(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 537 986 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.04.2025 Bulletin 2025/16

(21) Application number: **23202559.3**

(22) Date of filing: **10.10.2023**

(51) International Patent Classification (IPC):
B25F 5/00 *(2006.01)* ***B25F 5/02*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B25F 5/006; B25F 5/02

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

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(54) **ROTARY IMPACT TOOL**

(57) A rotary impact tool, comprising an outer housing and an inner housing at least partly surrounded by the outer housing; an motor installed in the inner housing, and an impact mechanism connected to the motor and fixedly mounted to the inner housing, to define an integrated inner sub-assembly comprising the motor and the impact mechanism; at least one elastic isolating element is disposed between the outer housing and the inner housing and extends circumferentially around the inner housing, so that the inner sub-assembly is elastically isolated from the outer housing. According to the present invention, the motor and the impact mechanism are combined to form an independent, integrated inner sub-assembly, which is held in a tool casing by means of the elastic element alone, thereby reducing the vibration suffered by the user from the impact mechanism and motor of the rotary impact tool.

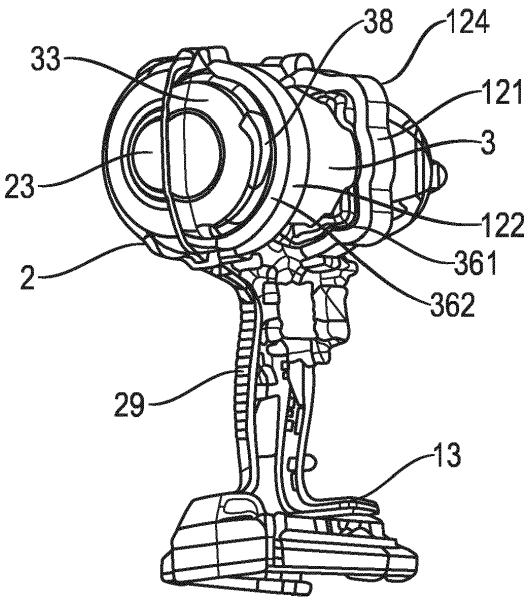

Fig. 2

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Description

TECHNICAL FIELD

[0001] The present invention relates to an impact tool, in particular a rotary impact tool capable of applying a rotary impact force to an output part.

BACKGROUND ART

[0002] During operation, electric tools and especially electric tools with an impact mechanism (such as impact wrenches) will generate vibration, which affects components and users and might even cause premature failure of the impact tool or damage to the user's health. Daily exposure limits for hand-arm vibration (HAV value) and limits for duration of use are formulated according to international standards for electrical devices as well as occupational health and safety laws of specific countries. If these limits are reached, further work is prohibited. People are becoming more and more aware of the negative effects of vibration on ergonomics and health, and it has thus become a competitive differentiation factor in the sale of electric tools.

[0003] For example, in an impact wrench, the motion of an motor, transmission gears and a tangential impact mechanism will generate excitations in the form of vibration during operation. Most of these excitations occur on a rotating shaft of the tangential impact mechanism, but there is also a considerable proportion of excitation that is perpendicular to the rotating shaft and rotational. These excitation forces will be transmitted to bearing seats where the motor and impact mechanism are mounted. If the bearings of the motor and impact mechanism within a casing are formed by direct contact with no damping, then these excitations will be transmitted one-to-one, or even amplified by the resonance effect. These excitations will be transmitted to the user via a handle in the casing, another casing surface in contact with the user, or another handle mounted on the tool, resulting in a high HAV value.

[0004] In addition, the power density of electric tools is increasing all the time, so an ever greater amount of cooling air needs to be supplied to motors and electronic devices. In order to effectively cool an electrical or electronic device, a position close to the electrical or electronic device is generally chosen for a cooling air inlet, such that external "cold" air first enters the electrical or electronic device in "suction mode". This requires the installation of a closed air duct between an motor fan and the electronic device, to avoid circuitous flow of cooling air.

[0005] The patent document US7152695B has disclosed an impact tool comprising a tool housing, the housing having a first component and a second component, each component comprising an internal surface and an external surface, and a tool housing air inlet or a tool housing air outlet. An motor may be installed in the tool housing and comprises an motor housing, the motor housing having an outer surface as well as an air inlet for leading cooling air into the motor and an exhaust vent for discharging hot exhaust air from the motor. The motor housing air inlet and exhaust vent open at the outer surface of the motor housing, and the motor housing exhaust vent may be spaced apart from the motor housing air inlet. A boot may be elastically connected to the outer surface of the motor housing, and a radial flange is disposed between the air inlet and the exhaust vent. The radial flange may have a part that extends to the first component and second component and is coupled therebetween so as to provide a vibration reduction effect, and forms a barrier between the air inlet and the exhaust vent, thereby substantially preventing exhaust air of the exhaust vent from entering the air inlet.

[0006] However, US7152695B only describes decoupling of the motor housing and the tool housing. The gearbox serving as the impact mechanism is still rigidly connected to the tool housing, and the origin of tool vibration is the workpiece reaction force acting on an output shaft of the tool during use; when the impact mechanism is still rigidly connected to the tool housing, vibration is also transmitted directly to the tool housing. Here, the elastic boot (which is only able to achieve attenuation of striking vibration transmitted to the motor) does not sustain or transmit the reaction force of tool use, and is not able to truly achieve a reduction in the impact vibration transmitted to the user's arms.

SUMMARY OF THE INVENTION

[0007] An objective of the present invention is to provide a rotary impact tool in which an motor and an impact mechanism are combined to form a unit similar to a secondary chassis, the unit being held in a tool casing by means of an elastic element alone, thereby reducing the vibration suffered by the user from the impact mechanism and motor of the rotary impact tool.

