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(54) **Electronically driven mobile equipment comprising a battery pack and electronic power supply unit for use with such a mobile equipment**

(57) The invention refers to an electronically driven mobile equipment (1) comprising a housing (2) with a recess (7) adapted for receiving at least one part (9) of a battery pack (6). The form of the recess (7) corresponds to the form of the at least one part (9) of the battery pack (6), in order to allow insertion of the at least one part (9) of the battery pack (6) into the recess (7) for operating the mobile equipment (1) by means of electric energy originating from the battery pack (6). A mobile equipment (1) adapted for operation with energy from a battery pack (6) is presented, which can be operated by energy from a mains power supply, too. It is suggested that the mobile equipment (1) comprises an electronic power supply unit (4) connectable to an electronic mains power supply by means of an electric cable (5). The power supply unit (4) has a casing (15) from which the cable (5) emerges. The form of at least one part (8) of the casing (15) corresponds to the form of the recess (7) in order to allow insertion of the at least one part (8) of the power supply unit (4) into the recess (7) after having removed the battery pack (6) and operation of the mobile equipment (1) by means of electric energy originating from the mains power supply.

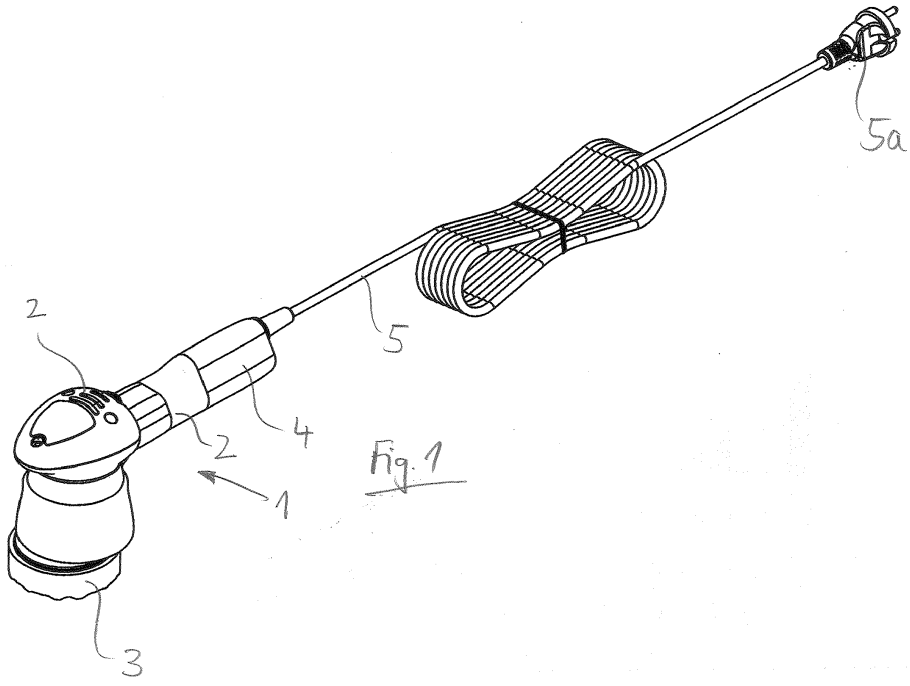

Fig. 1

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Description

[0001] The present invention refers to an electronically driven mobile equipment comprising a housing with a recess adapted for receiving at least one part of a battery pack. The form of the recess corresponds to the form of the at least one part of the battery pack, in order to allow insertion of the at least one part of the battery pack into the recess for operating the mobile equipment by means of electric energy originating from the battery pack.

[0002] Further, the invention refers to an electronic power supply unit, which can be connected to an electronic mains power supply by means of an electric cable. The power supply unit is adapted for use with an electronically driven mobile equipment of the above mentioned kind.

[0003] Mobile equipment of the above identified kind is well known in the prior art. For example, laptop computers are known which comprise a battery pack which can be inserted into an external recess of the laptop's housing, thereby automatically establishing an electronic connection between the electric contacts of the battery pack and the corresponding electric contacts of the laptop. Laptop computers can be operated with the electric energy originating from the battery pack for many hours.

[0004] If the battery has run down, an electric cable connected to the mains power supply can be connected to a socket provided in the laptop's housing establishing a connection between the mains power supply and the battery pack. An electric charging device is located between the mains power supply and the battery pack for charging the battery pack. The battery pack is located outside or inside the laptop's housing. While charging the battery a laptop user can continue to use the laptop with the energy originating from the battery pack. This is possible only because the laptop's power consumption is less than the charging power provided by the charger allowing charging of the battery contemporarily to a continuous use of the laptop.

[0005] In electronically driven mobile equipment which consumes more power than a laptop computer, for example in electric power tools, in particular in hand guided electric power tools such as grinders, polishers, sanders, planers, joining machines, edge trimmers, vertical routers, saws, glazing machines, scouring machines, drills, screwdrivers, mixers, and heat guns, it is at present not possible to connect the battery pack mounted to the tool's housing to a mains power supply, for charging the battery pack when the battery has run down and at the same time to continue to use the power tool. Therefore, it is common practice in the field of electric power tools which can be operated with the electric energy originating from a battery pack to simply replace an empty or run-down battery pack by a fully or at least better loaded battery pack. Charging of the battery packs is performed by means of separate external charging devices.

[0006] Furthermore, it is problematic with the laptop computers known from the prior art that the battery pack remains in the recess and is electrically connected to the laptop's electronic components, which provokes inevitably charging the battery pack each time the laptop is connected to the mains power supply even though the battery might not yet be fully run down. Each time the laptop is connected to the mains power supply a charging cycle is initiated. This reduces the life cycle of the battery pack because battery packs only endure a limited number of charging cycles.

