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(54) Title: COMBUSTION POWERED TOOL ASSEMBLY

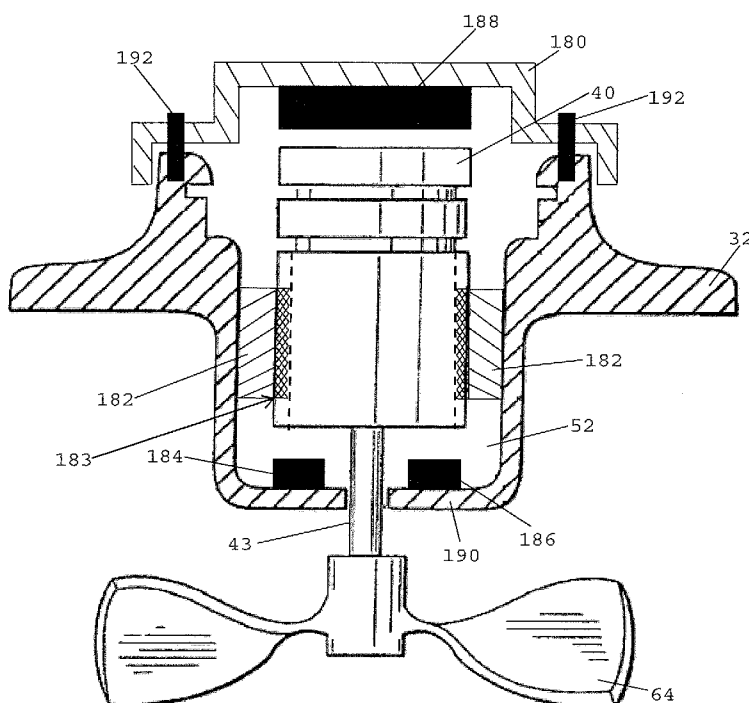


FIG. 3

(57) Abstract: Disclosed herein is a damper for a fan motor of a combustion chamber in a combustion powered tool for driving a fastener into a workpiece, the tool generating an upward axial acceleration of the motor upon a combustion in the chamber and a subsequent reciprocal axial acceleration of the motor, at least one of the accelerations causing the motor to oscillate relative to the tool, the damper comprising at least one damping device disposed within the tool to receive and absorb force to damp the oscillations of the motor relative to the tool.

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## COMBUSTION POWERED TOOL ASSEMBLY

### TECHNICAL FIELD

5                   The present disclosure relates generally to improvements in portable, combustion-powered fastener driving tools, and more particularly to arrangements to accommodate operational loading on a combustion chamber fan motor.

### BACKGROUND

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                  Portable, combustion-powered fastener driving tools are used for driving fasteners into workpieces. Such tools typically incorporate a tool housing enclosing a small internal combustion engine powered by a canister of pressurized fuel gas, also called a fuel cell. A battery-powered electronic power distribution  
15                   unit produces the spark for ignition, and a fan located in the combustion chamber provides an efficient combustion within the chamber and facilitates scavenging, including the exhaust of combustion by-products. The engine includes a reciprocating piston with an elongated, rigid driver blade disposed within a cylinder body.

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                  In operation, reciprocal accelerations are often induced on the fan motor causing the fan motor to oscillate with respect to the tool. The magnitude of these accelerations, if left unmanaged, is detrimental to the life and reliability of the combustion chamber fan motor.

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### SUMMARY

                  In one embodiment, a combustion-powered tool for driving a  
30                   fastener into a workpiece is provided that has a combustion chamber fan motor and at least one damping device disposed within the tool to receive and absorb force to damp oscillations of the motor relative to the tool during the tool's operation..

                  In another embodiment, a damper for a motor of a combustion chamber in a combustion powered tool, wherein the damper comprises at least one  
35                   damping device to reduce oscillations of the motor in use.

The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

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## **BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 is a fragmentary side view of a combustion powered fastener tool, the tool being partially cut away and in vertical section for purposes of clarity;

10           FIG. 2 is a vertical cross-section of a cylinder head and suspension mechanism of the tool of FIG.1;

FIG. 3 show a vertical cross-sections of a cylinder head and damper according to other embodiment;

15           FIG. 4 show a vertical cross-sections of a cylinder head and damper according to yet other embodiment;

FIG. 5 show a vertical cross-sections of a cylinder head and damper according to yet a further embodiment;

FIG. 6 show a vertical cross-sections of a cylinder head and damper according to other embodiment; and

20           FIG. 7 show a vertical cross-sections of a cylinder head and damper according to another embodiment;

## **DETAILED DESCRIPTION**

25           In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing  
30   from the spirit or scope of the subject matter presented herein. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the Figures, can be arranged, substituted, combined, separated, and designed in a wide variety of different configurations, all of which are explicitly contemplated herein.

This disclosure is directed generally to portable, combustion-powered fastener driving tools used for driving fasteners into workpieces. Such tools typically incorporate a generally pistol-shaped tool housing enclosing a small internal combustion engine. The engine is powered by a canister of pressurized fuel gas, also called a fuel cell. A battery-powered electronic power distribution unit produces the spark for ignition, and a fan located in the combustion chamber provides an efficient combustion within the chamber and facilitates scavenging, including the exhaust of combustion by-products. The engine includes a reciprocating piston with an elongated, rigid driver blade disposed within a cylinder body.

A valve sleeve is axially reciprocable about the cylinder and, through a linkage, moves to close the combustion chamber when a work contact element at the end of the linkage is pressed against a workpiece. This pressing action also triggers a fuel metering valve to introduce a specified volume of fuel into the closed combustion chamber.

Upon the pulling of a trigger switch, which causes the ignition of a charge of gas in the combustion chamber of the engine, the piston and driver blade are shot downward to impact a positioned fastener and drive it into the workpiece. The piston then returns to its original or "ready" position through differential gas pressures within the cylinder. Fasteners are fed magazine-style into the nosepiece, where they are held in a properly positioned orientation for receiving the impact of the driver blade.

Upon ignition of the combustible fuel/air mixture, the combustion in the chamber causes the acceleration of the piston/driver blade assembly and the penetration of the fastener into the workpiece if the fastener is present. This combined downward movement causes a reactive force or recoil of the tool body. Hence, the fan motor, which is suspended in the tool body, is subjected to acceleration in a direction opposite the power stroke of the piston/driver blade and fastener.

Then, within milliseconds, the momentum of the piston/driver blade assembly is stopped by the bumper at the opposite end of the cylinder, and the tool body is accelerated toward the workpiece. Therefore, the fan motor and shaft are subjected to an acceleration force that is opposite the direction of the first acceleration. These reciprocal accelerations cause the fan motor to oscillate with

respect to the tool. The magnitude of these accelerations, if left unmanaged, is detrimental to the life and reliability of the combustion chamber fan motor.

Disclosed in some embodiments is a damper for a fan motor of a combustion chamber in a combustion-powered tool for driving a fastener into a workpiece, the tool generating an upward axial acceleration of the motor upon a combustion in the chamber and a subsequent reciprocal axial acceleration of the motor, at least one of the accelerations causing the motor to oscillate relative to the tool, the damper including at least one damping device disposed within the tool to receive and absorb force to damp the oscillations of the motor relative to the tool.