[0008] According to an embodiment of the present invention, a rotary impact tool comprises an outer housing and an inner housing at least partly surrounded by the outer housing; an motor installed in the inner housing, and an impact mechanism connected to the motor and fixedly mounted to the inner housing, to define an integrated inner sub-assembly comprising the motor and the impact mechanism; at least one elastic isolating element is disposed between the outer housing and the inner housing and extends circumferentially around the inner housing, so that the inner sub-assembly is elastically isolated from the outer housing. In the present invention, an inner sub-assembly is formed by having the motor and the impact mechanism fixedly mounted to the inner housing, and this sub-assembly is supported in the outer housing by means of the elastic isolating element alone; in this way, the amount of vibration transmitted from the impact tool to the user's hands and arms during use is reduced effectively.

[0009] The inner housing is substantially cylindrical,

having a frontward open first end and a rearward closed second end, the motor is installed in the inner housing at a side close to the second end, the impact mechanism is fixedly mounted to the first end of the inner housing, the outer housing has substantially the same shape as the inner housing in an axial direction, and an inner surface of the outer housing has a greater diameter than an outer surface of the inner housing, with support being provided by the isolating element alone between the outer housing and the inner housing. An independent, integrated inner sub-assembly is formed from the motor and the impact mechanism by means of an additionally provided inner housing, and support is provided by the elastic isolating element alone between the outer housing and the inner sub-assembly, with no rigid connection, such that a reaction force acting on an output part will be attenuated by the elastic isolating element, thus achieving complete decoupling between the inner sub-assembly and the outer housing.

[0010] The isolating element comprises a first isolating element and a second isolating element, which surround circumferential outer surfaces close to the first end and second end of the inner housing respectively. The first isolating element is disposed at the first end close to the impact mechanism, thus ensuring a better vibration reduction effect. Having the second isolating element disposed close to the rear end of the impact tool helps to achieve structural balance and stability.

[0011] The outer surface of the inner housing and the inner surface of the outer housing are provided with a corresponding first positioning structure and a corresponding second positioning structure respectively, the first isolating element is received in the first positioning structure, and the second isolating element is received in the second positioning structure. Since the inner sub-assembly is supported in the outer housing by the isolating element alone, axial positioning of the isolating element is particularly important, and the positioning mechanism here ensures that the isolating element will not disengage from the outer surface of the inner housing or the inner surface of the outer housing. Axial movement between the outer housing and the inner housing is merely elastic deformation of the isolating element.

[0012] A handle extends below the outer housing, a power supply is connected to a lower end of the handle, and an electronic component connecting the power supply and the motor is accommodated in the handle. The handle gripped by the user is integrated with the outer housing and elastically isolated from the inner sub-assembly, so vibration of the inner sub-assembly will be attenuated by the elastic isolating element, and the amount of vibration transmitted to the handle will be considerably reduced.

[0013] An air intake for sucking in external air is provided on the handle or on the outer housing between the first positioning structure and second positioning structure, the outer housing is provided with an exhaust vent situated further rearwards than the second positioning structure, a part of the inner housing between the two isolating elements is provided with an air inlet, and the inner housing is provided with an air outlet situated further rearwards than the second positioning structure. Thus, the isolating element also serves as an air partition plate. The air intake sucks in cold external air which, , enters the motor through the air inlet of the inner housing under the action of the fan of the motor, flows through electronics components and/or the motor before being discharged from the air outlet behind the second isolating element, and is then discharged from the exhaust vent of the outer housing. An air intake channel and an exhaust channel are separated by the isolating element; in this way, diversion of the external cooling air is avoided, and the cooling effect is improved.

[0014] The motor comprises a fan provided at a rear side of the motor and a drive shaft provided at a front side of the motor, and the air inlet is provided on the inner housing at a position corresponding to the drive shaft and faces towards the handle. As the fan is disposed behind the motor while the air inlet is located in front of the motor, the cooling air can flow through the motor. Since the air inlet of the inner housing faces towards the handle, external air directly enters the inner housing to cool the motor after flowing through and cooling the electronic component in the handle, resulting in an optimized aerodynamic path.

[0015] The position of the air outlet on the inner housing is substantially opposite the position of the exhaust vent on the outer housing. Thus, exhaust gas that has already heated up is discharged directly, so will not enter the tool interior again and affect the cooling result.

[0016] According to an embodiment of the present invention, the isolating element comprises a uniform, continuous annular shape. Alternatively, the elements can be composed of 2 or more parts for easy of assembly or manufacturing. Since the inner housing is substantially cylindrical, the annular isolating element surrounds the inner housing, providing elastic deformation with six degrees of freedom.

[0017] According to another embodiment of the present invention, the isolating element comprises an annular shape having shape-fitting parts in its circumferential direction. The shape-fitting parts in the circumferential direction of the isolating element can prevent circumferential movement of the outer housing relative to the inner housing.

[0018] The isolating element further comprises axially extending protruding parts distributed discretely in the circumferential direction of the annular shape, to increase the strength of the isolating element in the axial direction.

[0019] According to another embodiment of the present invention, a rearward second end of the outer housing is not closed, and the outer housing surrounds the inner housing in the axial direction only. This helps to reduce the overall length of the tool; furthermore, the open second end may serve as an exhaust vent overall,

with no need for an additional exhaust vent.

[0020] According to another embodiment of the present invention, a rearward second end of the outer housing is closed, having a rear end face substantially perpendicular to the axial direction, and a third elastic isolating element is provided between the rear end face of the outer housing and a second end face formed at the closed second end of the inner housing. Thus, additional vibration decoupling is provided between the outer housing and the inner sub-assembly; furthermore, cushioning can be provided when the impact tool falls, preventing damage to the impact tool.