[0007] The only way to avoid the automatic charging of the battery each time the laptop is connected to the mains power supply is to remove the battery pack from the laptop. However, this leaves an empty, unappealing recess in the laptop's housing which clearly affects the aesthetic appearance and design of the laptop.

[0008] The same problems apply to other kinds of mobile equipment known from the prior art, which can be electrically driven by means of electric energy from a battery pack as well as with the electric energy originating from the mains power supply.

[0009] Therefore, it is an object of the present invention to provide for a mobile equipment having a large power consumption, which can be operated by means of electric energy originating from a battery pack and which can also be operated by means of electric energy originating from a mains power supply without drawback for the battery pack and the aesthetic appearance of the mobile equipment.

[0010] This object is solved by an electronically driven mobile equipment of the above identified kind, characterized in that the mobile equipment comprises an electronic power supply unit, which can be connected to an electronic mains power supply by means of an electric cable. The power supply unit has a casing from which the cable emerges. The form of at least one part of the casing corresponds to the form of the recess in order to allow insertion of the at least one part of the power supply unit into the recess after having removed the battery pack and to allow operation of the mobile equipment by means of electric energy originating from the mains power supply.

[0011] The electronically driven mobile equipment according to the present invention has the advantage that it can be operated with electric energy originating from a battery pack as well as from a mains power supply. With other words, the mobile equipment provides for a hybrid energy supply. The idea is to operate the mobile equipment in a normal operation condition with electric energy originating from the mains power supply. In that case the power supply unit would be neatly fitted inside the recess located in the mobile equipment's housing. In this way the mobile equipment can be easily operated for a longer period of time, even if the mobile equipment has a large power consumption like, for example, a hand guided electric power tool. In case the mobile equipment has to be used in a workspace with no mains power supply nearby or in a narrow and difficult to access workspace, the electronic power supply unit can be easily detached from

the mobile equipment and removed from the mobile equipment's housing. Then, the battery pack can be inserted into the recess provided externally in the mobile equipment's housing. The battery pack provides for a safe power supply for a restricted period of time. However, in practice this is not a real constraint, because the mobile equipment is intended for use with the battery pack only in exceptional cases from time to time. For the normal continuous operation of the mobile equipment the electronic power supply unit is intended to be used.

[0012] It is further an advantage of the present invention that the design and the aesthetic appearance of the mobile equipment is always appealing, no matter whether the mobile equipment is operated with the battery pack or with the mains power supply. It does not affect the design of the mobile equipment whether the power supply unit or the battery pack is inserted into the recess of the mobile equipment's housing, because both, the power supply unit as well as the battery pack, fit neatly into the recess preferably leaving no gaps or free spaces between the housing on the one hand and the casings of the inserted power supply unit and battery pack, respectively, on the other hand. Preferably, the battery pack and the casing of the power supply unit have similar designs so that the overall appearance and the design of the complete mobile equipment comprising the power supply unit and the battery pack, respectively, is essentially the same, no matter whether the power supply unit or the battery pack is inserted into the housing's recess. In that preferred embodiment the only visible difference between the power supply unit inserted into the recess and battery pack into the recess is the electric cable emerging from the power supply unit's casing and connecting the power supply unit to the mains power supply.

[0013] Finally, it is a further advantage of the present invention that the mobile equipment can be operated by means of electric energy originating from the main power supply for a long period of time without reducing the lifetime of the battery pack and without provoking a deterioration of the capacity of the batteries, which could lead to a damage and finally even to a complete failure of the battery pack. The reason for this is that when the mobile equipment is operated by means of electric energy originating from the mains power supply, the electronic power supply unit has to be inserted into the recess and electronically connected to the electronic components of the mobile equipment. In that case it is mandatory that the battery pack is detached from the mobile equipment and removed from the recess and housing. Hence, repeating automatic charging cycles or an overlong charging process of the batteries during operation of the mobile equipment by means of electric energy originating from the mains power supply is effectively avoided by removing the battery pack and replacing it with the power supply unit.

[0014] According to a preferred embodiment of the present invention, it is suggested that the power supply unit comprises power transformer means for transforming the energy originating from the mains power supply into energy suitable for operating the mobile equipment. The power transformer means located in the power supply unit's casing can be, for example, but are not limited to: one or more printed circuit boards (PCBs), coils of metal wire for realizing an inductive transformer, a programmable microprocessor, electronic storage means, relays, electric switches, diodes, transistors, triacs and other electronic components such as resistors, capacitors and inductances. All these electronic components necessary for power transformation are located within the casing of the power supply unit. Preferably, the power supply unit is adapted for receiving an input voltage of 100 V to 380 V, preferably 110 V or 230 V, and an input frequency of 50 Hz to 60 Hz. The output voltage preferably ranges between 12 V and 24 V, preferably 18 V. It is advantageous if the output voltage of the power supply unit corresponds to the output voltage provided by the battery pack intended for use with the respective mobile equipment. In that case the power supply unit can be simply replaced by the battery pack without any electric transformation etc.

[0015] According to another preferred embodiment of the present invention, it is suggested that the power supply unit is adapted to comply with the ATEX 95 equipment directive 94/9/EC. The directive 94/9/EC of the European Parliament and the Council of 23 March 1994 refers to the approximation of the laws of the Member States of the European Union concerning equipment and protective systems intended for use in potentially explosive atmospheres. For example, this directive stipulates that the electronic power supply unit must not cause any sparks during its operation. With other words, the power supply unit preferably used in the mobile equipment according to the present invention is a so-called safety isolating transformer adapted for use in potentially explosive atmospheres.

