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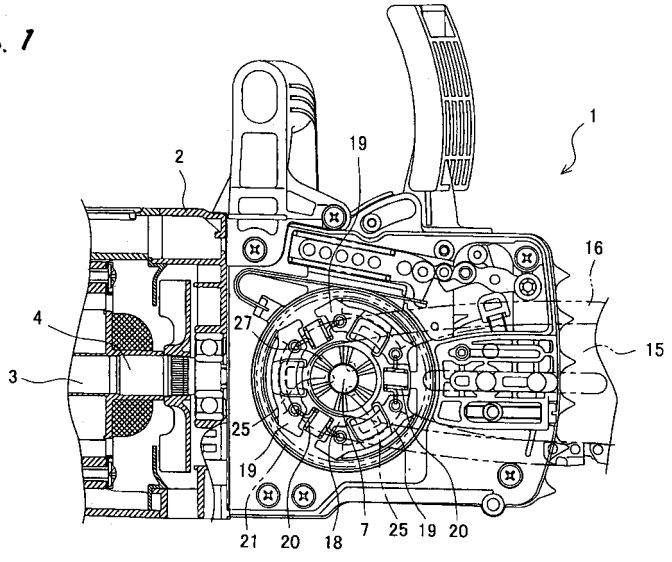
(54) Chain saw

(57) A spindle (7) is adapted to be rotated by a motor (3). A sprocket (13) is disposed coaxially with the spindle. A centrifugal clutch (18) is provided on an outer periphery of the spindle, and provided with weight members (19) movable in a direction perpendicular to an axial direction of the spindle. The weight members moves so as to project from an outer periphery of the centrifugal clutch. A connecting body (21) is integrally provided with the sprocket and covering the outer periphery of the centrifugal clutch. A cam is integrally provided with the sprocket and adapted to engage with the centrifugal clutch. An urging member urges the centrifugal clutch so as to separate from the cam. A coupling member (25) is provided on one of the outer periphery of the spindle and an inner periphery of the centrifugal clutch, and fitted with a groove formed on the other. The coupling member is movable within the groove in accordance with a rotation speed difference between the spindle and the centrifugal clutch. At the moment of activation of the motor, the centrifugal clutch is moved toward the cam against the urging force of the urging member by the movement of the coupling member within the groove, and the weight members are brought into contact with the connecting body, so that the sprocket is rotated integrally with the spindle. At the moment of deactivation of the motor, the centrifugal clutch is moved away from the cam with the aid of the urging forth of the urging member by the movement of the coupling member within the groove, and the weight members are separated from the connecting body, so that the integral rotation of the sprocket and the spindle is interrupted.

Fig. 1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a chain saw of a type that a housing incorporating a motor is provided with a guide bar, and cutting of an object is performed by rotating a chain along the guide bar.

[0002] Generally, a chain saw is so constructed that in a housing provided with a motor which is actuated by operating a trigger to activate, a spindle adapted to rotate by the actuation of the motor is laterally mounted, a sprocket adapted to rotate with the rotation of the spindle and a flat guide bar projecting forward are provided in a side part of the housing, and a chain is stretched between the sprocket and the guide bar. Accordingly, by rotating the chain along a circumferential edge of the guide bar with the rotation of the sprocket, it will be possible to cut an object, such as a log.

[0003] In the chain saw of this type, after the trigger has been operated to deactivate to stop power supply to the motor, the rotation of the chain will continue by inertia, and in this case, the object may be damaged and workability may become worse. For this reason, a so-called electric brake wherein a brake circuit having a brake coil is provided in a drive circuit of the motor, and at the time the trigger is operated to deactivate, the brake circuit is closed to apply a counter current to the motor for braking, has been often employed.

[0004] However, with the electric brake only, the chain will not stop immediately at the same timing that the trigger has been operated to deactivate, and there will be a braking time to some extend. To cope with this problem, Japanese Patent Publication No. 2004-314452A discloses a clutch mechanism in which a first cam is integrally provided on the sprocket, while a second cam which can be meshed with the first cam is provided on the spindle so as to be separately rotated and urged toward the first cam. In this mechanism, a guide groove including an inclined part and a circumferential locking part is provided on an outer peripheral face of the spindle, while a connecting groove in an axial direction is provided on an inner peripheral face of the second cam, so that steel ball is fitted between both the grooves.

[0005] According to this clutch mechanism, when the spindle starts to rotate, the second cam will be moved forward by a rotation difference between the spindle and the second cam, thereby to be engaged with the first cam, and when the spindle is braked by the electric brake, the second cam will be moved backward by a rotation difference caused by delay of the spindle with respect to the second cam, thereby to release connection with the first cam, when it has arrived at the locking part. Accordingly, the braking time of the chain can be shortened, as compared with the braking time by the electric brake only.