[0021] The isolating element is formed of polyurethane foam . The isolating element must have sufficient strength, good wear resistance and ultraviolet resistance, as well as having the same service life as the inner and outer housings formed of plastic; research has found that polyurethane foam is a material having all of these properties.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] A better understanding of the embodiments mentioned can be gained from the following detailed description with reference to the drawings. It is emphasized that the various components are not necessarily drawn to scale. In fact, dimensions may be increased or decreased at will for the purpose of clear description. In the drawings, identical reference numerals denote identical elements.

Fig. 1 is a complete schematic drawing of a rotary impact tool in an embodiment of the present invention.

Fig. 2 is a partial schematic drawing of the rotary impact tool shown in Fig. 1 with part of the outer housing removed.

Fig. 3 is an axial sectional view of a rotary impact tool in an embodiment of the present invention.

Fig. 4 is a partial schematic drawing of a rotary impact tool in another embodiment of the present invention.

Fig. 5 is a partial schematic drawing of a rotary impact tool in another embodiment of the present invention.

Fig. 6 is a partial schematic drawing of a rotary impact tool in another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0023] The rotary impact tool of the present invention is described below with reference to Figs. 1 - 6. The following description is merely exemplary, and does not limit the disclosed content of the present application or the applications or uses of the present invention. In the description of the present invention, it should be understood that orientations or positional relationships indicated by terms such as "centre", "longitudinal", "transverse", "length", "width", "thickness", "upper", "lower", "front", "rear", "left", "right", "vertical", "horizontal", "top", "bottom", "inside", "outside", "axial", "radial", and "circumferential" are based on orientations or positional relationships shown in the drawings, which are only for facilitating the description of the present invention and simplifying the description, rather than indicating or implying that devices or elements referred to must have a specific orientation or be constructed and operated in the specific orientation, and therefore cannot be construed as limiting the present invention.

[0024] Figs. 1 - 3 show an exemplary rotary impact tool, e.g. an impact wrench 1. The impact wrench 1 comprises an outer housing 2 and an inner housing 3 at least partly surrounded by the outer housing 2, with an motor 4 and an impact mechanism 5 accommodated in the inner housing 3. The impact mechanism 5 comprises an output shaft 6, wherein the impact mechanism 5 can apply an impact to the output shaft 6 lying on a work axis 7 in a direction of rotation about the work axis 7 under the driving action of the motor 4. A handle 29 extends from below the outer housing 2, and a user can grip and guide the impact wrench 1 by means of the handle 29 during operation. An on/off button is provided on the handle 29, and the motor 4 can be turned on or off by means of the on/off button. A battery or an AC power supply may be connected to a lower part of the handle 29, and an electronic component 13 connecting the power supply and the motor is accommodated in the handle 29. Preferably, the lower part of the handle 29 has an expanded part to serve as an interface for battery connection; the electronic component 13 is deployed close to the battery connection interface, to simplify the wiring layout and improve heat dissipation. Alternatively, the electronic components could be arranged behind the motor. In this case, the sucked in cold air would be first guided to flow through the motor and secondly over the electronics.

[0025] The outer housing 2 may be injection-moulded from a suitable composite material. In some embodiments, the outer housing 2 may comprise two substantially symmetric half-shells; these have an upper part 20 extending substantially in the axial direction of the work axis 7, and a half part which, from an upper part, gradually changes into the handle 29 formed by downward extension. The two half-shells are fitted together by fasteners such as screws, forming a hollow tube shape extending substantially in the axial direction. An upper part of the tube shape of the outer housing 2 comprises a front end facing towards the output shaft 6, and a rear end 22 which is opposite the front end 21 and remote from the output shaft 6. The front end 21 is open, and has a substantially annular sectional profile. Preferably, an inner surface 23

of the outer housing is substantially round; a suitable shape is chosen for an outer surface 24 according to the requirements of industrial design of the tool. Referring to Figs. 3 - 5, according to an embodiment of the present invention, the rear end 22 is open. According to another embodiment of the present invention, the rear end 22 is closed, having a rear end face 25 substantially perpendicular to the work axis 7; this is described in further detail below.

[0026] Similar to the outer housing 2, the inner housing 32 may also be injection-moulded from a suitable composite material. For example, the inner housing 3 could be formed by one cup-shaped part with motor to be installed into it from front. The inner housing 3 may also comprise two substantially symmetric half-shells, which are fitted together to form a cylindrical structure. It will be understood that the inner housing 3 may also be integrally formed. The inner housing 3 has a frontward open first end 31 and a rearward closed second end 32; a second end face 35 substantially perpendicular to the work axis 7 is formed at the closed second end 32. A part of the inner housing 3 that extends axially between the first end 31 and the second end 32 has an outer surface 34 and an inner surface 33 with a substantially annular sectional profile.

[0027] The motor 4 is installed in the inner housing at a side close to the second end 22, and a fan 8 is provided behind the motor 4. The inner surface 33 of the inner housing 3 is provided with ribs extending radially inwards, thus providing a form of fitting between the motor 4 and the inner housing 3, in order to fix the motor 3 in the inner housing in the axial and rotation directions.

[0028] The motor 4 comprises a drive shaft 9, which extends to a region in front of the motor and is connected to the impact mechanism 5. According to an embodiment of the present invention, the impact mechanism 5 comprises a gear transmission component, a main shaft, a hammer and the output shaft 6, as well as a gearbox 10 accommodating these components. The gear transmission component and hammer mentioned above have the following well-known structure: the gear transmission mechanism is meshed with the drive shaft 9, converts high-speed rotation of the drive shaft 9 of the motor 4 to rotation of the output shaft 6 by speed reduction, and transmits torque to the hammer, which repeatedly engages with and disengages from the output shaft 6, thereby producing impacts in the direction of rotation.