[0016] Preferably, the form of the casing of the power supply unit is such that the casing resumes the form of the housing of the mobile equipment in the region of the recess, when the electronic power supply unit is fully inserted into the recess. Similarly, it is preferred that the form of the battery pack is such that it resumes the form of the housing of the mobile equipment in the region of the recess, when the battery pack is fully inserted into the recess. It is further preferred that the form of the casing of the power supply unit conforms or is even identical to the form of the battery pack. According to these preferred embodiments the design of the battery pack and of the power supply unit's casing is such that - after insertion into the recess - they nicely fit into the overall aesthetic appearance and design of the mobile equipment. It is possible that at least part of the casing of the power supply unit or the battery pack constitutes part of the mobile equipment's housing when the power supply unit or the battery pack is fully inserted in the recess.

[0017] Depending on the type of mobile equipment, the power supply unit's casing and the battery pack, re-

spectively, can be formed to meet special needs of the mobile equipment. For example, if the mobile equipment is a hand-guided electronic power tool, the power supply unit's casing and the battery pack, respectively, can be formed like a handle or grip in order to allow the user of the tool to easily grip and safely hold the power tool during its operation. Similarly, if the mobile equipment was a laptop computer, and if the recess for receiving the power supply unit and the battery pack, respectively, was on the bottom of the laptop's housing, the power supply unit's casing and the battery pack, respectively, could be provided with specially damped resting means for safely placing the laptop onto a surface. If the recess was designed on the top of the laptop's housing, the power supply unit's casing and the battery pack, respectively, could be provided with some kind of input means for the laptop, for example a touchpad and respective buttons. Furthermore, the casing of the power supply unit as well as the battery pack could be provided with output means, such as a small display or colored status lights, in order to provide a user of the mobile equipment with information on the operation status of the mobile equipment and/or the power supply unit and the battery pack, respectively, for example, with information on the battery's current capacity and charge condition.

[0018] According to a preferred embodiment, the battery pack comprises at least one rechargeable battery or battery cell. Depending on the number of batteries or battery cells used in the battery pack and the way they are electrically interconnected with one another (in series or parallel), the battery pack provides for different output voltages and electric charges (ampere-hours, Ah). Of course, the more batteries or battery cells the battery pack comprises, the heavier the mobile equipment with the inserted battery pack will be. Therefore, for each mobile equipment driven by electric energy taken from a battery pack inserted into the recess, a compromise has to be found between the desired or requested minimum duration of operation with electric energy taken from the battery pack on the one hand and a desired or required maximum weight and size of the mobile equipment containing the battery pack inserted into the recess on the other hand. For example, the battery pack of a hand-guided electronic power tool should be adapted to operate the tool with electric energy from the battery pack at maximum power temporarily in narrow and difficult-to-reach workspaces and/or where no mains power supply socket is within reach.

[0019] According to a further preferred embodiment of the invention it is suggested that the mobile equipment comprises means for securing the battery pack and the power supply unit in the recess and for releasing them from the recess. Similarly, it is suggested that the battery pack and the power supply unit comprise means for securing the battery pack and the power supply unit in the recess and for releasing them from the recess. Preferably, insertion and removal of the battery pack and the electronic power supply unit should be easy and fast. Nonetheless, the battery pack and the power supply unit, respectively, should be adapted to be connected safely to the housing of the mobile equipment. In particular, a merely partial insertion of the battery pack and the power supply unit, respectively, into the recess should be avoided. At the same time, it should be avoided that a battery pack or a power supply unit inserted into the recess undesirably falls out of the recess during operation of the mobile equipment, for example, caused by a shock or vibrations. For this reason it is suggested that the mobile equipment and/or the power supply unit and the battery pack are equipped with means for securing the battery pack and the power supply unit in the recess and for releasing them from the recess upon a defined user activity and not just upon shock or vibrations.

[0020] The securing means could comprise, for example, a permanent magnet located in the recess or in the power supply unit and the battery pack. The respective corresponding part, i.e. the power supply unit and the battery pack, respectively, (with the permanent magnet located in the recess) or the recess (with the permanent magnet located in the power supply unit or the battery pack), are provided with corresponding magnetic elements, for example a metal plate, which is magnetically attracted by the permanent magnet, thereby securing the battery pack and the power supply unit, respectively, in the recess.

[0021] Alternatively, the securing means could comprise a mechanical slider provided at the outside of the mobile equipment's housing or the battery pack and the power supply unit, respectively. After fully inserting the battery pack and the power supply unit, respectively, into the recess, the slider can be sled into a locking position in order to secure the battery pack or the power supply unit in the recess. Before removing the battery pack or the power supply unit the slider can be sled into an unlocked position, thereby releasing the battery pack and the power supply unit, respectively, from the recess. Preferably, the battery pack and the power supply unit, respectively, are automatically electronically connected to the electronic components of the mobile equipment upon completed insertion of the battery pack or the power supply unit into the recess. No additional user activity for establishing an electronic connection between the battery pack and the power supply unit, respectively, on the one hand and the mobile equipment on the other hand is required.

[0022] According to another preferred embodiment of the invention it is suggested that the mobile equipment and/or the battery pack and the power supply unit comprise coding means for assuring that the mobile equipment can only be operated with such a battery pack and such a power supply unit which is actually intended and approved for use with the mobile equipment. The same or different coding means could be provided for assuring that the battery pack and the power supply unit, respectively, are correctly (in particular fully) inserted into the recess. The coding means suggested here could be of

the mechanical type or of the electronic type.

[0023] Mechanical coding means could inhibit the insertion of the battery pack and the power supply unit, respectively, into the recess of the mobile equipment's housing due to a mismatch in the form of the recess and the form of the power supply unit and the battery pack, respectively. Electronic coding means could electronically determine, whether the mechanically inserted battery pack or power supply unit is actually intended and approved for use with the mobile equipment and following this determination could allow operation of the mobile equipment (if the correct battery pack or power supply unit has been inserted) or inhibit operation of the mobile equipment (if the battery pack or the power supply unit is not of the type intended or approved for use with the mobile equipment). For example, an electronic read switch, a Hall-sensor or a micro-switch could be provided in the recess, in the battery pack and/or in the power supply unit. Only a correct and approved power supply unit or battery pack will activate the switch or sensor, thereby allowing operation of the mobile equipment.