[0006] However, since the electric brake is necessary and indispensable in operating the clutch mechanism, the clutch mechanism will not be operated when malfunction of the electric brake has happened, and the braking time will not be shortened. There has been another problem that because the motor must be provided with the brake coil for the counter current, a compact size of the motor cannot be attained, which leads to a large size of the entire chain saw, and further, a main wiring for the motor cannot be sufficiently secured, which results in restriction of the maximum output.

SUMMARY OF THE INVENTION

[0007] It is therefore an object of the invention to provide a chain saw in which braking time of a chain can be effectively shortened without necessity of providing an electric brake, even though the clutch mechanism of the above described type is employed, whereby compactness of the chain saw and increase of the maximum output can be expected.

[0008] In order to achieve the above object, according to the invention, there is provided a chain saw, comprising:

a motor;

a spindle, adapted to be rotated by the motor;

a sprocket, disposed coaxially with the spindle and adapted to be rotated in accordance with the rotation of the spindle, thereby circulating a chain stretched between the sprocket and an peripheral edge of a guide bar;

a centrifugal clutch, provided on an outer periphery of the spindle and provided with weight members movable in a direction perpendicular to an axial direction of the spindle, the centrifugal clutch being configured such that the weight members moves so as to project from an outer periphery of the centrifugal clutch;

a connecting body, integrally provided with the sprocket and covering the outer periphery of the centrifugal clutch;

a cam, integrally provided with the sprocket and adapted to engage with the centrifugal clutch;

an urging member, urging the centrifugal clutch so as to separate from the cam; and

a coupling member, provided on one of the outer periphery of the spindle and an inner periphery of the centrifugal clutch, and fitted with a groove formed on the other, the coupling member being movable within the groove in accordance with a rotation speed difference between the spindle and the centrifugal clutch, wherein:

at the moment of activation of the motor, the centrifugal clutch is moved toward the cam against the urging force of the urging member by the movement of the coupling member within the groove, and the weight members are brought into contact with the connecting body, so that the sprocket is rotated integrally with the spindle;

and
at the moment of deactivation of the motor, the centrifugal clutch is moved away from the cam with the aid of the urging forth of the urging member by the movement of the coupling member within the groove, and the weight members are separated from the connecting body, so that the integral rotation of the sprocket and the spindle is interrupted.

[0009] With this configuration, it will be possible to shorten the braking time of the chain effectively, without providing the electric brake. Particularly, by employing the centrifugal clutch, transmission of the rotation from the spindle to the cam and interruption of the rotation will be stably and reliably performed. Moreover, because the electric brake is not required, the motor having a small size in spite of the same output can be realized, which will make the entire chain saw compact. Besides, the main coil of the motor can be sufficiently secured in the motor of the same size, since the brake coil is not provided, and the maximum output can be increased.

[0010] Cam teeth may be provided on opposing faces of the cam and the centrifugal clutch, and adapted to be meshed with each other when the centrifugal clutch is moved toward the cam. Each of the cam teeth may be formed with a slant face configured such that the cam teeth are pushed away from each other when the rotation speed difference is generated at the moment of deactivation of the motor.

[0011] With this configuration, separation of the cam from the centrifugal clutch at the time the power supply to the motor has been stopped will be reliably performed, and reliability of the clutch operation will be enhanced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

Fig. 1 is a vertical section view showing a part of a chain saw according to one embodiment of the invention.
Fig. 2A is a transverse section view showing the part of the chain saw, showing a deactivated state.
Fig. 2B is a schematic view showing a positional relationship between guide grooves on a spindle and steel balls in the state of Fig. 2A.
Fig. 3A is a transverse section view showing the part of the chain saw, showing an activated state.
Fig. 3B is a schematic view showing a positional relationship between the guide grooves and the steel balls in the state of Fig. 3A.
Fig. 4A is a plan view of cam teeth formed on a cam and a centrifugal clutch in the chain saw.
Fig. 4B is a side view of the cam teeth of Fig. 4A.
Fig. 4C is an enlarged side view of the cam teeth of Fig. 4B.
Fig. 5A is a plan view of cam teeth according to a modified example.
Fig. 5B is a side view of the cam teeth of Fig. 5A.
Fig. 5C is an enlarged side view of the cam teeth of Fig. 5B.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0013] Embodiments of the invention will be described below in detail with reference to the accompanying drawings.