[0029] Referring to Figs. 3 and 4, the gearbox 10 is a tubular body, a rear part thereof being inserted into the inner housing 3 and engaged with a bearing seat of the gear transmission component installed in the inner housing 3, while a front part of the gearbox 10 that is exposed at the first end 31 of the inner housing 3 has a tapered shape pointed at the front and may be covered by a shroud made of synthetic resin. The output shaft 6 is supported at a front end of the gearbox 10 and protrudes towards the front. Mounting holes are provided on an outer periphery of the gearbox 10 at the position where it is exposed at the first end 31 of the inner housing 3, so that the gearbox 10 may be fixedly mounted to the first end 31 of the inner housing 3 by fasteners 11. Thus, the motor 4 and the impact mechanism 5 are both fixedly mounted in the inner housing, with no need for direct axial fixing between the motor 4 and the impact mechanism 5; overall, the motor 4, impact mechanism 5, output shaft 6 and inner housing 3 define an inner sub-assembly independent of the outer housing 2.

[0030] Referring to Figs. 3 - 6, the outer housing 2 has substantially the same shape as the inner housing 3 in the axial direction, and the inner surface 23 of the outer housing 2 has a larger diameter than the outer surface 34 of the inner housing 3; at least one elastic isolating element 12 is disposed between the inner surface 23 of the outer housing 2 and the outer surface 34 of the inner housing 3 and extends around the circumferential direction of the inner housing 3, such that the inner sub-assembly is elastically isolated from the outer housing. As stated above, in the present invention, an inner sub-assembly is formed by fixedly mounting the motor 4 and the impact mechanism 5 to the inner housing 3. Vibration caused by the reaction force of the workpiece being processed acting on the output shaft 6 of the impact tool during use, vibration produced by the hammer of the impact mechanism 5 in the process of striking, and vibration produced by the motor 4 in the process of rotating, are the main sources of vibration in the impact tool; these sources of vibration are all integrated in the inner sub-assembly. The inner sub-assembly is supported in the outer housing 2 by the elastic isolating element 12 alone, without any rigid connection, so the elastic isolating element 12 achieves decoupling of vibration between the outer housing 2 and the inner sub-assembly. The isolating element 12 attenuates the transmission of vibration of the inner sub-assembly to the outer housing 2, and hardly any of the vibration produced by the inner sub-assembly will be transmitted to the handle 29 below the outer housing 2. Consequently, when gripping the handle 29 below the outer housing 2, the user's hand will not be affected, meeting the requirements of the daily exposure limits for hand-arm vibration (HAV value) and limits for duration of use.

[0031] According to a preferred embodiment of the present invention, the isolating element 12 comprises a first isolating element 121 and a second isolating element 122, which surround circumferential outer surfaces close to the first end 31 and second end 32 of the inner housing 3 respectively. Having the first isolating element 121 disposed at the first end 31 close to the impact mechanism 5 has a better vibration reduction effect. Having the second isolating element 122 disposed close to the rear end of the impact tool helps to achieve structural balance and stability. It will be understood that the isolating element 12 of the present invention is not limited to two; for example, the isolating element 12 may be a single isolating element extending substantially in the axial direction from the first end towards the second

end of the inner housing, but assembly might be relatively complex. There could also be 3, 4 or more isolating elements 12, jointly supported between the inner housing and outer housing, but in this case it is likewise possible that the problems of structural complexity and difficulty of assembly will be faced.

[0032] Since the inner sub-assembly is supported in the outer housing 2 by means of the elastic isolating element 12 alone, the isolating element 12 is acted on by an axial shearing force and deforms when the impact mechanism 5 is acted on by the reaction force of the workpiece and vibrates axially; in this way, the effect of attenuating vibration is achieved. That is to say, all relative movement between the outer housing 2 and inner housing 3 is caused by elastic deformation of the isolating element 12, and cannot be physical movement of the isolating element relative to the outer housing or inner housing. To ensure axial positioning of the isolating element 12, the outer surface 34 of the inner housing 3 is provided with a positioning structure 36 for supporting and positioning the isolating element; correspondingly, the inner surface 23 of the outer housing 2 is provided with a corresponding positioning structure 26 for supporting and positioning the isolating element. In a schematic embodiment of the present invention, the positioning structure 36 of the inner housing 3 is formed as an annular groove extending radially outwards along the outer surface of the inner housing, and the isolating element can be received in the annular groove. The positioning structure 26 of the outer housing 2 is formed as an annular groove extending radially inwards along the inner surface of the outer housing, its position being aligned with the annular groove on the inner housing, and the isolating element 12 can be clamped in the two annular grooves.

[0033] Preferably, the positioning mechanisms are also two in number. The first isolating element 121 is received in first positioning structures 361, 261, and the second isolating element 122 is received in second positioning structures 362, 262. Here, the positioning mechanism ensures that the isolating element will not disengage from the outer surface of the inner housing or the inner surface of the outer housing; axial movement between the outer housing and the inner housing is merely elastic deformation of the isolating element.