[0024] The same or different coding means could be provided and adapted for assuring that the battery pack or the power supply unit is correctly (fully) inserted into the recess. For example, it is possible that the coding means activate the mobile equipment only after the battery pack or the power supply unit has been completely inserted into the recess, even though the battery pack and the power supply unit, respectively, are already electronically connected to the electronic components of the mobile equipment before the battery pack or the power supply unit are completely inserted into the recess. These coding means could comprise for example, but not limited to, an electronic read switch, a Hall-sensor or a micro-switch could be provided in the recess, in the battery pack and/or in the power supply unit.

[0025] It is particularly advantageous if the mobile equipment comprises a hand guided electric power tool. In particular, the mobile equipment could comprise one of, but not limited to, a grinder, a polisher, a sander, a planer, a joining machine, an edge trimmer, a vertical router, a saw, a glazing machine, a scouring machine, a drill, a screwdriver, a mixer, a heat gun and a vacuum cleaner. In more detail, the hand-guided power tool could be one of, but not limited to, a straight grinder, an angular grinder, a vertical grinder, an angular polisher, a random orbital polisher, an angular sander, an orbital sander, a random orbital sander, a planetary sander, a jigsaw, a plunge circular saw, a percussion drill, a rotary hammer drill and a drill-screwdriver. The advantages of the present invention are particularly apparent, if the mobile equipment is an electric power tool. Electric power tools tend to have a rather high power consumption and, hence, benefit from the present invention a lot. Until now a hybrid power supply for electronic power tools is not known. The present invention gives the user the opportunity to have only a single power tool which can be operated both by electric energy from a battery pack and by electric energy from the mains power supply. Up to now the user had to have two separate tools, one driven with a battery pack and the other driven with the mains power supply, for example a drill driven by the mains power supply and an electric screwdriver driven by a battery pack. Now the user only needs a single tool, for example a drill, which can be driven both with the electric energy from a battery pack and with the electric energy from the mains power supply.

[0026] The object of the present invention is also solved by an electronic power supply unit of the above identified kind, characterized in that the power supply unit has a casing from which the cable emerges, the form of the casing being adapted to the form of the recess of the mobile equipment in order to fit at least part of the power supply unit into the recess after having removed the battery pack, in order to operate the mobile equipment by means of electric energy originating from the mains power supply.

[0027] Hence, an electrical power supply unit is proposed for any type and kind of battery driven electric mobile equipment. According to the invention the casing of the power supply unit is formed such that it neatly fits into the recess originally adapted for receiving the equipment's battery pack. This means that depending on the type and kind of electric mobile equipment to be equipped with the power supply unit according to the present invention, the electric characteristics and the mechanical characteristics of the power supply unit have to be adapted in order to fit the electric mobile equipment from an electrical point of view as well as from a mechanical point of view. With other words, the power supply unit's mechanical interface as well as its electrical interface towards the mobile equipment has to correspond the corresponding interfaces of the battery pack towards the mobile equipment.

[0028] For example the electric characteristics to be adapted can be one or more of an input and an output voltage, an input and an output frequency and a maximum output current. For example the mechanical characteristics to be adapted can be one or more of the external form of the casing, type and position of securing means (for holding the casing in the recess) and type and form of coding means (for assuring that only power supply units adapted and approved for use with the intended electric mobile equipment can be used). Summing up, the power supply unit constitutes a kind of fake battery pack, mechanically and electrically corresponding to the real battery pack with the main difference that the power supply unit drives the mobile equipment with energy from a mains power supply, which after transformation is directly fed to the mobile equipment.

[0029] Further features and advantages of the present invention will be explained in more detail in the following specification taking into consideration the drawings. These show:

Figure 1 an electric power tool according to a pre-

ferred embodiment of the present invention equipped with a power supply unit inserted into a recess of the tool's housing;

Figure 2 a battery pack adapted for being inserted into the recess of the housing of the power tool according to figure 1 after having removed the power supply unit;

Figure 3 the electric power tool according to figure 1 in a more detailed, partially sectional view;

Figure 4 the battery pack of figure 2 in a more detailed, partially sectional view;

Figure 5 the tool according to figure 3 with a battery pack inserted into the recess of the tool's housing instead of the power supply unit;

Figure 6 the housing of the power tool according to figures 3 and 5 without a power supply unit and a battery pack inserted into the recess of the tool's housing;

Figure 7 the power supply unit adapted for being inserted into the recess of the housing of the tool of figures 1 and 6, in a more detailed, partially sectional view;

Figure 8 an electric power tool according to another preferred embodiment of the present invention equipped with a battery pack to be inserted into a recess of the tool's housing;

Figure 9 a top view of the power supply unit adapted for being inserted into the recess of the housing of the tool of figure 8; and

Figure 10 a side view of the power supply unit adapted for being inserted into the recess of the housing of the tool of figure 8.

[0030] Figures 1 and 2 show an example of an electronically driven mobile equipment according to the present invention. In this embodiment the mobile equipment comprises an electronic power tool, in particular a hand guided electronic power tool, for example a polisher. In figure 1 the polisher in its entirety is designated with reference sign 1. The following description is directed to the preferred embodiment of figure 1, that is to a polisher 1, its construction and its functioning. Of course, the following description refers to any other type of electronically driven mobile equipment according to the present invention just the same.

[0031] The polisher 1 comprises a housing 2, preferably made of a plastic material. Of course, at least part of the housing 2 could be made of any other material than plastic, too, for example metal or carbon fiber. Furthermore, it comprises a power supply unit 4 (see figure 1) and a battery pack 6 (see figure 2). The power supply unit 4 or the battery pack 6 can be releasably connected to the housing 2, thereby providing power supply to the polisher 1 and its electric components either from a mains power supply or from the battery pack 6.