In some embodiments, the tool includes a cavity in which the motor is located and the damper includes first and second damping devices disposed within the cavity and being spaced apart in the axial direction, the fan motor being disposed between the first and second damping devices wherein during oscillation the motor is engagable with the first and second damping devices to damp the oscillations of the motor relative to the tool. In some embodiments, at least one of the first and second damper devices is formed from one or more resilient members.

In some embodiments, the motor may be mounted so as to be axially movable within the cavity. The motor may be disposed relative to the tool so that it is free to move axially. In some embodiments the motor may be able to move axially but is restrained from rotation about the chamber axis. In other embodiments the motor may be mounted to the tool so as to be restrained so as to be only capable of limited axial movement. In some embodiments this limited axial movement is provided by resilience in the mount.

In some embodiments, the damper may use hydraulic damping to restrict the oscillations. In some embodiments the motor may be mounted to the tool using a mount that incorporates a hydraulic circuit which allows for limited axial movement of the motor relative to the tool. In some embodiments a hydraulic (such as a pneumatic) cylinder piston arrangement is used to absorb force on the motor.

In some embodiments, the tool may comprise a main portion in which at least part of the force is transmitted that induces the axial acceleration in the tool, wherein the motor is mounted to a mounting portion of the tool and the damper is disposed between the main portion of the tool and the mounting portion of the tool so as to

absorb force so as to damp oscillation of the mounting portion relative to the main portion. In some embodiments, the motor may be rigidly mounted to the mounting portion of the tool. In some embodiments, the combustion chamber is defined in part by a cylinder head and the mounting portion forms part of the cylinder head.

5                   In some embodiments there may be provided a combustion-powered tool for driving a fastener into a workpiece, the tool having a combustion chamber, a combustion chamber fan having a motor; and a damper to receive and absorb force to damp oscillation of the motor in response to combustion within the combustion chamber. In some embodiments the damper may be any one (or  
10 combination) of dampers disclosed above.

FIG.1 is a fragmentary side view of a combustion powered fastener tool, the tool (generally designated 10) being partially cut away and in vertical section for purposes of clarity. While one type of combustion-powered tool is depicted here, it is contemplated that other tool configurations and arrangements of  
15 components may be provided that are suitable for use with the dampers disclosed herein. The tool 10 has a housing 12 including a main power source chamber 14 dimensioned to enclose a self-contained internal combustion power source 16, a fuel cell chamber 18 generally parallel with and adjacent to the main chamber 14, and a handle portion 20 extending from one side of the fuel cell chamber and  
20 opposite the main chamber.

In addition, a fastener magazine 22 may be positioned to extend generally parallel to the handle portion 20 from an engagement point with a nosepiece 26 depending from a lower end 28 of the main chamber 14. A battery (not shown) is provided for supplying electrical power to the tool 10, and is  
25 releasably housed in a compartment (not shown) located on the opposite side of the housing 12 from the fastener magazine 22. Opposite the lower end 28 of the main chamber is an upper end 30. A cap 32 covers the upper end 30 and is releasably fastened to the housing 12 to protect the fan motor and spark plug. As used herein, "lower" and "upper" are used to refer to the tool 10 in its operation orientation as  
30 depicted in FIG. 1; however, it will be understood that this invention may be used in a variety of orientations depending on the application.

A mechanically linked fuel metering valve (not shown) such as that shown in U.S. Patent No. 4,483,474 may be used. Alternatively, an electromagnetic, solenoid type fuel metering valve (not shown) or an injector valve  
35 of the type described in commonly assigned U.S. Patent No. 5,263,439 is provided to introduce fuel into the combustion chamber as is known in the art. A pressurized

liquid hydrocarbon fuel, such as MAPP, is contained within a fuel cell located in the fuel cell chamber 18 and pressurized by a propellant as is known in the art.

FIG. 2 is a vertical cross-section of a cylinder head and suspension mechanism of the tool of FIG.1. Referring now to FIGS. 1 and 2, a cylinder head 34, disposed at the upper end 30 of the main chamber, defines an upper end of a combustion chamber 36, and provides a spark plug port (not shown) for a spark plug (not shown), an electric fan motor 40, and a sealing O-ring (not shown). The fan motor 40 may be a conventional iron core motor, also known as permanent magnet, brushed DC motor of the type produced by Nidec Copal of Tokyo, Japan, Canon of Japan, as well as may other known motor manufacturers. The motor 40 has an armature shaft end 42 with an armature (not shown) and an armature shaft 43, and a brush end 45 opposite the armature shaft end.

The fan motor 40 is slidably suspended by a fan motor suspension mechanism, generally designated 50, within a depending cavity 52 in the center of the cylinder head 34 that allows for some longitudinal movement of the motor. As shown in FIG. 2, the motor 40 is preferably retained in the cavity 52 so that an air gap 54 is created between the lower or armature shaft end 42 of the motor and a floor 56 of the cavity 52. The function of the air gap 54 is to provide clearance for the motor during oscillations occurring in the course of operation. Preferably, the armature shaft 43 extends through a hole 57 of the floor 56.

As further shown in FIG. 2, the suspension mechanism 50 includes a motor mount, generally designated 60, having an inner, annular ring 62, a central, resilient web portion (web) 64, and an outer, annular ring 66. The inner ring 62 is configured to contact and secure the fan motor 40 at a sidewall 63 of the motor, in the illustrated form, at a portion of the motor longitudinally closer to the brush end 45 than to the armature shaft end 42. For securing the inner ring 62 to the motor 40, two inner retaining rings 68, such as snap rings, may be disposed at least partially around the sidewall 63 of the motor and axially surround the inner ring. The inner retaining rings 68 may be received into a pair of corresponding grooves 70 formed into the sidewall 63, the grooves having inner walls 71 configured for axially constraining the retaining rings. Thus, the inner ring 62 is sandwiched or axially constrained by the retaining rings 68, and provides an attachment point for the motor 40.

The outer ring 66 of the mount 60 is secured to a portion of the tool 10, and in the form shown, the cylinder head 34. In the exemplary embodiment shown in FIG. 2, the outer ring 66 is retained against an annular shoulder 72 of the cylinder head 34. Another retaining ring 74, such as a snap ring having a larger

diameter than the pair of retaining rings 68, secures the outer ring to the cylinder head 34. The retaining ring 74 is disposed over the outer ring 66 and, when secured, is received into a groove 76 formed into the cylinder head and disposed above the shoulder 72, so that it is axially constrained by inner walls 77 of the  
5 groove. Thus, the outer ring 66 is axially secured between the shoulder 72 and the retaining ring 74.

The web 64 extends radially between the inner ring 62 and the outer ring 66, connecting the inner ring to the outer ring. To allow a degree of axial movement by the motor 40, the web 64 is shaped to have one or more corrugations,  
10 folds, or bellows 80. Though corrugations 80 are described herein, it will be understood that folds, bellows or similar shapes may be used. The corrugations 80 may extend axially to one or more peaks 82 that do not go beyond the axial outer surfaces of the inner ring 62 and the outer ring 66, so that the corrugations 80 (including the peaks 82) are recessed in relation to the outer surfaces of the inner  
15 ring 62 and the outer ring 66. The corrugations 80 provide resilience to the web 64, and thus shock absorption for the motor 40.

The mount 60 may be formed in a unitary piece and in some embodiments may be formed from a thermoplastic polyester elastomer, such as  
HYTREL® elastomer, manufactured by E.I. DuPont de Nemours and Company of  
20 Wilmington, Del. The mount 60 formed from HYTREL® elastomer provides a desired amount of resilience for absorbing or dampening acceleration of the motor 40. The mount 60 may also be configured for use with existing combustion tools.