[0034] The isolating element 12 comprises a substantially annular structure; since the inner housing is substantially tubular, the annular isolating element surrounds the inner housing, providing elastic deformation with six degrees of freedom. The thickness of the annular shape is substantially equal to or slightly greater than the difference between the radius of the inner surface of the outer housing and the radius of the outer surface of the inner housing, to ensure that the inner sub-assembly can be supported in the outer housing by the isolating element 12 alone. The axial length of the annular shape may be suitably dimensioned according to the power of the impact tool and the material of the isolating element. Preferably:

According to another embodiment of the present invention, referring to Fig. 4, the second isolating element 122 is a uniform, continuous annular shape; since the second isolating element 122 is disposed close to the second end of the inner housing where the motor is installed, the annular shape is the form that saves the most space, because it conforms to the set round shape of the motor. It can be understood that the isolating elements can be composed of 2 or more parts for easy of assembly or manufacturing. The first isolating element 121 comprises an annular shape having shape-fitting parts 124 in its circumferential direction. Since the gearbox 10 is fixedly mounted to the end face of the first end 31 of the inner housing 3 by fasteners such as screws, the cross section of the inner housing 3 perpendicular to the work axis 7 at the first end 31 is not a regular round shape, but a square circle having slightly outward-protruding fastener installation parts at the positions where the fasteners are installed. The first isolating element 121 similarly has shape-fitting parts in its circumferential direction which are adapted to the fastener installation parts, such that the first isolating element 121 fits perfectly between the inner housing 2 and the outer housing 3; this can not only prevent circumferential movement of the outer housing relative to the inner housing, but also results in the formation of an air gap between the outer housing 2 and the inner housing 3.

[0035] Referring to Fig. 5, according to another embodiment of the present invention, the isolating element 12 further comprises axially extending protruding parts 125 distributed discretely in the circumferential direction of the annular shape, to increase the strength of the isolating element in the axial direction; this results in a better vibration attenuation effect and a better service life.

[0036] Referring to Fig. 6, according to another embodiment of the present invention, the second end 22 of the outer housing 2 is closed, having a rear end face 25 substantially perpendicular to the work axis, and a third elastic isolating element 123 is provided between the rear end face 25 of the outer housing and the second end face 35 formed at the closed second end of the inner housing. Thus, additional vibration decoupling is provided between the outer housing and the inner sub-assembly; furthermore, cushioning can be provided when the impact tool falls, preventing damage to the impact tool.

[0037] Again referring to Figs. 1 - 3, an air intake 27 for sucking in external "cold" air is provided on the handle 29 at a position close to the electronic component 13. The outer housing 2 is provided with an exhaust vent 28 situated further rearwards than the second positioning structure 262. A part of the inner housing 3 between the first positioning structure 361 and the second positioning structure 362 is provided with an air inlet 37, and the inner housing 3 is provided with an air outlet 38 situated further rearwards than the second positioning structure 362. Thus, the air intake 27 on the handle 29 sucks in cold external air which, after cooling the electronic component 13 accommodated in the handle 29, enters the inner

housing through the air inlet 37 of the inner housing 3 under the action of the fan 8 of the motor 4, flows through the motor 4 before being discharged from the air outlet 38 behind the second positioning structure 362, and is then discharged from the exhaust vent 28 of the outer housing. Since the first isolating element 121 and second isolating element 122 are clamped and positioned with a perfect fit between the first positioning structures 261, 361 and the second positioning structures 262, 362, the isolating elements also serve as air partition plates. External air sucked in from below the handle is confined within a gap 14 of the outer housing and inner housing between the first isolating element 121 and second isolating element 122; in this way, diversion of the external cooling air is avoided, for a better cooling effect. Furthermore, because the fan 8 of the motor 4 is disposed at a rear part of the motor 4, rotation of the fan 8 forms negative pressure in front of the motor; the external airflow sucked into the handle can only enter the cavity of the inner housing through the air inlet 37 disposed on the inner housing between the first positioning structure 361 and the second positioning structure 362 under the action of the negative pressure, and after cooling the motor, is discharged through the air outlet 38 to a region behind the second isolating element 122. At this time, the exhaust air that has already heated up will be blocked by the second isolating element 122, so will not flow back into the gap 14 of the outer housing and inner housing between the first isolating element 121 and second isolating element 122. Alternatively, the air intake 27 can be provided on the outer housing, between the first positioning structure 261 and second positioning structure 262. As the electronic components are arranged directly behind the motor, in this case, the sucked in cold air would be first guided to flow through the motor and secondly over the electronics. According to a preferred embodiment of the present invention, as shown in Fig. 2, the air inlet 37 is disposed at a position on the inner housing that corresponds to the drive shaft 9, and faces towards the handle 29. The fan 8 is disposed behind the motor 4, and the air inlet 37 is located in front of the motor 4; thus, the external cooling air sucked in through the air intake 27 below the handle flows through and cools the electronic component in the handle before entering the inner housing directly through the air inlet 37 located above the handle, and flows through the motor 4 under the action of the fan 8. Thus, an air intake channel has the optimal aerodynamic path.

[0038] In the embodiments shown in Figs. 1, 2 and 6, the second end 22 of the outer housing 2 is closed, i.e. the outer housing 2 comprises a closed rear end face 25. In this case, preferably, the position of the air outlet 38 on the inner housing 3 is substantially aligned with the position of the exhaust vent 28 on the outer housing 2; thus, exhaust air that has already cooled the electronic component and the motor and heated up is discharged directly along the shortest path, so will not affect the relatively cold airflow in the air intake channel.

[0039] However, a second end of the outer housing 2 may also be not closed, or may even be completely open; for example, in the impact wrench shown in Figs. 3 - 5, the outer housing 2 surrounds the inner housing 3 in the axial direction only. The outer housing 2 and inner housing 3 have substantially the same length in the axial direction, or the axial length of the outer housing 2 is slightly less than the axial length of the inner housing 3, and the second end face 25 of the inner housing protrudes rearwards slightly beyond the second end 22 of the outer housing. This helps to reduce the overall length of the tool. Furthermore, the open second end 22 may serve as an exhaust vent overall, with no need for an additional exhaust vent.