[0032] The housing 2 comprises an electric motor in its inside, preferably a brushless electric motor (not shown in the figures). The electric motor has a motor shaft, which performs a rotational movement about its longitudinal axis if electric supply energy is provided to the motor. Furthermore, the polisher 1 comprises a working element 3 which performs a rotational, an orbital or a random orbital movement. Transmission means (not shown in the figures) are provided in the housing 2 located between the electric motor and the working element 3 in order to transform the rotational movement of the motor shaft into the desired movement of the working element 3.

[0033] The polisher 1 can be operated with electric energy originating from a power supply unit 4 connected to a mains power supply by means of an electric cable 5. At its distal end the cable 5 has a plug 5a which can be inserted into a corresponding socket (not shown) of the mains power supply. Depending on the country the polisher 1 is to be used, the type of plug 5a can vary significantly. Alternatively, the polisher 1 can be operated with electric energy originating from a battery pack 6 (see figure 2). Therefore, the polisher 1 can be alternatively equipped with the power supply unit 4 or with the battery pack 6. The power supply unit 4 as well as the battery pack 6 can be releasably connected to the housing 2 of the polisher 1, thereby providing power supply to the polisher 1 and its electric components either from a mains power supply or from the battery pack 6.

[0034] As can be seen in figure 6, the polisher 1 is provided with an external recess 7 in its housing 2. The recess 7 has an opens to the outside and can be accessed with the power supply unit 4 or the battery pack 6 from the outside. It is not necessary to open the housing 2 in order to insert the power supply unit 4 or the battery pack 6 into the recess 7. The recess 7 is adapted for receiving at least part of the power supply unit 4 or the battery pack 6. That part of the power supply unit 4 that is received in the recess 7 of the polisher's housing 2 is designated with reference sign 8 (see figures 3 and 7). Similarly, that part of the battery pack 6 that is received by the recess 7 is designated with reference sign 9 (see figures 4 and 5). That part of the power supply unit 4 which remains outside the recess 7 when the power supply unit 4 is fully inserted into the recess 7 is designated with reference sign 10. Similarly, that part of the battery pack 6, which remains outside the recess 7 when the battery pack 6 is fully inserted into the recess 7 is designated with reference sign 11. The regions 8 and 10 of the power supply unit 4 and the regions 9 and 11 of the batter pack 6, respectively, are separated by a dashed line in figures 3, 4, 5 and 7.

[0035] The polisher 1 is provided with electrical contacts 12 (see figures 3, 5 and 6) extending into the recess 7. The contacts 12 are located at the bottom of the recess 7. They are connected to the electronic components of the polisher 1, in particular to a control unit of the tool and the electric motor. The contacts 12 are preferably embodied as longitudinal pins made of a conductive material, for example metal, in particular copper. The longitudinal axis of the contact pins 12 extends essentially parallel to a direction 13 of insertion (see figure 6) in which the power supply unit 4 and the battery pack 6 are inserted into the recess 7 from outside. When the power supply unit 4 or the battery pack 6 is fully inserted into the recess 7 an electric connection is automatically established between the electronic components of the polisher 1 on the one hand and the power supply unit 4 or the battery pack 6 on the other hand. The power supply unit 4 and the battery pack 6 are provided with a corresponding socket element 14 (schematically shown in figures 3, 4, 5 and 7), which is adapted for receiving the contact pins 12 and for establishing the electric connection between the electronic components of the polisher 1 on the one hand and the power supply unit 4 or the battery pack 6 on the other hand.

[0036] Of course, it would also be possible that the polisher 1 is provided with a socket similar to socket element 14 and that the power supply unit 4 and the battery pack 6, respectively, are provided with connecting means such as the connection pins 12, for cooperation with the socket in order to establish the electric connection.

[0037] The power supply unit 4 comprises a casing 15 (see figure 7) comprising a first part 8 within the region, which is inserted into the recess 7, and a second part 10 within the region, which remains outside the recess 7 if the power supply unit 4 is fully inserted into the recess 7. In this connection "fully inserted" does not mean that the entire power supply unit 4 is inserted into recess 7 but rather that the power supply unit 4 is inserted into the recess 7 as far as possible, which means that the entire part 8 of the power supply unit 4 is inserted into the recess 7 and the socket element 14 has entered into electric connection with the contact pins 12. The casing 15 is preferably made of a plastic material. Within the casing 15 the power supply unit 4 comprises electronic components for performing a power transmission. These can comprise a printed circuit board (PCB) 16, which has conducting paths (not shown) and numerous other electronic components mounted thereon. The electronic components mounted on the PCB 16, for example, comprise coils 17 adapted for transforming the energy originating from the mains power supply (e.g. 230 V) into energy suitable for operating the polisher 1 (e.g. 12 V or 18 V). Furthermore, the power supply unit 4 comprises a safety fuse 18 which is accessible from outside the casing 15. The electronic power supply unit 4 is preferably adapted to comply with the ATEX 95 equipment directive 94/9/EC. Hence, the power supply unit 4 is a safety isolating transformer, which can be used in potentially explosive atmospheres.

[0038] The battery pack 6 also comprises a casing 19 preferably made of plastic material (see figure 4). The casing 19 comprises a first part 9 in the region of the battery pack 6, which is completely inserted into the recess 7. Further, the casing 19 comprises a second part 11 in the region, which remains outside the recess 7 and the housing 2 of the polisher 1, when the battery pack 6 is fully inserted into the recess 7. Again, the term "fully inserted" does not mean that the entire battery pack 6 is inserted into the recess 7. Rather, only the entire part 9 of the casing 19 is inserted into the recess 7, while the part 11 remains outside the housing 2 and the recess 7. Inside the casing 19 a plurality of batteries or battery cells 20 are provided. For charging the battery pack 6 it is inserted into a separate external charging device connected to the mains power supply. The charging device comprises a connector similar to the connector pins 12 of the polisher 1 in order to establish an electronic connection with the socket element 14 when the battery pack 6 is inserted into the charging device.