FIG. 3 shows a vertical cross-section of a cylinder head and damper of a combustion powered fastener tool according to another embodiment, where  
25 parts similar to those previously described are similarly numbered. The motor 40 is located within the cavity 52. The motor 40 and the main chamber cap 32 are free to move relative to each other along the axis of the armature shaft 43. A pair of flange members 182 project inwardly from a side wall of the main chamber cap 32. The flange members are attached to the side walls. The flange members are  
30 slidably received into corresponding slots 183 formed in the side wall of the motor 40. The motor is guided by the flanges during relative upward and downward movement but is prevented by the flanges from rotating in reaction to the motor's operation. In some embodiments the flanges are absent or replaced with other guiding means.

35 Damper which in the illustrated form includes damping devices indicated by numerals 184, 186 and 188 and in the form of resilient blocks are disposed within the cavity 52. In this embodiment the damping devices are each in

the form of a polymer block, but may take any suitable form such as rubber pieces, compression springs, etc. The damping devices are spaced apart in the axial direction defined by the shaft 43, and the fan motor 40 is disposed between the damping devices 184 & 186 and 188. Damping devices 184 & 186 are attached to a  
5 bottom wall portion 190 of the cap 32, and damping device 188 is attached to a cavity cap 180 fastened to the main chamber cap 32 by any suitable means but which in this embodiment are rivets 192. During oscillation the motor moves into and out of engagement with the damper to damp the oscillations of the motor relative to the tool.

10 FIG. 4 shows a vertical cross-section of a cylinder head and damper of a combustion powered fastener tool according to another embodiment, where parts similar to those previously described are similarly numbered. In the embodiment as illustrated in FIG. 4, however, the damping devices of the damper 184, 186 and 188 are fastened to top and bottom surfaces of the motor. The  
15 damping devices are fastened by an adhesive in this embodiment, but any suitable fastening means, such as screws or other mechanical fasteners, may be used. A spring, in this but not all embodiments a coil spring 189, causes the motor to be spaced apart from the inside surfaces of caps 180 and 32 providing space for the relative movement of the motor 40 and caps. In some embodiments spring 189 is  
20 absent, and in other embodiments the flanges are absent or replaced with other motor guiding means. The spring 189 can also act as a damper and act to damp the movement of the motor. The spring 189 can be selected to have an appropriate spring stiffness (or spring constant) to reduce the oscillations of the motor. The stiffer the spring the higher the amount of damping. The damping of the motor may  
25 be effected by the spring 189 and the resilient blocks 184, 186 and 188 acting in combination.

FIG. 5 shows a vertical cross-section of a cylinder head and damper of a combustion powered fastener tool according to yet another embodiment where parts similar to those previously described are similarly numbered. In this  
30 embodiment, however, the motor 40 is connected to the cavity cap cover by damper which in the illustrated form are resilient members in the form of springs 202 and also to the bottom wall portion 190 by other resilient members which in the illustrated form are also springs 200. The motor is consequently suspended within the cavity 52 and the springs damp oscillations of the motor 40 that may be induced  
35 on combustion of the chamber. The springs may be attached to the caps and motor by any suitable fasteners such as mechanical fasteners, for example.

FIG. 6 shows a vertical cross-section of a cylinder head and damper of a combustion powered fastener tool according to another embodiment, where parts similar to those previously described are similarly numbered. In this embodiment, a damper for the motor is provided which in the illustrated form is hydraulic. The hydraulic damper may be in the form of pneumatic dampers. Any number of dampers may be employed. In the illustrated form the damper 204 is positioned between the cavity cap 180 and the top end of the motor 40 (i.e. the brush end 45 of the motor). Dampers 206 and 208 are disposed between the bottom end of motor 40 (i.e. the armature shaft end 42). In the illustrated form the three dampers can act in combination with each other to reduce oscillations of the motor 40. . In one alternative embodiment, damper 204 is omitted, and in another embodiment the dampers 206 and 208 are omitted.

FIG. 7 shows a vertical cross-section of a cylinder head and damper of a combustion powered fastener tool according to another embodiment of the invention, where parts similar to those previously described are similarly numbered. In this embodiment, the main chamber cap 32 of the combustion chamber 36 is attached to the housing 127 by damper, which in the illustrated form is in the form of springs 210 and 212. Any suitable form of dampers may be used, such as blocks of resilient material or hydraulic or pneumatic dampers. The motor is also attached, in this embodiment rigidly, to the housing 12. The motor and the main chamber cap 32 are free to move relative to each other along the axis of the armature shaft 43. Consequently, the motor and combustion chamber are at least in part mechanically isolated from each other so that oscillations of the combustion chamber are transmitted through the body to the motor 40 with reduced intensity.

Referring again to FIG. 1, the generally cylindrical combustion chamber 36 opens and closes by sliding motion valve member 130, which is moved within the main chamber 14 by a workpiece contacting element 132 on the nosepiece 26 using a linkage in a known manner. The valve member 130 serves as a gas control device in the combustion chamber, and sidewalls of the combustion chamber are defined by the valve member 130, the upper end of which sealingly engages the O-ring (not shown) to seal the upper end of the combustion chamber. A lower portion 136 of the valve member 130 circumscribes a generally cylindrical body or cylinder 138. An upper end of the cylindrical body 138 is provided with an exterior O-ring (not shown) which engages a corresponding portion of the valve member 130 to seal a lower end of the combustion chamber 36.

Within the cylinder body 138 is a reciprocally disposed piston 144 to which is attached a rigid, elongate driver blade 146 used to drive fasteners (not

shown), suitably positioned in the nosepiece 26, into a workpiece (not shown). A lower end of the cylinder body defines a seat 148 for a bumper 150 which defines the lower limit of travel of the piston 144. At the opposite end of the cylinder body 138, a piston stop retaining ring 152 is affixed to limit the upward travel of the  
5 piston 144.

Located in the handle portion 20 of the housing 12 are the controls for operating the tool 10. A trigger switch assembly 154 includes a trigger switch 156, a trigger 158, and a biased trigger return member 160. An ECU 162 under the control of the trigger switch 156 activates the spark plug (not shown).

10 In operation, as the trigger 158 is pulled, a signal is generated from the ECU 160 to cause a discharge at the spark gap of the spark plug 38, which ignites the fuel that has been injected into the combustion chamber 36 and vaporized or fragmented by a fan 164. The fan 164 is driven by the armature shaft 43, and is located within the combustion chamber 36 to enhance the combustion  
15 process and to facilitate cooling and scavenging. The fan motor 40 is preferably controlled by a head switch and/or the trigger switch 156, as disclosed in more detail in the prior patents incorporated by reference.

The ignition forces the piston 144 and the driver blade 146 down the cylinder body 138 until the driver blade contacts a fastener and drives it into the  
20 substrate as is well known in the art. The piston then returns to its original, or "ready" position through differential gas pressures within the cylinder, which are maintained in part by the sealed condition of the combustion chamber 36.