[0014] As shown in Figs. 1 and 2A, a chain saw 1 according to one embodiment of the invention is so constructed that a motor 3 is contained in a housing 2 so as to be directed forward (In these figures, the right side is designated as a forward side), in front of its output shaft 4, a spindle 7 is rotatably supported by ball bearings 5, 6 in a lateral direction perpendicular to the output shaft 4, and bevel gears 8, 9 respectively fixed to the output shaft 4 and the spindle 7 are meshed with each other, whereby rotation of the output shaft 4 can be transmitted to the spindle 7. An end of the spindle 7 at an opposite side to the bevel gear 9 passes through the housing 2 to be projected sideward. A cylindrical cam 11 having a flange 12 at a side close to the ball bearing 6 is mounted over a projecting end 10 of the spindle 7 so as to separately rotate, and a sprocket 13 is fixed to the cam 11 perpendicularly so as to rotate integrally therewith. In front of this sprocket 13, a flat guide bar 15 is fixed to a side face of the housing 2 by a securing bolt 14 in a manner of projecting forward, and an endless chain 16 is stretched between the sprocket 13 and a circumferential edge of the guide bar 15. Therefore, when the sprocket 13 rotates, the chain 16 will rotate along a groove 17 which is formed on the circumferential edge of the guide bar 15.

[0015] On the other hand, a disc-shaped centrifugal clutch 18 having a larger diameter than the flange 12 of the cam 11 is mounted over the spindle 7 between the cam 11 and the ball bearing 6 coaxially with the spindle 7, and so as to extend perpendicularly to the spindle 7. This centrifugal clutch 18 has a known shape that three weight members 19 which are interconnected in a circumferential direction by three connecting springs 20 so as to move in a radial direction are provided on its outer circumference, whereby the centrifugal clutch 18 is urged in a direction to be contracted. A bowl-shaped connecting body 21 is fitted to the cam 11 between the flange 12 and the sprocket 13 so as to rotate integrally with the cam 11. The connecting body 21 has a slightly larger inner diameter than an outer diameter of the centrifugal clutch 18 at an opened end, and covers the centrifugal clutch 18 in a non-contact manner while the motor 3 is stopped. Denoted by numeral 22 is a washer which is clamped and fixed between the flange 12 and the connecting body 21.

[0016] Three connecting grooves 23 which extend in

an axial direction and open toward the ball bearing 6 are formed on an inner peripheral face of the centrifugal clutch 18 at three equidistant positions in the circumferential direction. On the other hand, three guide grooves 24 which are inclined at a predetermined lead angle from an axis of the spindle 7 are formed on an outer peripheral face of the spindle 7 similarly at three equidistant positions in the circumferential direction. Steel balls 25 are respectively held between the connecting grooves 23 and the guide grooves 24. Accordingly, the centrifugal clutch 18 can move back and forth with respect to the spindle 7 in the axial direction thereof, within a range in which the steel balls 25 roll in the guide grooves 24, and can also rotate integrally with the spindle 7.

[0017] A coil spring 26 is provided between the washer 22 and the centrifugal clutch 18, so that the centrifugal clutch 18 is urged to a position in Fig. 2A, where the steel balls 25 are positioned at backward ends (as for the spindle 7 and the centrifugal clutch 18, a side of the projected end 10 of the spindle 7 is designated as a forward side) of the guide grooves 24, while the motor 3 is stopped.

[0018] As shown in Figs. 4A to 4C, cam teeth 27 having the same shape are formed on respective faces of the flange 12 of the cam 11 and the centrifugal clutch 18 opposed to each other. These cam teeth 27, each of which has a gentle slanted face 28 and a steep slanted face 29, are provided at six equidistant positions in the circumferential direction. Accordingly, when the centrifugal clutch 18 moves forward to approach the flange 12, both the cam teeth 27 will be meshed with each other.

[0019] In the chain saw 1 having the above described structure, in a state where the motor 3 is stopped, as shown in Fig. 2A, the centrifugal clutch 18 is in a retreated position where it is urged by the coil spring 26, as described above, to be separated from the flange 12 of the cam 11, and the weight members 19 of the centrifugal clutch 18 are also in a contracted position where they are not in contact with the connecting body 21.

[0020] In this state, when the trigger (not shown) provided on the housing 2 is operated to activate the motor 3, the spindle 7 will rotate (clockwise rotation in Fig. 1) with the rotation of the output shaft 4 by way of the bevel gears 8, 9. This rotation of the spindle 7 will make a rotation difference that the centrifugal clutch 18 is delayed with respect to the spindle 7, and the centrifugal clutch 18 will move forward resisting urging force of the coil spring 26, while the steel balls 25 roll forward along the guide grooves 24 as shown in Fig. 3B. At this forward position, the centrifugal clutch 18 will be brought into contact with the cam 11, enabling the cam teeth 27 to be meshed with each other as shown in Fig. 3A.