[0040] Many types of material may be used for the isolating element. Preferably, the isolating element is formed of a non-metal material capable of elastic deformation. More preferably, the isolating element is formed of polyurethane foam. Polyurethane foam has sufficient strength, good wear resistance and ultraviolet resistance, as well as having the same service life as the inner and outer housings formed of plastic, so is an ideal elastic isolating element for the present invention. Of course, the material, density or thickness, etc. of the isolating element is altered appropriately according to the strength required for attenuation of the striking vibration transmitted from the inner sub-assembly.

[0041] As stated above, although exemplary embodiments of the present invention have been explained herein with reference to the drawings, the present invention is not limited to the specific embodiments described above, and may have many other embodiments. The scope of the present invention should be defined by the claims and their equivalent meaning.

Claims

1. Rotary impact tool, comprising an outer housing and an inner housing at least partly surrounded by the outer housing; an motor installed in the inner housing, and an impact mechanism connected to the motor and fixedly mounted to the inner housing, to define an integrated inner sub-assembly comprising the motor and the impact mechanism; **characterized in that**
   at least one elastic isolating element is disposed between the outer housing and the inner housing and extends circumferentially around the inner housing, so that the inner sub-assembly is elastically isolated from the outer housing.

2. Rotary impact tool according to Claim 1, **characterized in that**
   the inner housing is substantially cylindrical, having a frontward open first end and a rearward closed second end, the motor is installed in the inner housing at a side close to the second end, the impact mechanism is fixedly mounted to the first end of the inner

housing, the outer housing has substantially the same shape as the inner housing in an axial direction, and an inner surface of the outer housing has a greater diameter than an outer surface of the inner housing, with support being provided by the isolating element alone between the outer housing and the inner housing.

3. Rotary impact tool according to Claim 2, **characterized in that**
the isolating element comprises a first isolating element and a second isolating element, which surround circumferential outer surfaces close to the first end and second end of the inner housing respectively.

4. Rotary impact tool according to Claim 3, **characterized in that**
the outer surface of the inner housing and the inner surface of the outer housing are provided with a corresponding first positioning structure and a corresponding second positioning structure respectively, the first isolating element is received in the first positioning structure, and the second isolating element is received in the second positioning structure.

5. Rotary impact tool according to Claim 4, **characterized in that** a handle extends below the outer housing, a power supply is connected to a lower end of the handle, and an electronic component connecting the power supply and the motor is accommodated in the handle.

6. Rotary impact tool according to Claim 5, **characterized in that**
an air intake for sucking in external air is provided on the handle or on the outer housing between the first positioning structure and the second positioning structure, the outer housing is provided with an exhaust vent situated further rearwards than the second positioning structure, a part of the inner housing between the two isolating elements is provided with an air inlet, and the inner housing is provided with an air outlet situated further rearwards than the second positioning structure.

7. Rotary impact tool according to Claim 6, **characterized in that**
the motor comprises a fan provided at a rear side of the motor and a drive shaft provided at a front side of the motor, and the air inlet is provided on the inner housing at a position corresponding to the drive shaft and faces towards the handle.

8. Rotary impact tool according to Claim 7, **characterized in that**
the position of the air outlet on the inner housing is substantially opposite the position of the exhaust vent on the outer housing.

9. Rotary impact tool according to Claim 1, **characterized in that**
the isolating element comprises a uniform, continuous annular shape.

10. Rotary impact tool according to Claim 1, **characterized in that**
the isolating element comprises an annular shape having shape-fitting parts in its circumferential direction.

11. Rotary impact tool according to Claim 9 or 10, **characterized in that**
the isolating element further comprises axially extending protruding parts distributed discretely in the circumferential direction of the annular shape.

12. Rotary impact tool according to any one of Claims 2 - 11, **characterized in that** a rearward second end of the outer housing is not closed, and the outer housing surrounds the inner housing in the axial direction only.

13. Rotary impact tool according to any one of Claims 2 - 11, **characterized in that** a rearward second end of the outer housing is closed, having a rear end face substantially perpendicular to the axial direction, and a third elastic isolating element is provided between the rear end face of the outer housing and a second end face formed at the closed second end of the inner housing.

14. Rotary impact tool according to any one of the preceding claims, **characterized in that**
the isolating element is formed of polyurethane foam.

