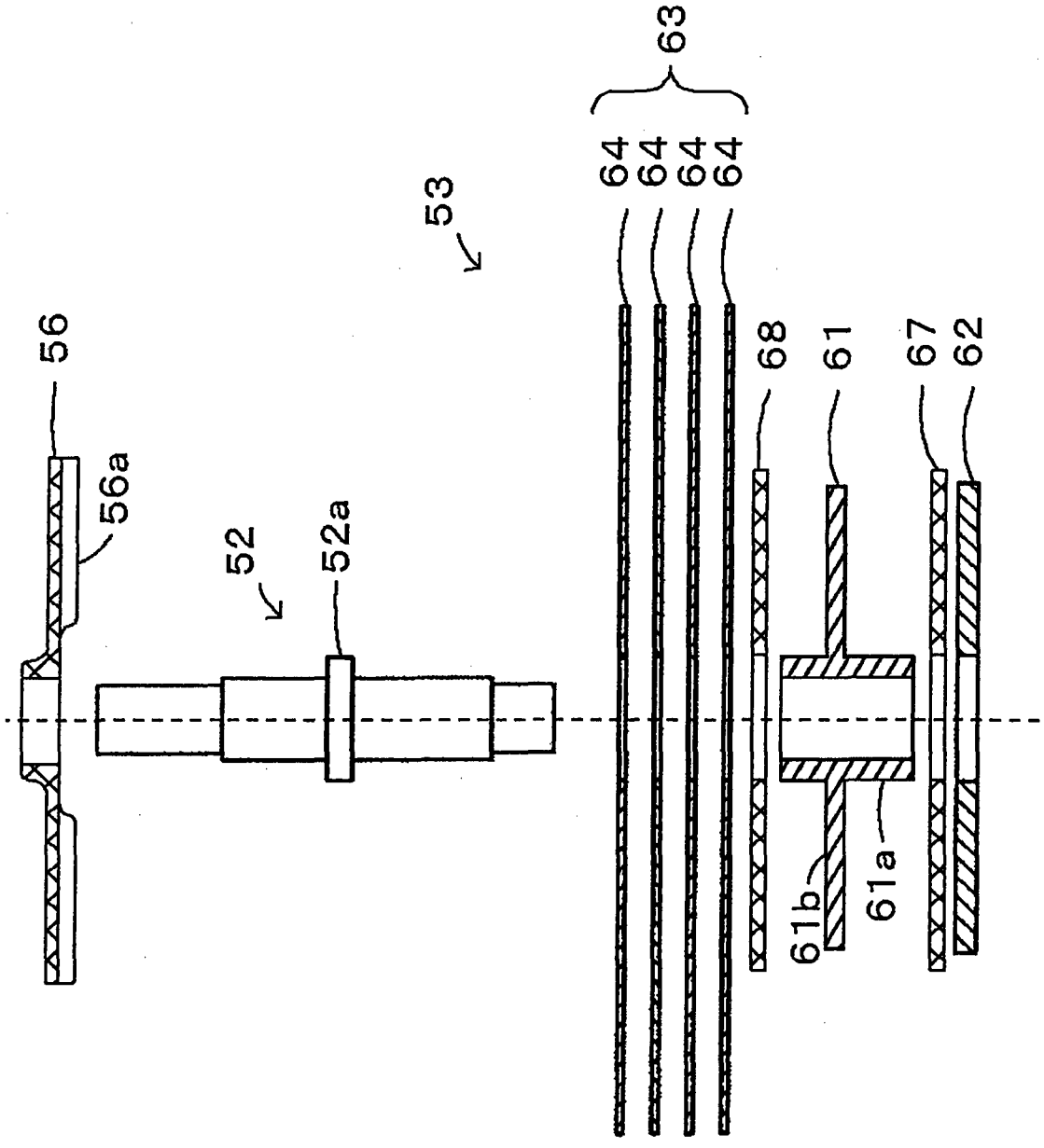


FIG. 7

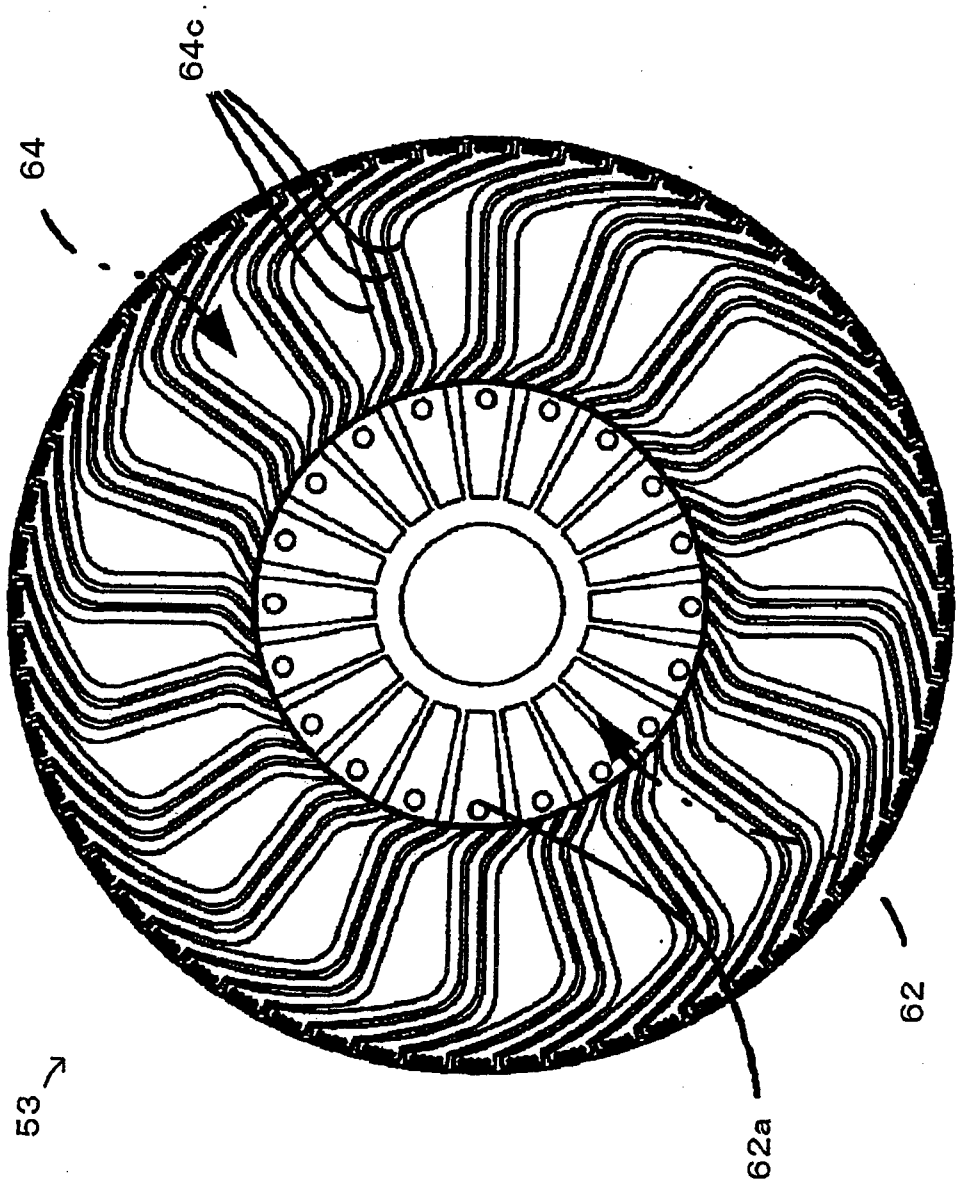


FIG. 8

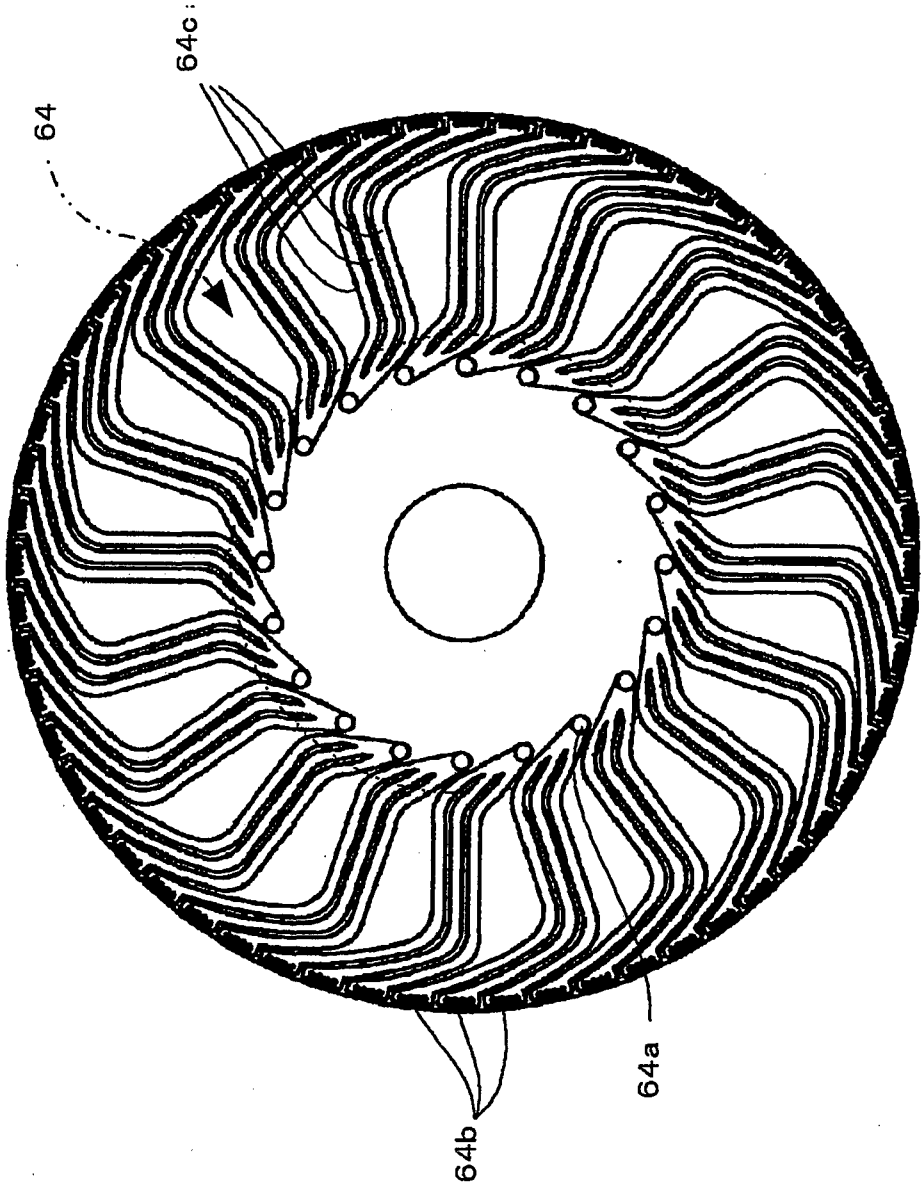


FIG. 9

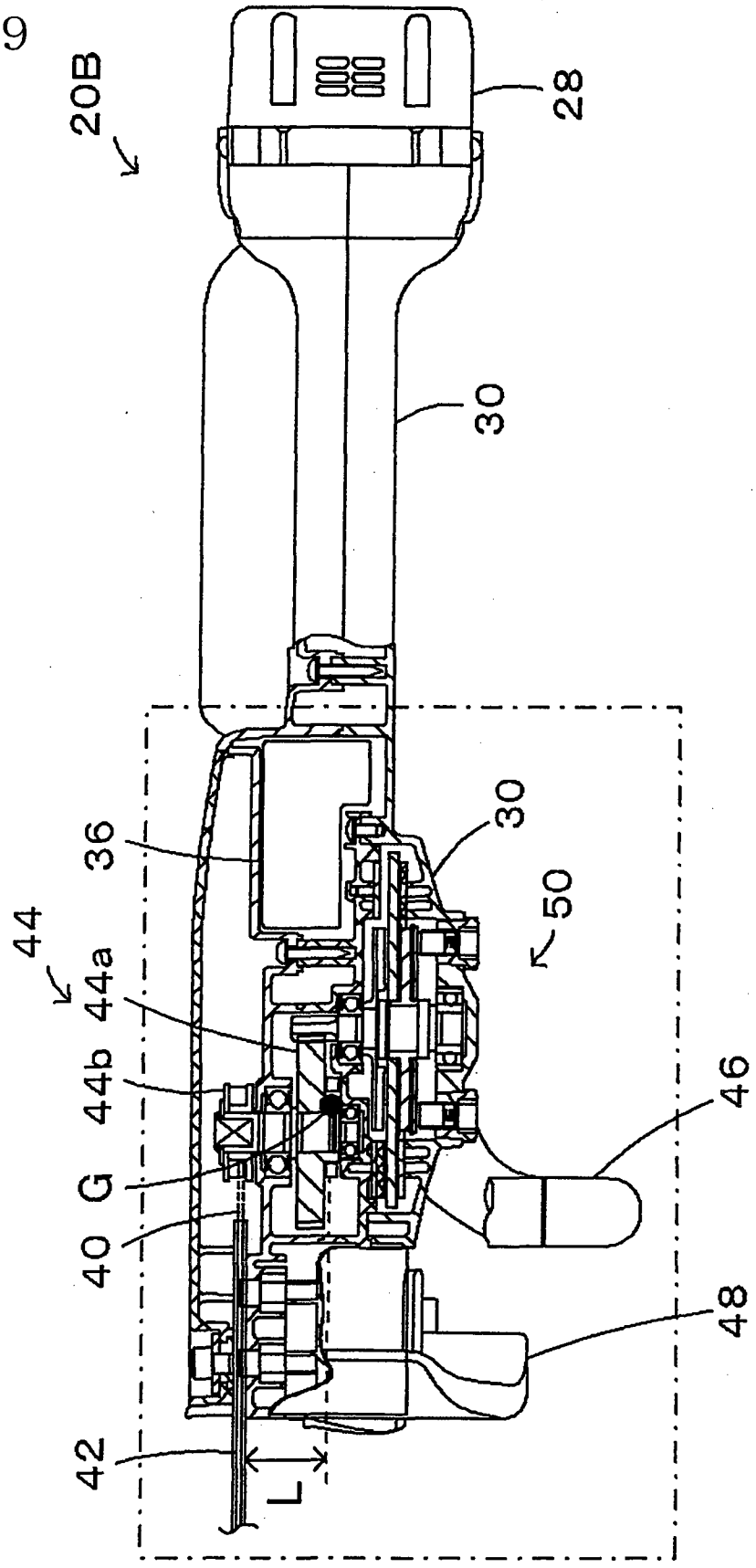


FIG. 10

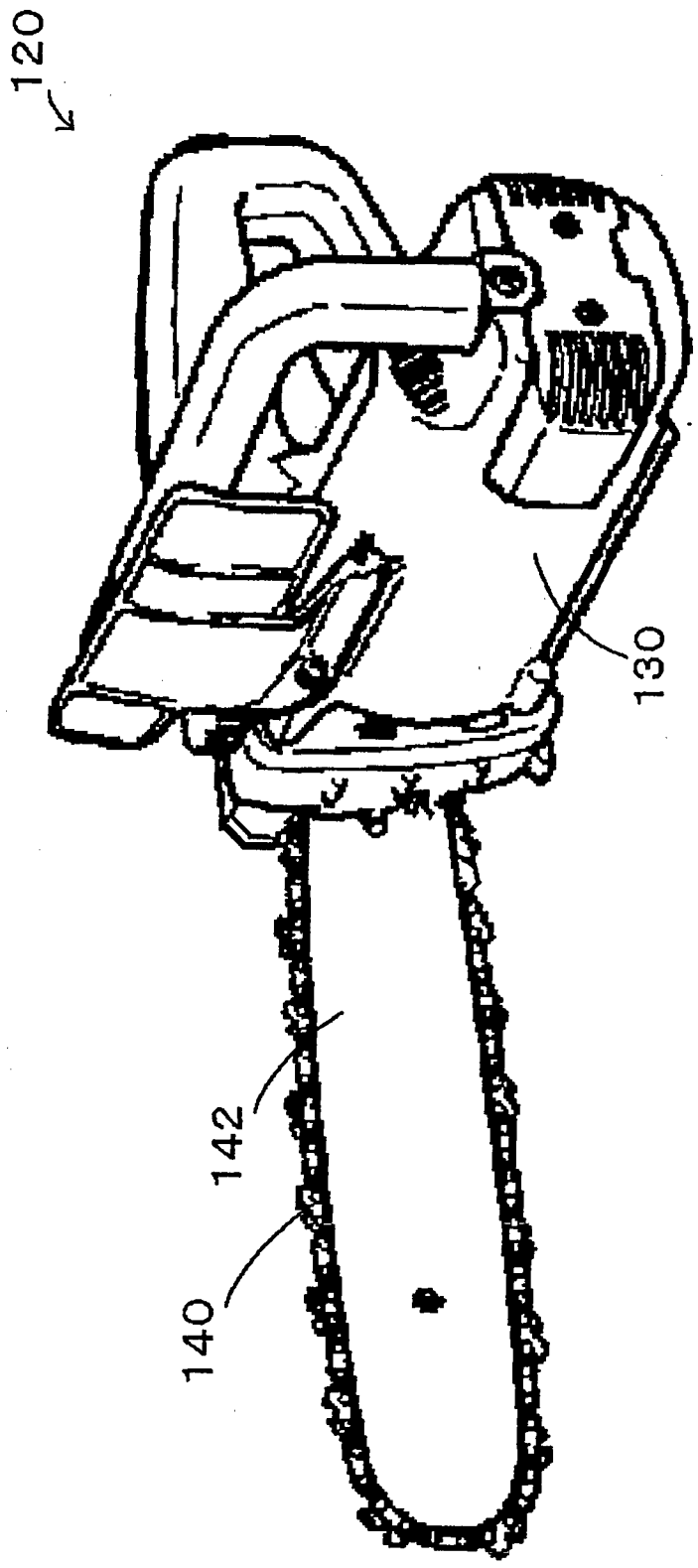