[0021] On this occasion, when centrifugal force acting on the weight members 19 by the rotation of the centrifugal clutch 18 following the rotation of the spindle 7 exceeds contraction urging force of the connecting springs 20, the weight members 19 will move in a radial direction and come into contact with the inner face of the connecting body 21. As the results, the cam 11 will be coupled to the spindle 7 by way of the centrifugal clutch 18 and the connecting body 21, and the sprocket 13 will rotate together with the cam 11 thereby to rotate the chain 16 along the guide bar 15, whereby cutting of the object by the chain 16 will be permitted.

[0022] After the cutting work has finished, the trigger will be operated to deactivate the motor 3. Then, rotation speed of the centrifugal clutch 18 together with the spindle 7 will be lowered thereby to decrease the centrifugal force to be exerted on the weight members 19. Consequently, the weight members 19 will move in a direction to be contracted by the urging force of the connecting springs 20, and will be separated from the connecting body 21 thereby to interrupt transmission of the rotation to the cam 11 by way of the connecting body 21. Along with this motion of the centrifugal clutch 18, the centrifugal clutch 18 will be urged by the coil spring 26 to retreat, while the steel balls 25 roll backward along the guide grooves 24 as shown in Fig. 2B, so that the cam teeth 27 will be released from the mesh with each other thereby to return to the position as shown in Fig. 2A.

[0023] In case where even a slight rotation difference has occurred between the cam 11 and the centrifugal clutch 18 on this moment, the steep slanted faces 29 formed on the cam teeth 27 will be butted against each other to press the cam 11 in a separating direction, whereby separation of the centrifugal clutch 18 will be reliably performed. In this manner, the cam 11 and the sprocket 13 will be brought into a condition of rotation free with respect to the spindle 7. However, because a large braking force by friction between the guide bar 15 and the chain 16 which rotates in sliding contact with the circumferential edge of the guide bar 15 will be exerted on the chain 16 and the sprocket 13, the rotation of the chain 16 and the sprocket 13 will be immediately stopped.

[0024] When the motor 3 is deactivated, since the weight members 19 of the centrifugal clutch 18 will be separated from the connecting body 21 due to decrease of the rotation speed of the spindle 7, and at the same time, the centrifugal clutch 18 will be separated from the cam 11 by the coil spring 26, whereby the integral rotation of the spindle 7 and the sprocket 13 will be interrupted, the braking time of the chain 16 can be shortened effectively, without providing an electric brake. Particularly, because the centrifugal clutch 18 is employed, transmission of the rotation from the spindle 7 to the cam 11 and interruption of the rotation can be stably and reliably performed. Moreover, because the electric brake is not required, downsizing of the motor 3 in spite of the same output can be realized, which will make the entire chain saw compact. Besides, the main coil of the motor 3 can be sufficiently secured in the motor 3 of the same size, since the brake coil is not provided, and the maximum output can be increased.

[0025] In addition, the cam teeth 27 of the cam 11 and the centrifugal clutch 18 are provided with the steep slanted faces 29 which press the mating cam teeth 27 away from each other, when the cam teeth 27 have come into

contact with the mating cam teeth 27 due to the rotation difference between the cam 11 and the centrifugal clutch 18. Therefore, separation of the cam 11 from the centrifugal clutch 18 when the power supply to the motor 3 is stopped will be reliably performed, and reliability of the clutch operation will be enhanced.

[0026] In this embodiment, the guide grooves 24 and the connecting grooves 23 are respectively formed on the outer peripheral face of the spindle 7 and on the inner peripheral face of the centrifugal clutch 18. However, to the contrary, it is also possible to provide the guide grooves inclined at the determined lead angle on the centrifugal clutch 18 and the connecting grooves in the axial direction on the spindle 7, thereby to move the centrifugal clutch 18 forward and backward by the rotation difference between the spindle 7 and the centrifugal clutch 18.

[0027] Instead of the steel balls 25, semispherical projections may be provided on either one of the inner peripheral face of the centrifugal clutch 18 and the outer peripheral face of the spindle 7, and the projections may be engaged with the guide grooves in the other, thereby to guide the centrifugal clutch 18.

[0028] Instead of the coil spring 26 pushing the centrifugal clutch 18 backward, a disc spring or a leaf spring may be employed. Further, such a spring member may be arranged so as to pull the centrifugal clutch 18 backward.