[0039] It can be clearly seen from figures 3 that the external form of the casing 15 of the electronic power supply unit 4 is such that the casing 15 resumes the form of the housing 2 of the mobile equipment 1 in the region of the recess 7, when the power supply unit 4 is fully inserted into the recess 7. Hence, the form of the housing 2 is continued by the form of the part 10 of the casing 15, which remains outside of the recess 7 when the power supply unit 4 is fully inserted into the recess 7. This means that the casing 15 of the power supply unit 4 and the housing 2 both influence the polisher's design. Both the housing 2 as well as the casing 15 provide for the appealing design of the polisher 1, when the power supply unit 4 is inserted into the polisher 1.

[0040] Similarly it is suggested that the form of the casing 19 of the battery pack 6 is such that the casing 19 resumes the form of the housing 2 of the mobile equipment 1 in the region of the recess 7, when the battery pack 6 is fully inserted into the recess 7 (see figure 5). Again both the housing 2 as well as the casing 19 influence the overall design of the polisher 1. The appealing design of the polisher 1 is obtained by means of a cooperation of the housing 2 and the external part 11 of the casing 19 of the battery pack 6.

[0041] Preferably, the external form of the casing 15 of the power supply unit 4 and of the casing 19 of the battery pack 6 are near to identical in order to provide for a similar or even the same aesthetic appearance of the polisher 1 irrespective of whether the power supply unit 4 or the battery pack 6 is inserted into the recess 7.

[0042] Preferably, the polisher 1 comprises means 21 (see figure 6) for securing the power supply unit 4 and the battery pack 6, respectively, in the recess 7 after insertion and for releasing them from the recess 7. In the embodiment of figure 6 the securing means 21 are only schematically shown and comprise an elastically resilient finger, which is connected to the housing 2 at one end

and comprises a protrusion extending towards the inserted power supply unit 4 and battery pack 6, respectively, on its other end. When the power supply unit 4 or the battery pack 6 is inserted into the recess 7 in the direction 13 the protrusion of the securing means 21 is forced out of the way by the power supply unit 4 or the battery packs 6 and moves away from the inserted power supply unit 4 or the battery pack 6 in the direction of the lower wall of the housing 2. When the power supply unit 4 or the battery pack 6 is fully inserted in the recess 7, a cavity or a hole in the housing 15 of the power supply unit 4 or in the housing 19 of the battery pack 6 is located at a position corresponding to the position of the protrusion of the securing means 21. Hence, the securing means 21 can elastically move back into its original position (before the power supply unit 4 or the battery pack 6 was inserted into the recess 7), whereby the protrusions enters into the cavity or hole. The protrusion interacts with the cavity or hole in the casing 15 or the casing 19. By means of this interaction the power supply unit 4 or the battery pack 6 is mechanically secured in its fully inserted position in the recess 7.

[0043] For removing the power supply unit 4 or the battery pack 6 the securing means 21 can be disabled or released. Preferably, this is effected from outside of the housing 2 by a certain user activity, for example by pressing a release button (not shown in the figures). Of course, it is possible that the securing means similar to the securing means 21 are located at or in the casing 15 of the power supply unit 4 or the casing 19 of the battery pack 6 and that the corresponding cavity or hole is located in the housing 2 of the polisher 1.

[0044] Preferably, the external form of the casing 15 of the power supply unit 4 and of the casing 19 of the battery pack 6 is adapted to the form of the recess 7 so that the power supply unit 4 and the battery pack 6 neatly fit into the recess 7 leaving almost no gaps or clearances between the housing 2 and the casing 15; 19. If the form of the casing 15 of the power supply unit 4 and of the casing 19 of the battery pack 6 was significantly different than the form of the recess 7, then the power supply unit 4 and the battery pack 6 would not fit into the recess 7. Therefore, the external form of the casings 15, 19 in co-operation with the form of the recess 7 can be regarded as coding means for assuring that only such a battery pack 6 and such a power supply unit 4 can be inserted into the recess 7 which is actually intended and approved for use with the mobile equipment 1.

[0045] Further it is preferred that if the power supply unit 4 and the battery pack 6 are not fully inserted into the recess 7 the socket element 14 at the front end of the inserted power supply unit 4 and battery pack 6, respectively, will not come into electric contact with the contact pins 12. Only if the power supply unit 4 and the battery pack 6 are fully inserted into the recess 7 the contact between the socket member 14 and the contact pins 12 is established. Therefore, the location and the co-operation of the contact pins 12 and the socket member 14 can be regarded as coding means for assuring that the battery pack 6 and the power supply unit 4, respectively, are correctly and in particular fully inserted into the recess 7.

[0046] As already mentioned, the present invention refers to any kind of electrically driven mobile equipment. Preferably, the mobile equipment comprises a hand guided electric power tool. Besides the polisher 1 shown in the figures, the electric power tool could also be one of but not limited to a grinder, a polisher, a planner, a joining machine, an edge trimmer, a vertical router, a saw, a glazing machine, a scaring machine, a drill, a screw driver, a mixer, a heat gun and a vacuum cleaner.

[0047] Figure 8 shows a further preferred embodiment of an electric power tool according to the present invention. In this embodiment the tool 1 is embodied as a portable electric drill or cordless electric screwdriver equipped with a battery pack 6 to be inserted into the recess 7 of the tool's housing 2. The recess 7 is embodied at the bottom end of a grip portion 22 of the housing 2. There are guiding rails 23 extending along opposite sidewalls of the recess 7. The battery pack 6 comprises corresponding guiding rails 24 located at a top wall of the battery pack's casing 19. The rails 24 of the battery pack 6 are adapted to interact with the rails 23 of the recess 7, when the battery pack 6 is inserted into the recess 7. The battery pack 6 is inserted sideways (in respect to a longitudinal extension of the grip portion 22 of the housing 2) into the recess 7 in the insertion direction 13 represented by an arrow.