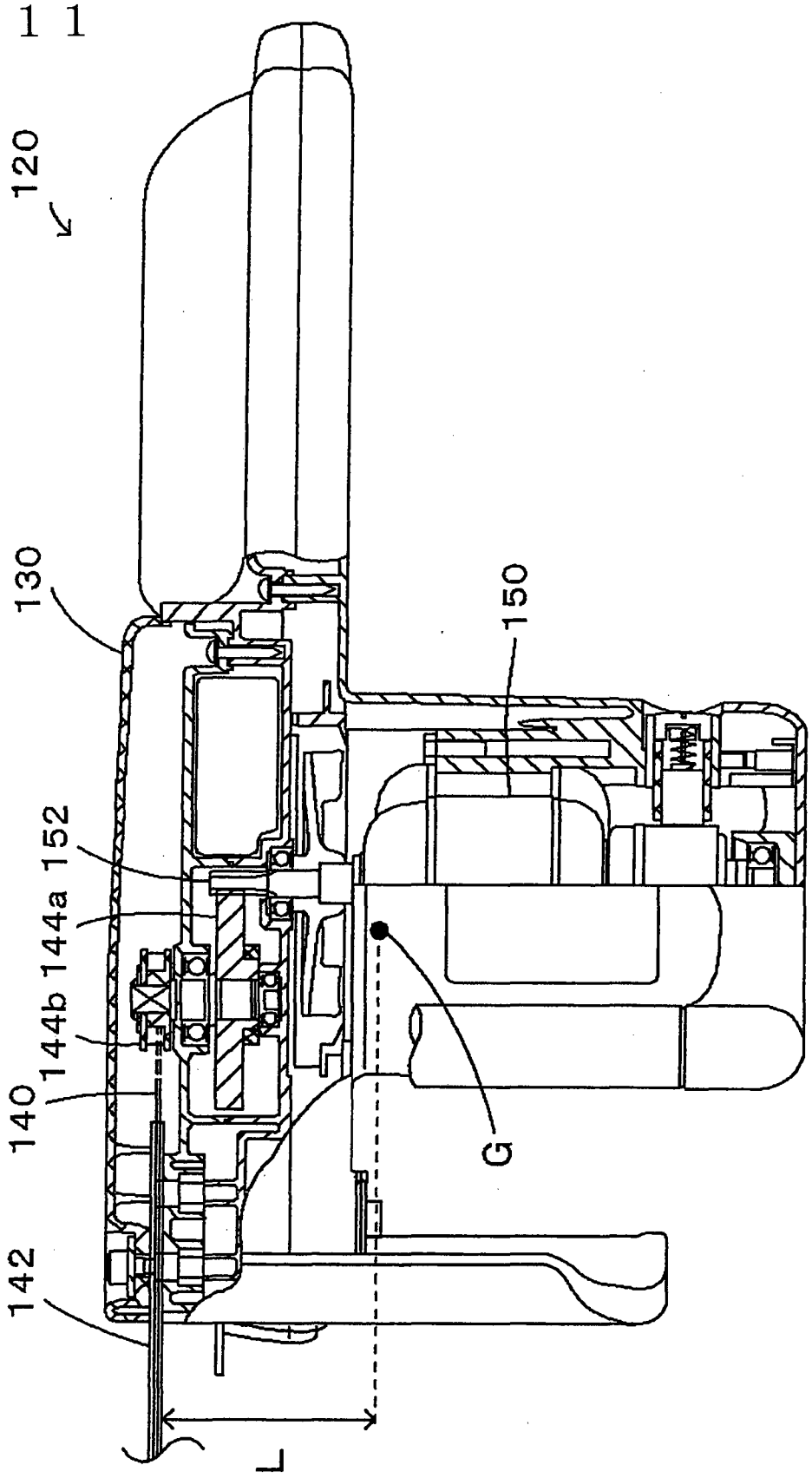


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2011/071768

A. CLASSIFICATION OF SUBJECT MATTER
INV. B27B17/08
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)
B27B H02K B23D

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 680 862 A (WIELAND DIETER [DE] ET AL) 21 July 1987 (1987-07-21)	1
Y	the whole document in particular: column 3, line 66 - column 4, line 10 figure 3	2-8

Y	US 2006/202584 A1 (JORE LINCOLN M [US] ET AL) 14 September 2006 (2006-09-14) the whole document in particular: paragraphs [0002], [0005]	2-8

A	DE 25 34 534 A1 (SPONSOR OY) 19 February 1976 (1976-02-19) the whole document in particular: page 3, paragraph 1	2-4

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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	Date of mailing of the international search report
30 December 2011	05/01/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Rijks, Mark

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2011/071768

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

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