[0029] In the above embodiment, the cam 11 is mounted over the projected end of the spindle 7. However, a rotary shaft of a cam may be provided separately from the spindle 7 and rotatably supported, so that the cam and the centrifugal clutch 18 may be coaxially opposed to each other without interposing the spindle 7.

[0030] Furthermore, the slanted faces of the cam teeth 27, which press each other in the separating direction when the clutch 18 is operated, may be provided on the cam teeth of either one of the cam 11 and the centrifugal clutch 18. It is of course possible to appropriately decrease the number of the cam teeth, and to change the shape of the cam teeth. As shown in Figs. 5A to 5C, vertical faces 30 extending in the axial direction may be provided in place of the steep slanted faces 29.

[0031] Although only some exemplary embodiments of the invention have been described in detail above, those skilled in the art will readily appreciated that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of the invention. Accordingly, all such modifications are intended to be included within the scope of the invention.

[0032] It is explicitly stated that all features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original disclosure as well as for the purpose of restricting the claimed invention independent of the composition of the features in the embodiments and/or the claims. It is explicitly stated that all value ranges or indications of groups of entities disclose every possible intermediate value or intermediate entity for the purpose of original disclosure as well as for the purpose of restricting the claimed invention, in particular as limits of value ranges.

Claims

1. A chain saw (1), comprising:

a motor (3);
a spindle (7), adapted to be rotated by the motor;
a sprocket (13), disposed coaxially with the spindle and adapted to be rotated in accordance with the rotation of the spindle, thereby circulating a chain stretched between the sprocket and an peripheral edge of a guide bar;
a centrifugal clutch (18), provided on an outer periphery of the spindle and provided with weight members (19) movable in a direction perpendicular to an axial direction of the spindle, the centrifugal clutch being configured such that the weight members moves so as to project from an outer periphery of the centrifugal clutch;
a connecting body (21), integrally provided with the sprocket and covering the outer periphery of the centrifugal clutch;
a cam (11), integrally provided with the sprocket and adapted to engage with the centrifugal clutch;
an urging member (26), urging the centrifugal clutch so as to separate from the cam; and
a coupling member (25), provided on one of the outer periphery of the spindle and an inner periphery of the centrifugal clutch, and fitted with a groove (24) formed on the other, the coupling member being movable within the groove in accordance with a rotation speed difference between the spindle and the centrifugal clutch, wherein:

at the moment of activation of the motor, the centrifugal clutch is moved toward the cam against the urging force of the urging member by the movement of the coupling member within the groove, and the weight members are brought into contact with the connecting body, so that the sprocket is rotated integrally with the spindle; and
at the moment of deactivation of the motor, the centrifugal clutch is moved away from the cam with the aid of the urging forth of the urging member by the movement of the coupling member within the groove, and the weight members are separated from the connecting body, so that the integral rotation of the sprocket and the spindle is interrupted.

2. The chain saw as set forth in claim 1, wherein:

cam teeth (27) are provided on opposing faces of the cam and the centrifugal clutch, and adapted to be meshed with each other when the centrifugal clutch is moved toward the cam; and
each of the cam teeth is formed with a slant face (29) configured such that the cam teeth are pushed away from each other when the rotation speed difference is generated at the moment of deactivation of the motor.