The fan motor 40 experiences two primary accelerations during this cycle. First, when the ignition of combustible gases in the chamber 36 forces the  
25 piston 144 downwardly toward the workpiece, and preferably forces a fastener into the workpiece, the tool 10 experiences an opposing upward force, or a recoil force, in the opposite direction. The fan motor 40, which is suspended by the suspension mechanism 50 in the tool 10, is accelerated upwardly in the direction of the recoil of the tool by a force transmitted through the suspension mechanism. Furthermore,  
30 the armature shaft 43 is accelerated in the same direction by having constrained movement relative to the motor 40 within limits of axial play. Then, in less than approximately ten milliseconds, the piston 144 bottoms-out in the cylinder against the bumper 150. This action changes the acceleration of the tool 10 towards the workpiece. Therefore, the motor and shaft are now accelerated in this new, opposite  
35 direction. The suspension mechanisms, motor mounts and or dampers provide a shock absorbing and isolating system to minimize the operational dynamics of the

main chamber 14 caused by the combustion on the motor 40 and also to protect the motor from axial acceleration and large oscillations.

The motor mount and/or dampers decrease acceleration of the motor resulting from the combustion during operation. The motor mounts and/or dampers may be tuned and dampen oscillation and dynamically operates without detrimental contact within the positive constraints of the tool 10 (bottoming or topping out). The motor mounts and or dampers may anticipate the two opposite accelerations separated by a predetermined fairly repeatable time and resiliently constrains the motor 40, preferably within the bounds of the cavity 52, to minimize the acceleration force of "g's" witnessed by the motor. The motor 40 need not be custom designed to provide for the acceleration forces generated by the tool 10. Instead, with the motor mounts and or dampers able to absorb the acceleration and dampen the oscillation, a less expensive motor may be provided, which reduces the overall manufacturing cost of the tool without impairing performance.

The motor mounts and or dampers may be tuned so that, in operation, the motor 40 does not oscillate excessively with respect to the tool 10 and either bottom out or top out. By "tuned" it is meant that the resilience of the motor mounts and or dampers may be adjusted to prevent a particular motor from excessive oscillation within predetermined, application-specific limits, depending on the combustion-induced force generated by the particular power source 16.

One skilled in the art will appreciate that the motor mounts and/or dampers can be designed and/or tuned using variations as described above, and as shown by example in FIGs. 1-7, to optimize the support and damping characteristics on the motor 40.

The present disclosure thus provides motor mounts and dampers for portable combustion-powered tools that may be inexpensively made, are easily tuned, and may be retrofitted into some existing tools, including tools having standard motors.

While particular embodiments of the motor mounts and dampers for combustion-powered tool have been shown and described, it will be appreciated by those skilled in the art that changes and modifications may be made thereto without departing from the invention in its broader aspects and as set forth in the following claims. For example, the motor guiding means may comprise rods or rails along which the motor may ride, or the flange may extend from the motor and be received by grooves formed in the cap.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as

"comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

- 5       The reference to any prior art in this specification is not, and should not be taken as, an acknowledgement or any form of suggestion that that prior art forms part of the common general knowledge in Australia. .

**THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:**

1. A damper for a fan motor of a combustion chamber in a combustion-powered tool for driving a fastener into a workpiece, the tool generating an upward axial acceleration of the motor upon a combustion in the chamber and a subsequent reciprocal axial acceleration of the motor, at least one of the accelerations causing the motor to oscillate relative to the tool, the damper comprising at least one damping device disposed within the tool to receive and absorb force to damp the oscillations of the motor relative to the tool.
2. The damper of claim 1, wherein the tool comprises a cavity in which the motor is located and the damper comprises first and second damping devices disposed within the cavity and being spaced apart in the axial direction, at least a portion of the fan motor being disposed between the first and second damping devices wherein during oscillation the motor is engagable with the first and second damping devices to damp the oscillations of the motor relative to the tool.
3. The damper of claim 2, wherein at least one of the first and second damper devices is formed from one or more resilient members.
4. The damper of either claim 2 or 3, wherein the motor is mounted so as to be axially movable within the cavity.
5. The damper of claim 1, wherein the damping device comprises a hydraulic damper.
6. The damper of claim 1, wherein the tool comprises a main portion in which at least part of the force is transmitted that induces the axial acceleration in the tool, wherein the motor is mounted to a mounting portion of the tool and the damper is disposed between the main portion of the tool and the mounting portion of the tool so as to absorb force so as to damp oscillation of the mounting portion relative to the main portion.

7. The damper of claim 6, wherein the motor is rigidly mounted to the mounting portion of the tool.
8. A damper of claim 6 wherein the combustion chamber is defined in part by a cylinder head and the mounting portion forms part of the cylinder head.
9. A combustion-powered tool for driving a fastener into a workpiece, the tool comprising:  
a combustion chamber;  
a combustion chamber fan having a motor; and  
a damper to receive and absorb force to damp oscillation of the motor in response to combustion within the combustion chamber.
10. The combustion-powered tool of claim 9, wherein the tool comprises a cavity in which the motor is located and the damper comprises first and second damping devices disposed within the cavity and being spaced apart in the axial direction, at least a portion of the fan motor being disposed between the first and second damping devices wherein during oscillation the motor is engagable with the first and second damping devices to damp the oscillations of the motor relative to the tool.
11. The combustion-powered tool of claim 10, wherein at least one of the first and second damper devices is formed from one or more resilient members.
12. The combustion-powered tool of either claim 10 or 11, wherein the motor is mounted so as to be axially movable within the cavity.
13. The combustion-powered tool of claim claim 10, wherein the damper comprises a hydraulic damper.
14. The combustion-powered tool of claim claim 10, wherein the tool comprises a main portion in which at least part of the force is transmitted that induces the

axial acceleration in the tool, wherein the motor is mounted to a mounting portion of the tool and the damper is disposed between the main portion of the tool and the mounting portion of the tool so as to absorb force so as to damp oscillation of the mounting portion relative to the main portion.

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15. The combustion-powered tool of claim 14, wherein the motor is rigidly mounted to the mounting portion of the tool.

16. The combustion-powered tool of claim claim 14 wherein the combustion  
10 chamber is defined in part by a cylinder head and the mounting portion forms part of the cylinder head.

17. A damper for a fan motor of a combustion chamber in a combustion-powered tool for driving a fastener into a workpiece, wherein the damper comprising at  
15 least one resilient web portion extending substantially laterally to a vertical axis defined by a motor shaft of the fan motor.

18. The damper as per claim 17 wherein the tool comprises a motor mount to mount the fan motor within the tool, the motor mount comprising at least two annular  
20 rings spaced apart from each other, at least one ring being in contact with the motor, the resilient web portion extending between the two annular rings.

19. The damper as per claim 17 wherein the resilient web portion further including at least a corrugation within the resilient web portion.

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20. The damper for a fan motor of a combustion chamber in a combustion-powered tool for driving a fastener into a workpiece, wherein the damper comprising at least one resilient block.

30 21. The damper for a fan motor of a combustion chamber in a combustion-powered tool for driving a fastener into a workpiece wherein the tool comprises a cavity within which the motor is located, the damper further comprising a first damping device and a second damping device disposed within the cavity and being spaced apart from each other in the axial direction, at least a portion of the

fan motor being disposed between the first and second damping devices, the damping devices being resilient blocks.