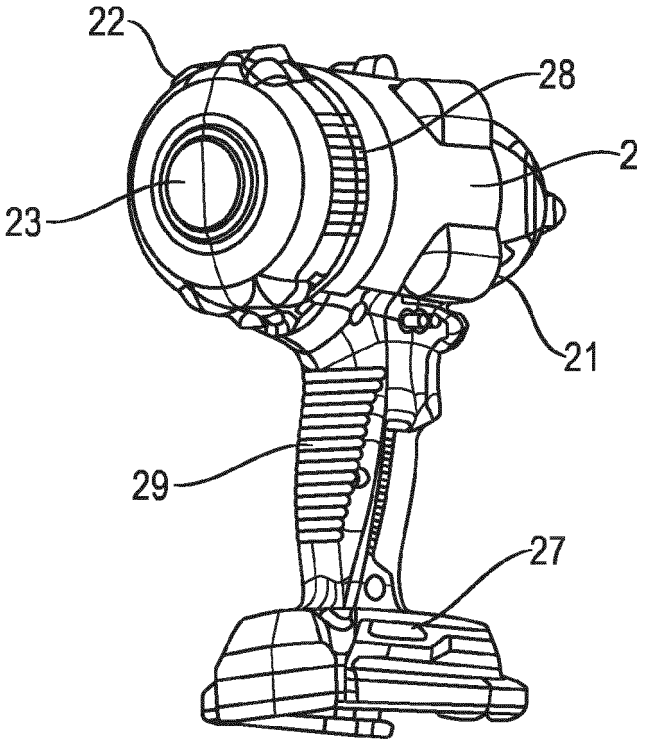

Fig. 1

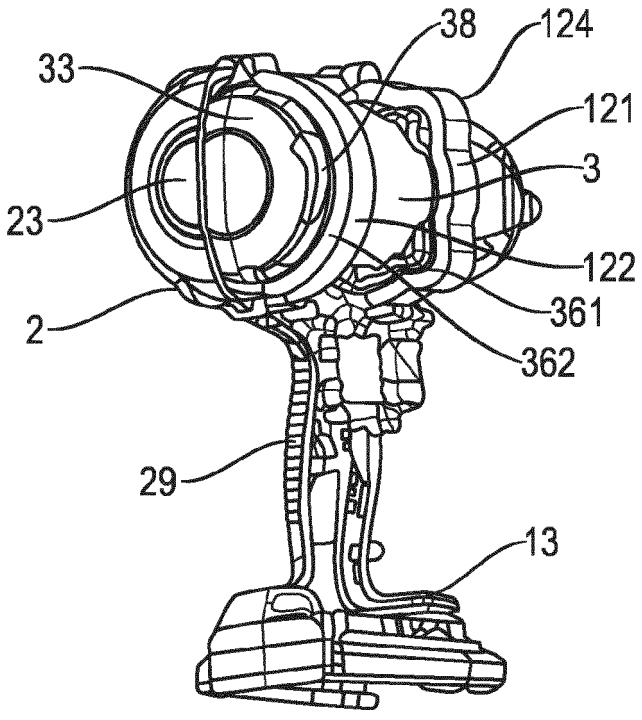

Fig. 2

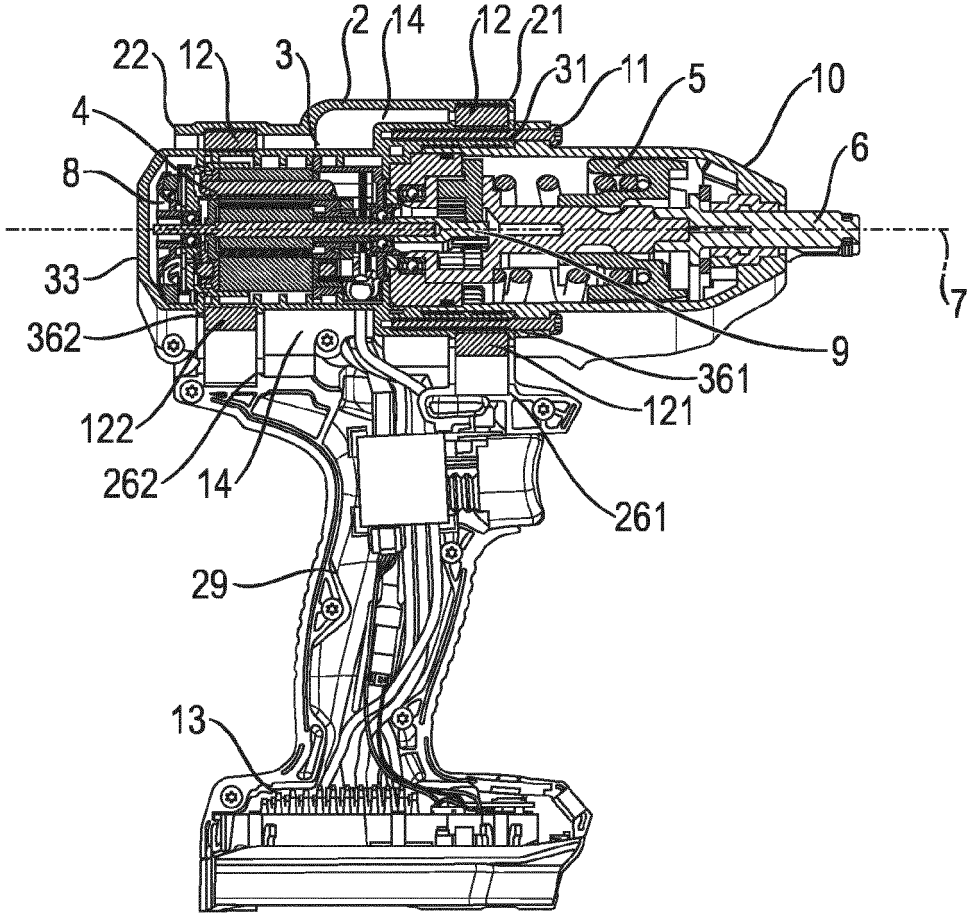
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Fig. 3

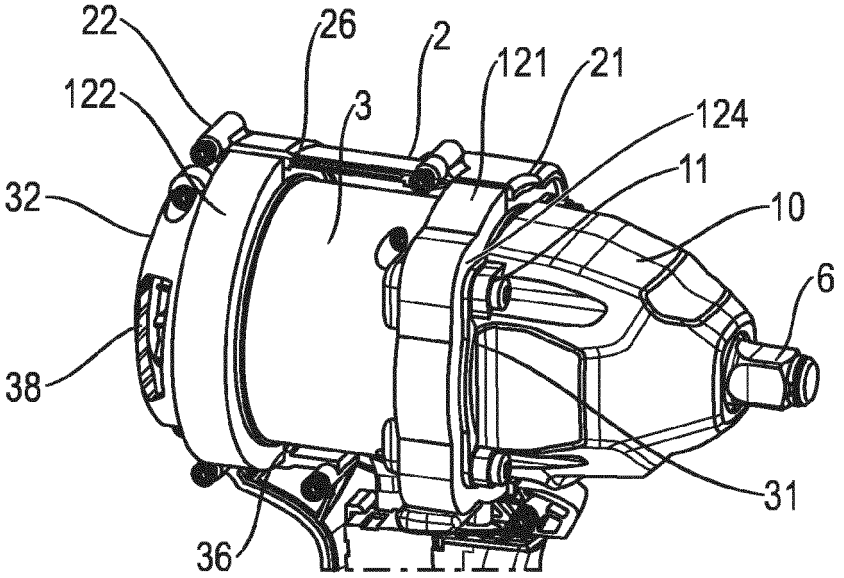
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Fig. 4