[0048] During its insertion the battery pack 6 performs a sliding movement of the guiding rails 24 relative to the guiding rails 23. After fully inserting the battery pack 6 into the recess 7, a front wall of the housing 2 or the grip portion 22, respectively, may abut against a corresponding wall of the battery pack 6 facing backwards towards the housing 2 and the grip portion 22, respectively, thereby limiting the insertion movement and bringing it to an end. Additionally or alternatively, snapping means are provided within the recess 7, which interact with corresponding cavities 5 located in the battery pack 6 or its casing 19, respectively, as soon as the battery pack 6 is fully inserted into the recess 7. The snapping means in co-operation with the cavities 25 provide for a safe and secure fixation of the battery pack 6 within the recess 7. The snapping means can be adopted to automatically move out of the cavities 25 and to release the battery pack 6 from the recess 7, if a force is exerted on the battery pack 6 into a direction opposition to arrow 13. This force could be applied by a user of the tool 1. Possibly, additional securing means (not shown in figure 8) would have to be pressed by the user before the snapping means leave the cavities 25 and the battery pack 6 is released from the recess 7.

[0049] When the battery pack 6 is inserted into the recess 7, a socket element 14 provided on the top wall of the casing 19 and comprising a plurality of electric contact elements interacts with corresponding contact pins 12

(not shown in figure 8) located inside the recess 7. The electrical contacts established between the contact elements of the socket element 14 and the contact pins 12 serve for transmitting electric energy from the battery pack 6 to the tool 1, in particular to its electric motor and the tool's other electrical components. Furthermore, the electrical contacts may serve for transmitting status and/or control information between the tool 1 and the battery pack 6.

[0050] Figures 9 and 10 show a power supply unit 4 adapted for being inserted into the recess 7 of the housing 2 of the tool 1 of figure 8, after the battery pack 6 has been removed. Figure 9 shows a top view and figure 10 a side view of the power supply unit 4. The power supply unit 4 comprises a casing 15 which comprises a first part 8, which is inserted in the recess 7, and a second part 10, which remains outside the recess 7, if the power supply unit 4 is fully inserted into the recess 7. A dashed line is drawn in figure 10 in order to separate the part 8 to be inserted into the recess 7 from the part 10 remaining outside of the recess 7 when the power supply unit 4 is fully inserted into the recess 7. The dashed line is not straight (like in figures 3, 4, 5 and 7) but rather comprises a sharp bend of approximately 45°.

[0051] A top wall of the casing 15 comprises guiding rails 24 similar or identical to those of the battery pack 6. The guiding rails 24 of the casing 15 are adapted to cooperate with the recess' guiding rails 23 when the power supply unit 4 is sled into the recess 7. The guiding rails 24 of the power supply unit 4 form part of a sledge which slides along the corresponding guiding rails 23 of the recess 7. Furthermore, the power supply unit 4 also comprises cavities 25 for receiving the tool's snapping means when the power supply unit 4 is fully inserted into the recess 7. Additionally or alternatively, the power supply unit 4 can comprise additional securing means (not shown in figures 9 or 10) which have to be actuated, for example by pressing, by the user before the snapping means leave the cavities 25 and the power supply unit 4 is released from the recess 7. Also the position and the design of the contact elements of the power supply unit's socket element 14 are identical to those of the battery pack 6, allowing the automatic establishment of electronic contacts between the contact pins 12 of the tool 1 and the contact elements of the socket element 14, when the power supply unit 4 is fully inserted into the recess 7.

[0052] Hence, the external form of the power supply unit 4 and in particular of the part 8 of the casing 15 is identical to that of the battery pack 6 and of part 9 of its casing 19, respectively. The power supply unit 4 is inserted into the recess 7 just the same way as a battery pack 6 would be inserted therein. Just the same, the electronic contact between the power supply unit 4 and the tool 1 is established the same way as it would be established between a battery pack 6 and the tool 1. Hence, the power supply unit's mechanical interface towards the tool 1 is identical to that of a battery pack 6 adapted for being inserted into and held within the recess 7 of the tool 1.

[0053] Additionally, also the electronic characteristics of the power supply unit 4 correspond to those of the battery pack 6, in particular in respect to input and output voltage, input and output frequencies, maximum output current, etc. The main difference is that the power supply unit 4 transforms energy from a mains power supply into energy (voltage and/or current) adapted for driving the tool 1 and its electric motor and other electronic components, respectively, and directly operates the tool 1 with that transformed energy, without storing it in storing means, like a battery. Hence, also the power supply unit's electrical interface towards the tool 1 is identical to that of a battery pack 6 adapted for driving the tool 1 with an appropriate electric signal. Preferably, the power supply unit 4 provides for the same electrical driving signal that a battery pack 6 adapted for use with the tool 1 would.

[0054] Of course, form and dimensions of that part 10 of the casing 15, which remains outside the recess 7, when the power supply unit 4 is fully inserted into the recess 7, may slightly differ from the form and dimensions of the corresponding part 11 of the battery pack's casing 19. The form and dimensions of the part 8 of the casing 15 of the power supply unit 4 must correspond to the form and dimensions of the corresponding part 9 of the casing 19 of the battery pack 6 only insofar as proper insertion and fixation of the power supply unit 4 inside the recess 7 is assured.