22. A damper for a fan motor of a combustion chamber in a combustion-powered tool for driving a fastener into a workpiece wherein the damper is a spring member.
23. A damper for a fan motor of a combustion chamber in a combustion-powered tool for driving a fastener into a workpiece wherein the tool comprising a cavity in which the motor is located, the damper comprising at least one spring member and at least one resilient block, the damper acting to reduce oscillations of the motor in use.
24. A damper for a fan motor of a combustion chamber in a combustion-powered tool for driving a fastener into a workpiece wherein the tool comprising a cavity defined by a cap and a wall portion, the motor is located within the cavity, the damper further comprising a spring member, three resilient blocks, the spring being disposed on the motor and causing the motor to be spaced apart from the wall portion, at least two resilient blocks also being coaxially aligned with each other along a lateral axis of the motor, the two coaxially aligned resilient blocks being axially spaced from the third resilient block.
25. A damper for a fan motor of a combustion chamber in a combustion-powered tool for driving a fastener into a workpiece wherein the tool comprises a cavity defined by a cap and wall portion, the motor positioned within the cavity, the damper comprising at least four springs, two springs being positioned between the motor and cap while the other two springs being positioned between the wall portion and motor.
26. The damper as per claim 25 wherein at least two springs are axially aligned with each other and are laterally spaced from the other springs.
27. A damper for a fan motor of a combustion chamber in a combustion-powered tool for driving a fastener into a workpiece wherein the tool comprises a cavity

defined by a cap and a wall portion, the motor positioned within the cavity, the damper comprising at least three hydraulic dampers, at least two of the hydraulic dampers being coaxially aligned along a lateral axis of the motor and being axially spaced apart from the third damper.

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28. A damper for a fan motor of a combustion chamber in a combustion-powered tool for driving a fastener into a workpiece wherein the tool comprises a housing, a cylinder, the cylinder including a cylinder head, the damper comprising at least one spring, the spring extending between the housing and cylinder head.

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29. A damper for a fan motor of a combustion chamber in a combustion-powered tool for driving a fastener into a workpiece wherein the tool comprises a cavity defined by a cap and a wall portion, the damper comprising three resilient blocks, two resilient blocks being coaxially aligned along a lateral axis of the motor, the two coaxially aligned blocks being axially spaced from the third block.

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30. The damper as per claim 29 wherein all three blocks are positioned on the motor

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31. The damper as per claim 29 wherein at least one block is positioned on the cap and at least one block is positioned on the wall portion.

32. A damper for a motor of a combustion chamber in a combustion powered tool, wherein the damper comprises at least one damping device to reduce oscillations of the motor in use.

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33. The damper as per claim 32 wherein the damping device is a resilient block.

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34. The damper as per claim 32 wherein the damper is a spring.

35. The damper as per claims 32 to 34 wherein the damper mechanically isolates the fan motor from the rest of the tool to reduce oscillations of the motor.

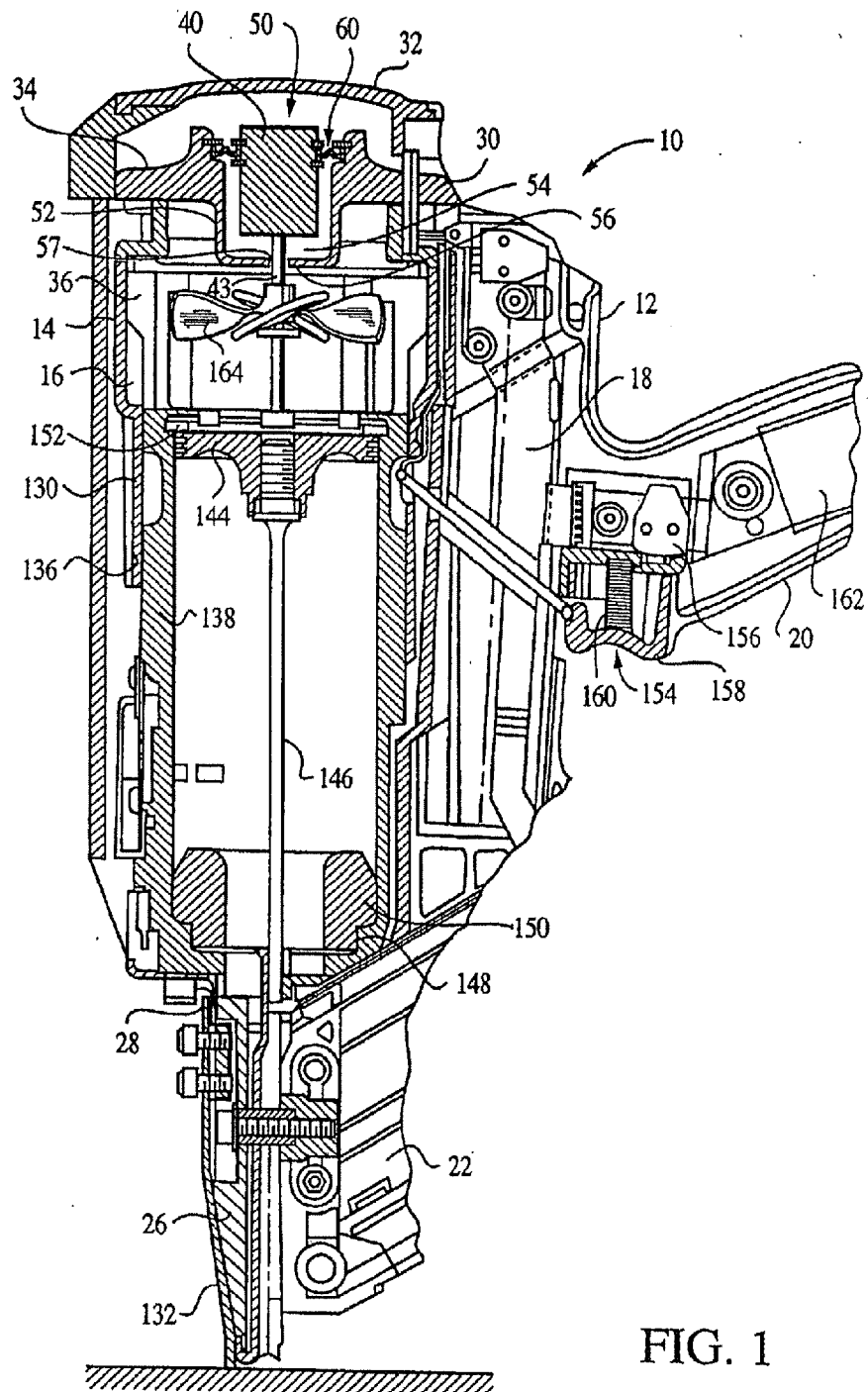
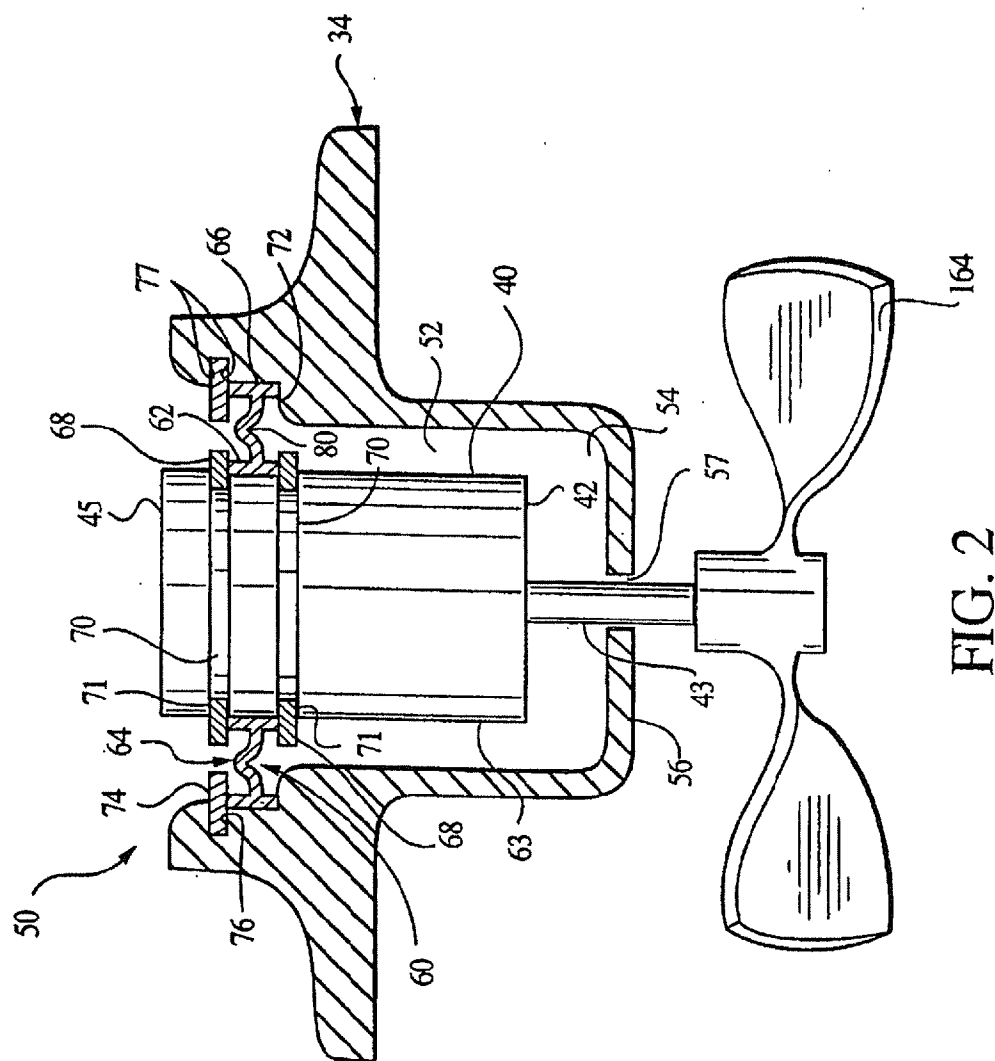