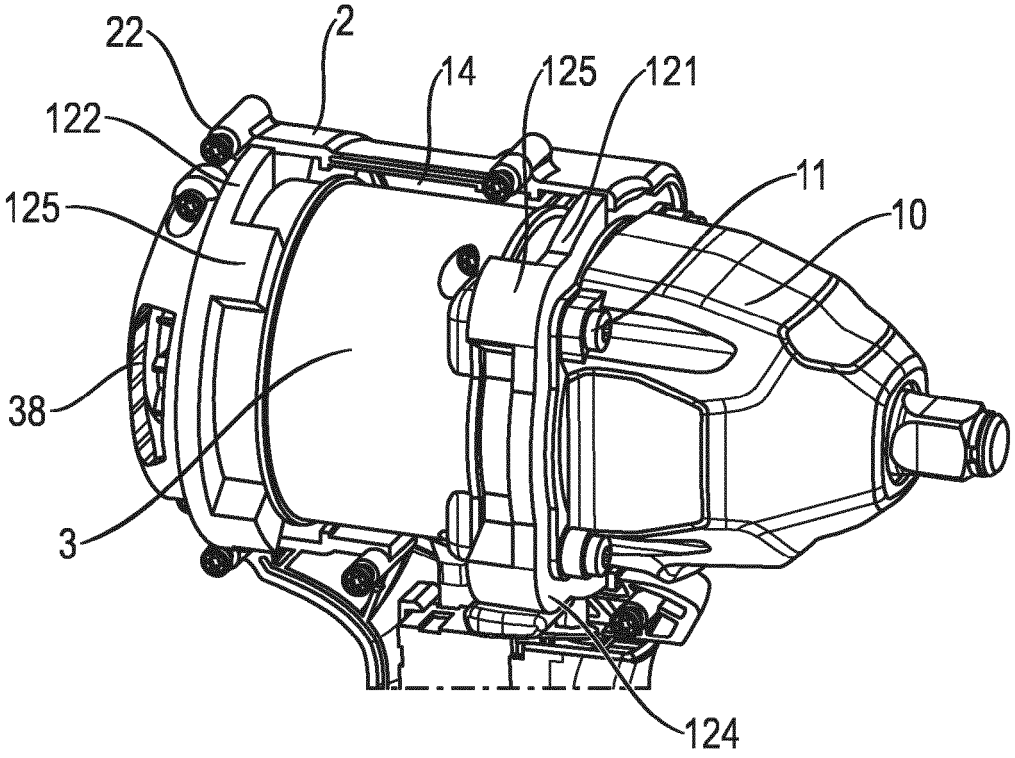
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Fig. 5

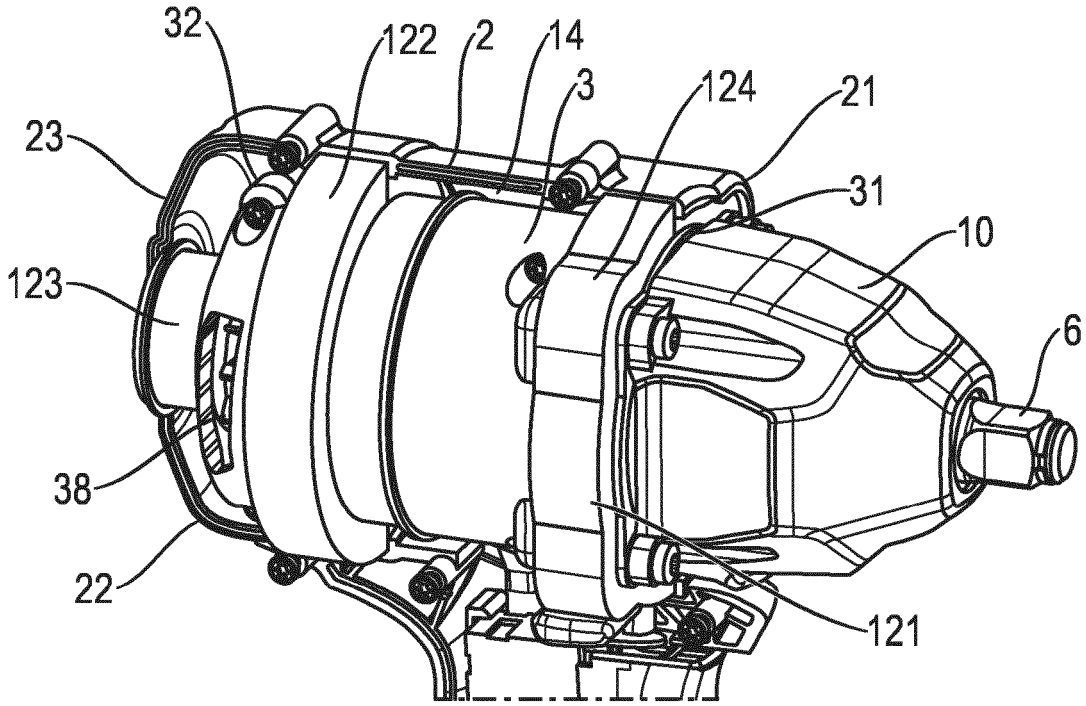
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Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 2559

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			B25F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11 March 2024	Joosting, Thetmar

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