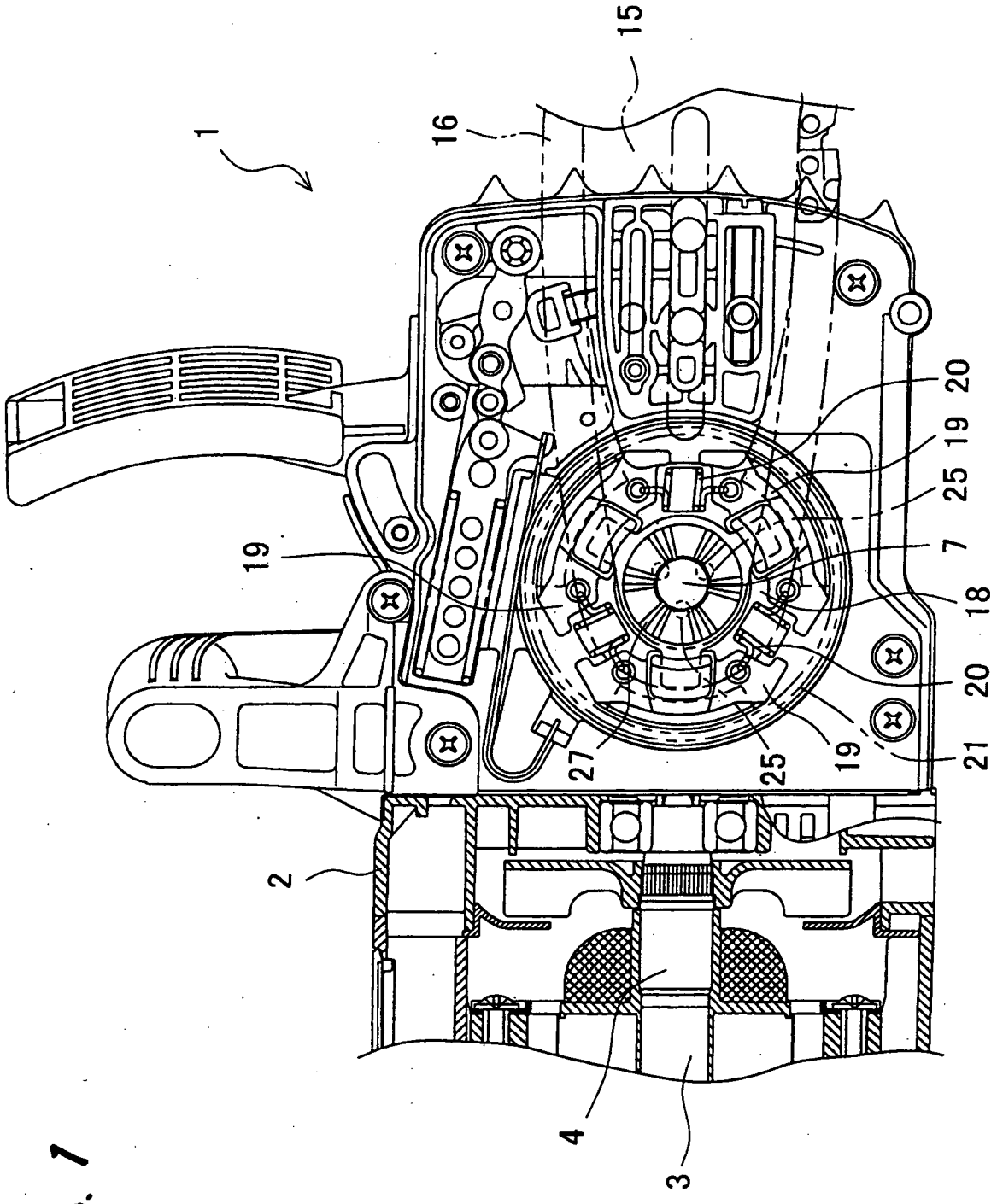


Fig. 1

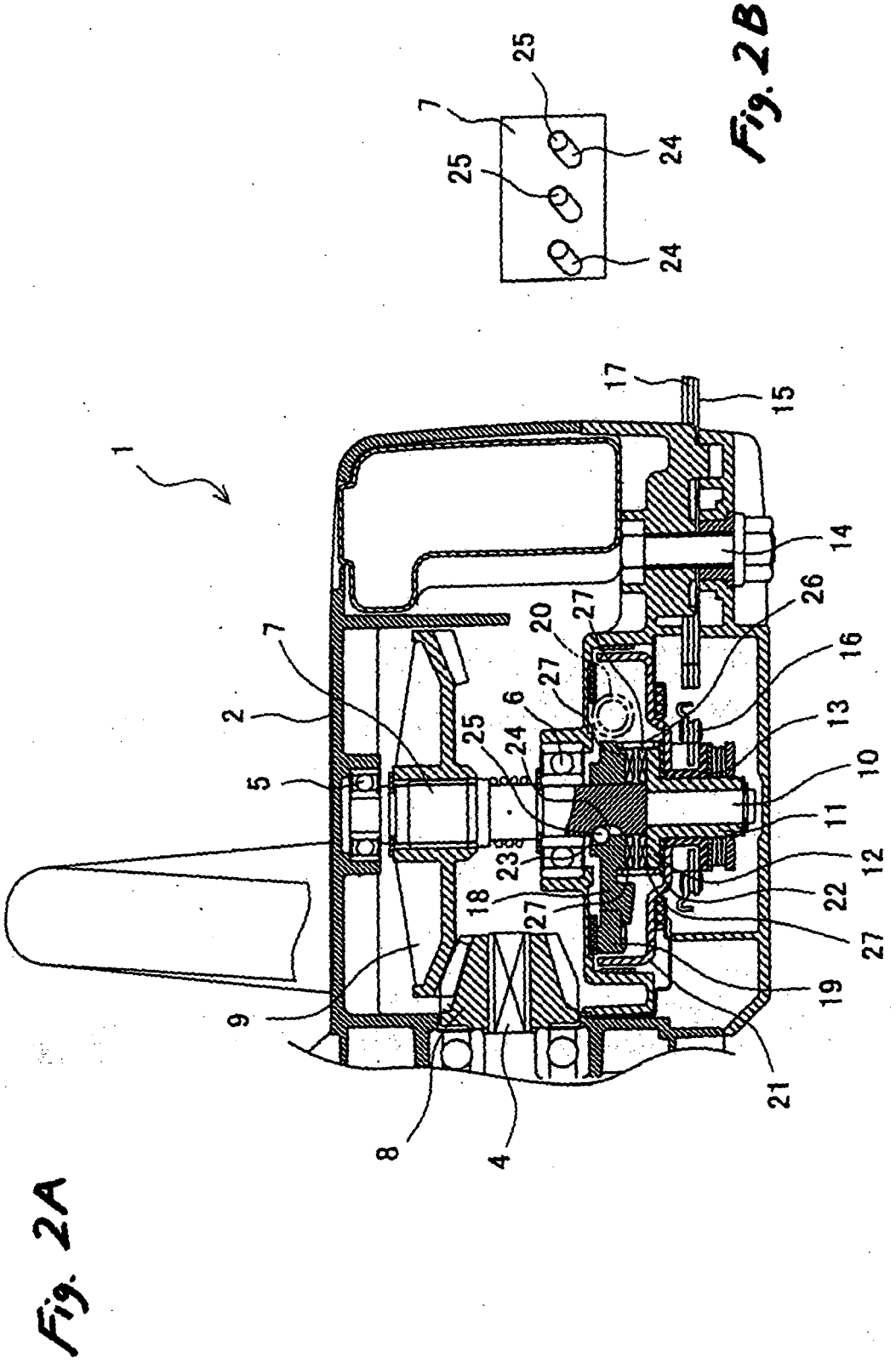


Fig. 2A

Fig. 2B

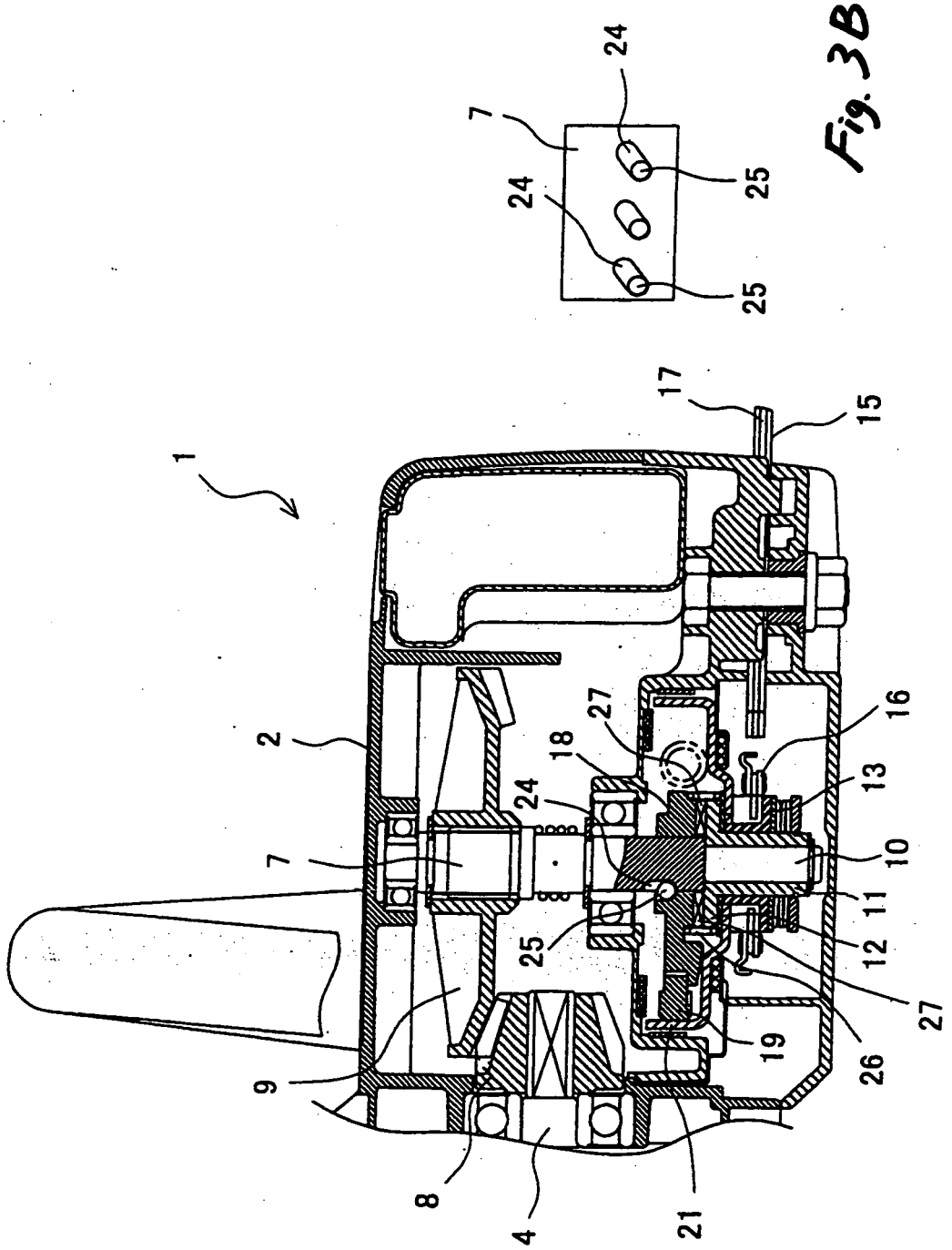


Fig. 3A

Fig. 3B

Fig. 4A

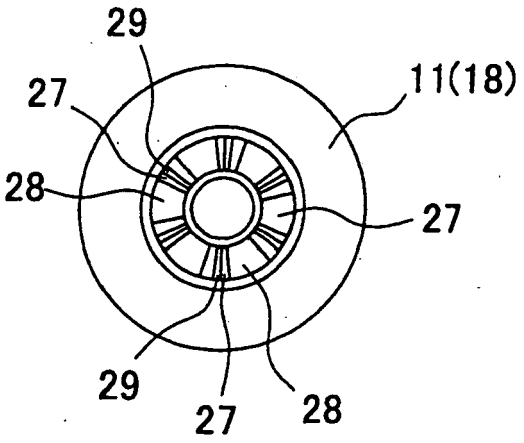


Fig. 4B

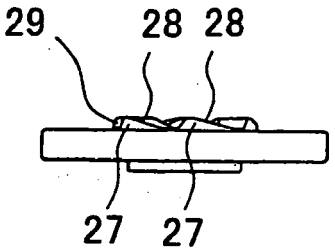


Fig. 4C

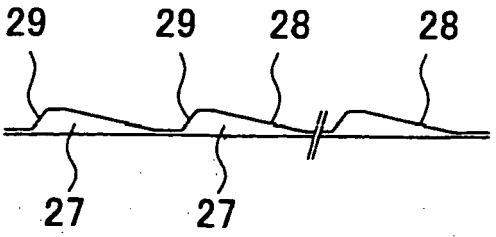


Fig. 5A

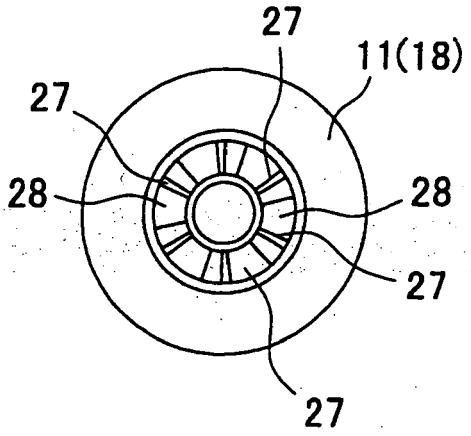


Fig. 5B

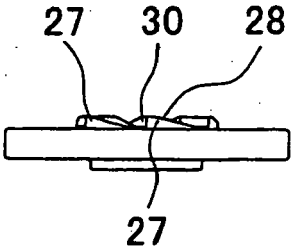
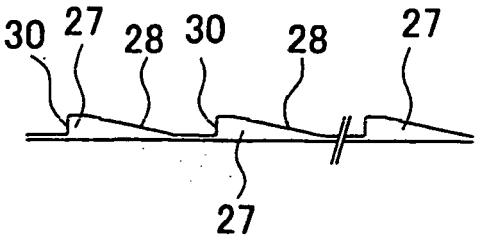


Fig. 5C



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EUROPEAN SEARCH REPORT

Application Number
EP 06 02 0720

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 0 761 398 A1 (MAKITA CORP [JP]) 12 March 1997 (1997-03-12) * column 7, line 12 - column 12, line 15; figures 5,8,10,11 * -----	1,2	INV. B27B17/10 B27B17/08

TECHNICAL FIELDS SEARCHED (IPC)

B27B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 January 2007	Frisch, Ulrich

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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11-01-2007

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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