FIG. 1



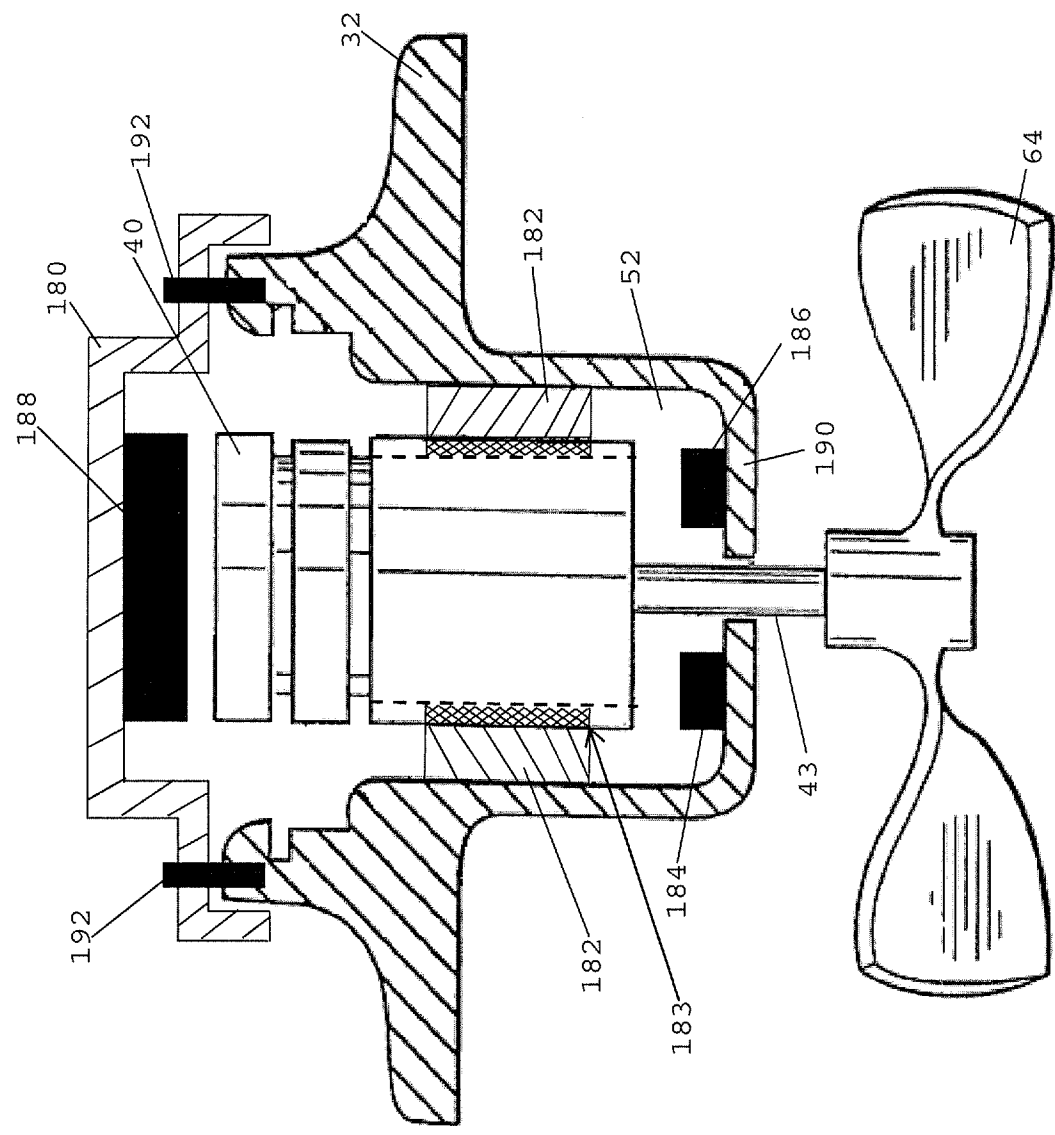


FIG. 3

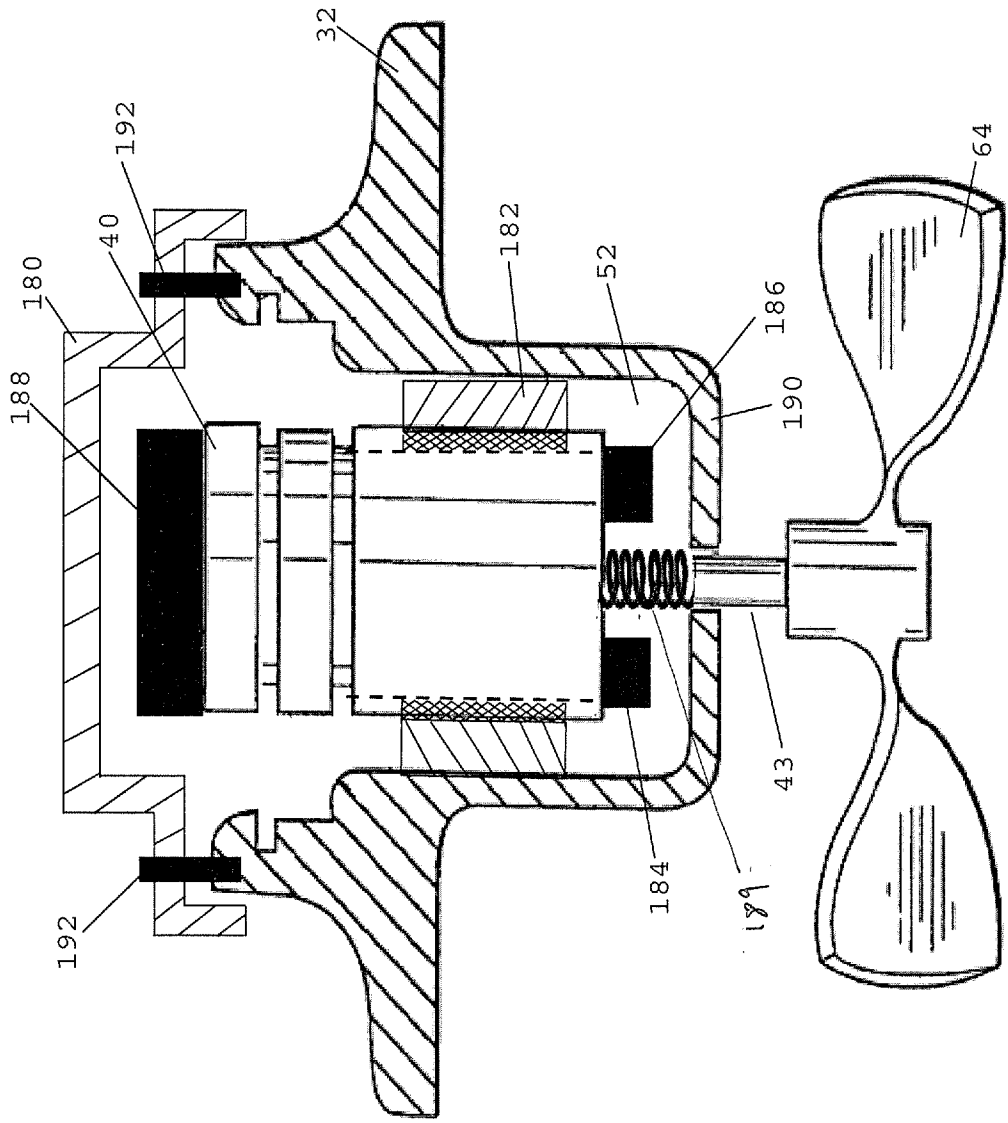


FIG. 4

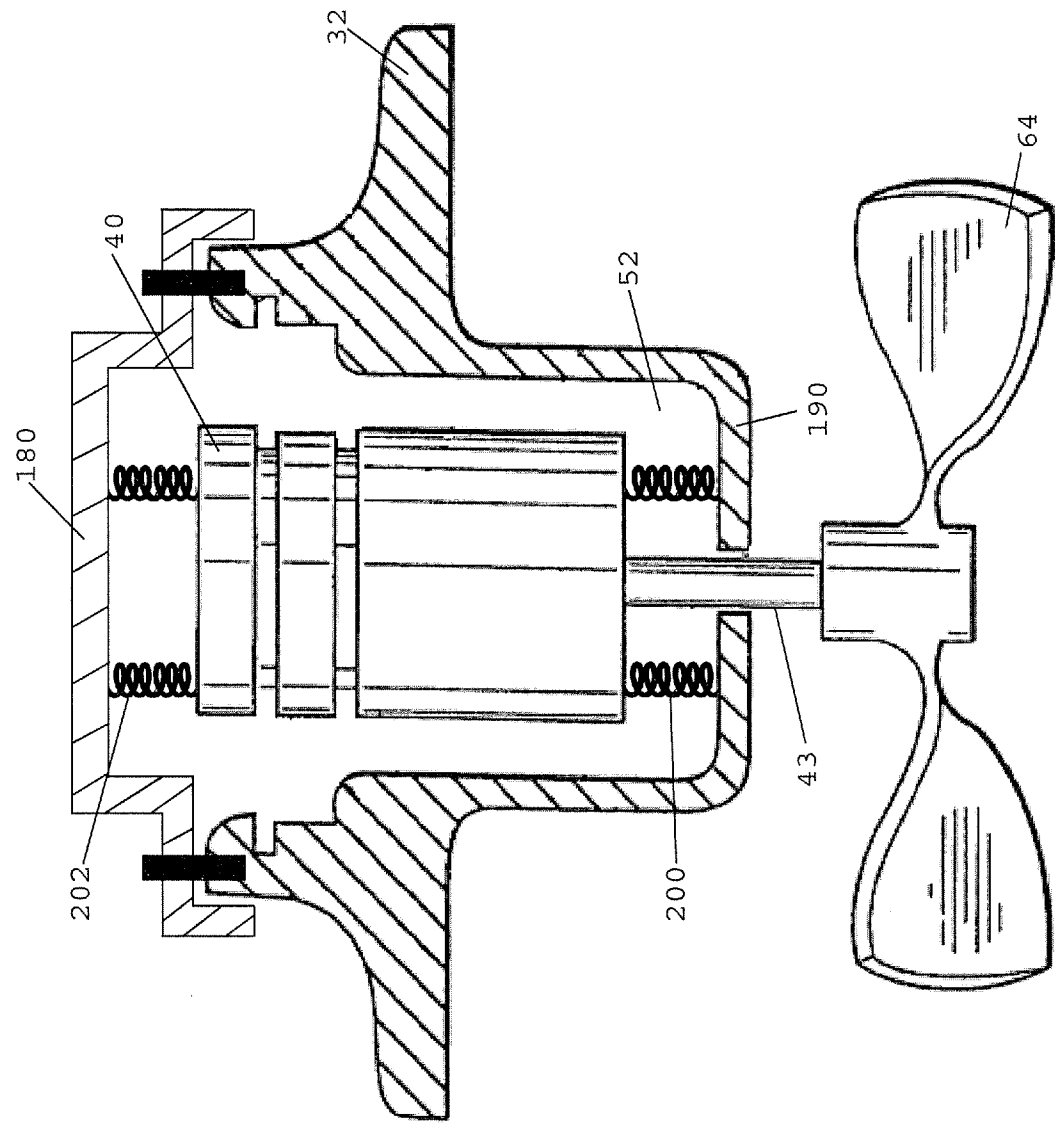


FIG. 5

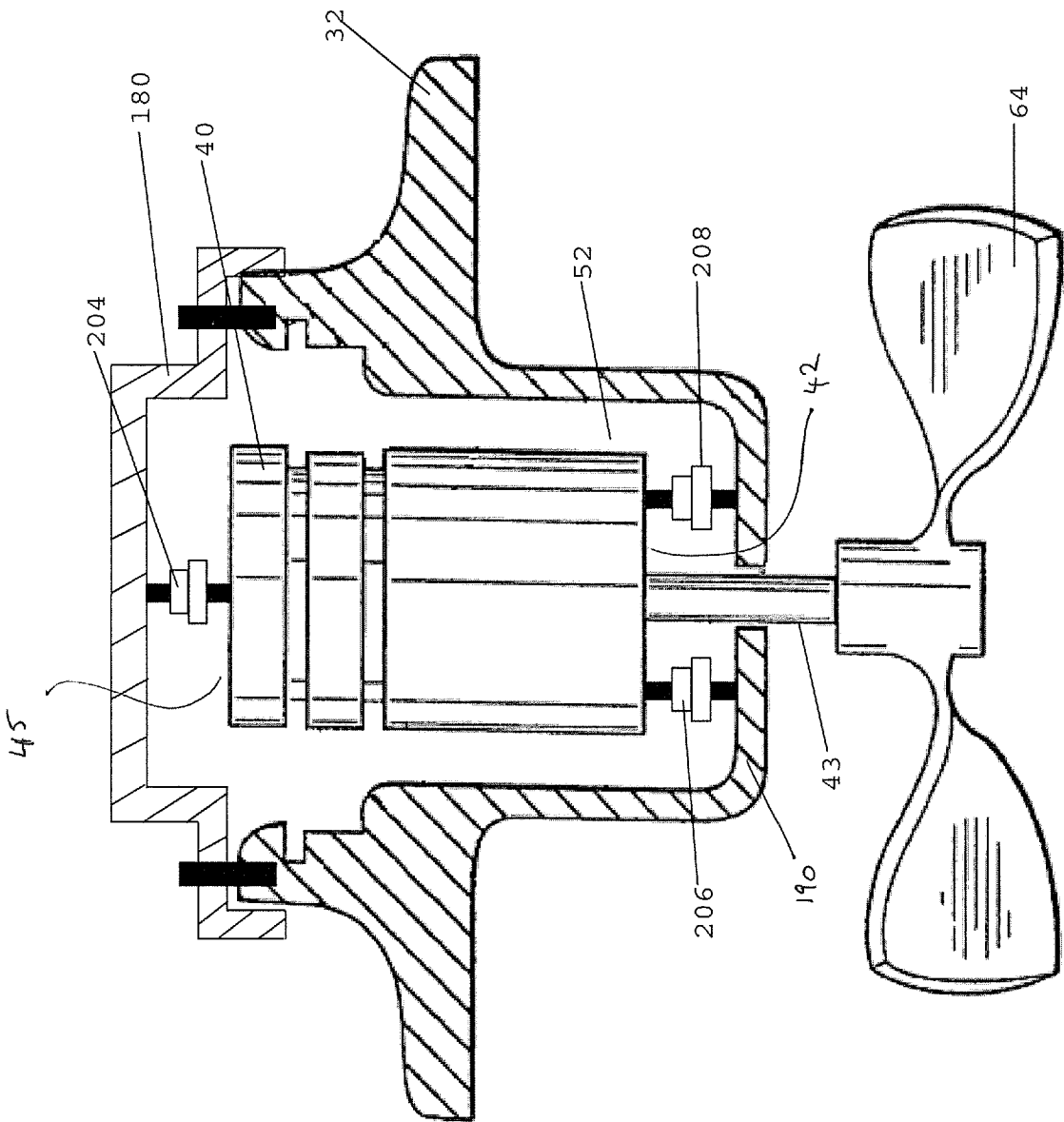


FIG. 6

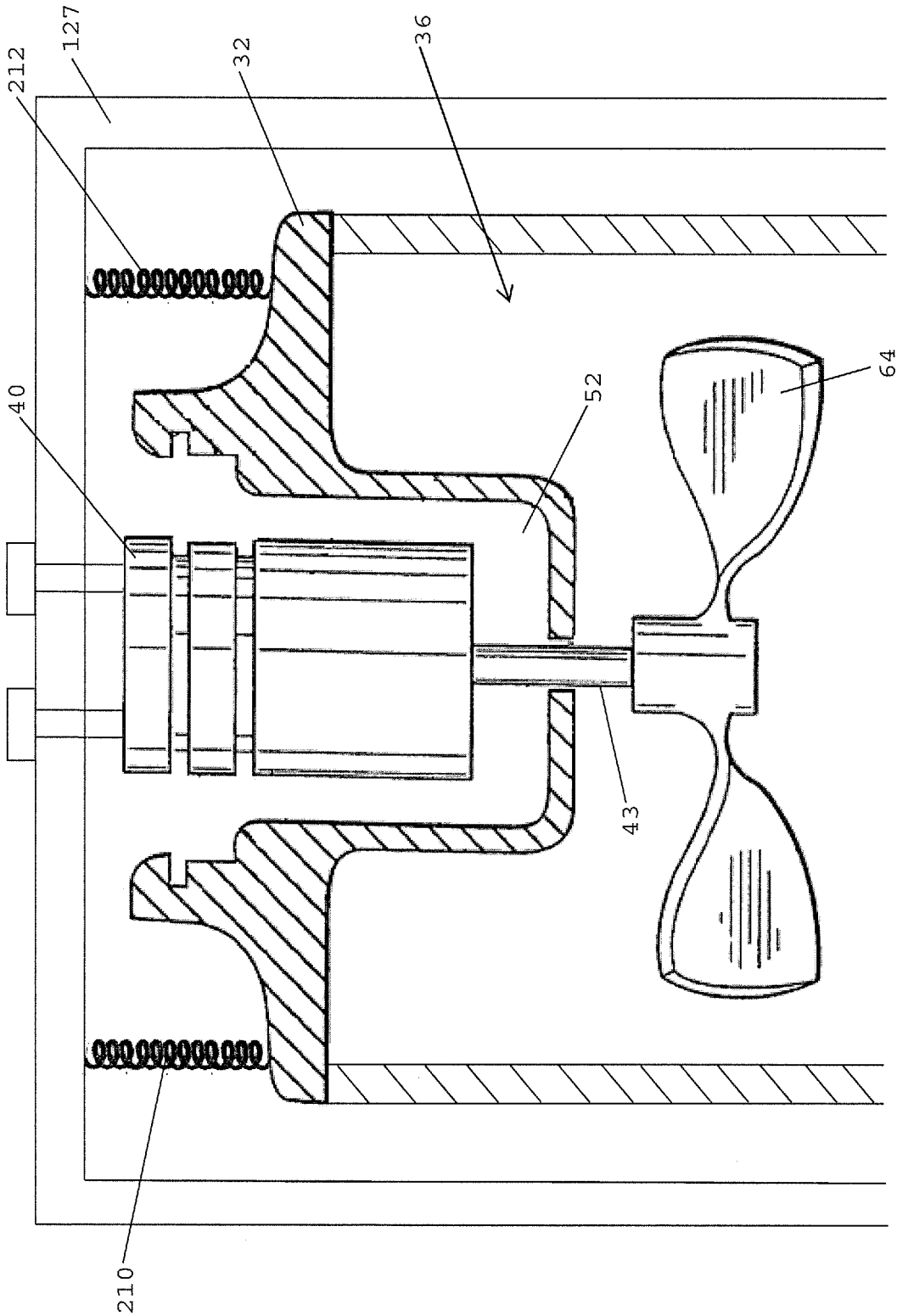


FIG. 7

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2012/034628

A. CLASSIFICATION OF SUBJECT MATTER  
INV. B25C1/08 B25F5/00  
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)  
B25C B25F

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 practicable, search terms used)

EP0-Internal

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| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                | Relevant to claim No.                                   |
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☒ Further documents are listed in the continuation of Box C.

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Date of the actual completion of the international search

20 July 2012

Date of mailing of the international search report

31/07/2012

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## INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2012/034628

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No

PCT/US2012/034628

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