[0055] For example, the casing 15 of the power supply unit 4 may be provided with additional ventilation openings 26 which allow warm air created during energy transformation operation in the power supply unit 4 to escape from the inside of the casing 19 to the environment. Furthermore, additional venting means (not shown in the figures) like a fan or ventilator could be provided in the casing 19. The venting means could be adapted for actively conveying the warm air to the environment through the ventilation openings 26. The additional venting means could be coupled to and controlled by a temperature control circuit comprising a temperature sensor for determining the current temperature inside the casing 19 and means for activating/deactivating the venting means if the inside temperature exceeds a predefined threshold value. The energy for driving the temperature control circuit and the additional venting means could also be provided from the mains power supply, preferably only after transforming the energy form the mains power supply into the energy for driving the tool 1. The cable 5 exits the casing 15 of the power supply unit 4 at a rear wall in the insertion direction 13. Of course, the cable 5 could exit the casing 15 through any other part 10 of the casing 15, too, except for that part 8 of the casing 15, which is received by the recess 7, when the power supply unit 4 is fully inserted in the recess 7.

Claims

1. Electronically driven mobile equipment (1) comprising a housing (2) with a recess (7) adapted for receiving at least one part (9) of a battery pack (6), the form of the recess (7) corresponding to the form of the at least one part (9) of the battery pack (6), in order to allow insertion of the at least one part (9) of the battery pack (6) into the recess (7) and operation of the mobile equipment (1) by means of electric energy originating from the battery pack (6), **characterized in that** the mobile equipment (1) comprises an electronic power supply unit (4) connectable to an electronic mains power supply by means of an electric cable (5), the power supply unit (4) having a casing (15) from which the cable (5) emerges, the form of at least one part (8) of the casing (15) corresponds to the form of the recess (7) in order to allow insertion of the at least one part (8) of the power supply unit (4) into the recess (7) after having removed the battery pack (6) and operation of the mobile equipment (1) by means of electric energy originating from the mains power supply.

2. Mobile equipment (1) according to claim 1, **characterized in that** the power supply unit (4) adapted for use with a certain mobile equipment (1) has a mechanical interface towards the recess (7) and an electric interface towards electronic components of the mobile equipment (1), wherein the mechanical and electric interfaces correspond to the mechanical and electric interfaces of a battery pack (4), which is adapted and intended for use with the mobile equipment (1), towards the recess (7) and the mobile equipment (1), respectively.

3. Mobile equipment (1) according to claim 1 or 2, **characterized in that** the power supply unit (4) adapted for use with a certain mobile equipment (1) has a mechanical interface towards the recess (7) and an electric interface towards electronic components of the mobile equipment (1), wherein the mechanical interface is adapted to the form and design of the recess (7) and the electric interface is adapted to the electronic characteristics of the mobile equipment's electronic components.

4. Mobile equipment (1) according to one of the preceding claims, **characterized in that** the power supply unit (4) comprises power transformer means (17) for transforming the energy originating from the mains power supply into energy suitable for operating the mobile equipment (1).

5. Mobile equipment (1) according to one of the preceding claims, **characterized in that** the power supply unit (4) is adapted to comply with the ATEX 95 equipment directive 94/9/EC.

6. Mobile equipment (1) according to one of the preceding claims, **characterized in that** the form of the casing (15) of the power supply unit (4) conforms to the form of a battery pack (6) adapted and intended for use with the mobile equipment (1).

7. Mobile equipment (1) according to one of the preceding claims, **characterized in that** the battery pack (6) comprises at least one rechargeable battery or battery cell (20).

8. Mobile equipment (1) according to one of the preceding claims, **characterized in that** the mobile equipment (1) comprises means (21) for securing the battery pack (6) and the power supply unit (4) in the recess (7) and for releasing them from the recess (7).

9. Mobile equipment (1) according to one of the preceding claims, **characterized in that** the battery pack (6) and the power supply unit (4) comprise means for securing the battery pack (6) and the power supply unit (4) in the recess (7) and for releasing them from the recess (7) .

10. Mobile equipment (1) according to one of the preceding claims, **characterized in that** the mobile equipment (1) and/or the battery pack (6) and the power supply unit (4) comprise coding means for assuring that only such a battery pack (6) and such a power supply unit (4) can be inserted into the recess (7) which is intended for use with the mobile equipment (1) and/or for assuring that the battery pack (6) and the power supply unit (4), respectively, are correctly inserted into the recess (7).

11. Mobile equipment (1) according to one of the preceding claims, **characterized in that** the mobile equipment (1) comprises a hand guided electric tool.

12. Mobile equipment (1) according to one of the preceding claims, **characterized in that** the mobile equipment (1) comprises one of a grinder, a polisher, a sander, a planer, a joining machine, an edge trimmer, a vertical router, a saw, a glazing machine, a scouring machine, a drill, a screwdriver, a mixer, a heat gun and a vacuum cleaner.

13. Mobile equipment (1) according to claim 12, **characterized in that** the mobile equipment (1) comprises one of a straight grinder, an angular grinder, a vertical grinder, an angular polisher, a random orbital polisher, an angular sander, an orbital sander, a random orbital sander, a planetary sander, a jigsaw, a plunge circular saw, a percussion drill, a rotary hammer drill and a drill-screwdriver.

14. Electronic power supply unit (4) connectable to an

electronic mains power supply by means of an electric cable (5) and adapted for use with an electronically driven mobile equipment (1) comprising a housing (2) and an external recess (7) located in the housing (2) for receiving a battery pack (6), the form of the battery pack (6) being adapted to the form of the recess (7) in order to fit at least part (9) of the battery pack (6) into the recess (7), in order to operate the mobile equipment (1) by means of electric energy originating from the battery pack (6), **characterized in that** the electronic power supply unit (4) has a casing (15) from which the cable (5) emerges, the form of the casing (15) being adapted to the form of the recess (7) of the mobile equipment in order to fit at least part (8) of the power supply unit (4) into the recess (7) after having removed the battery pack (6), in order to operate the mobile equipment (1) by means of electric energy originating from the mains power supply.

15. Power supply unit (4) according to claim 14, **characterized in that** the power supply unit (4) is adapted for use with an electronically driven mobile equipment (1) according to one of the claims 2 to 13.

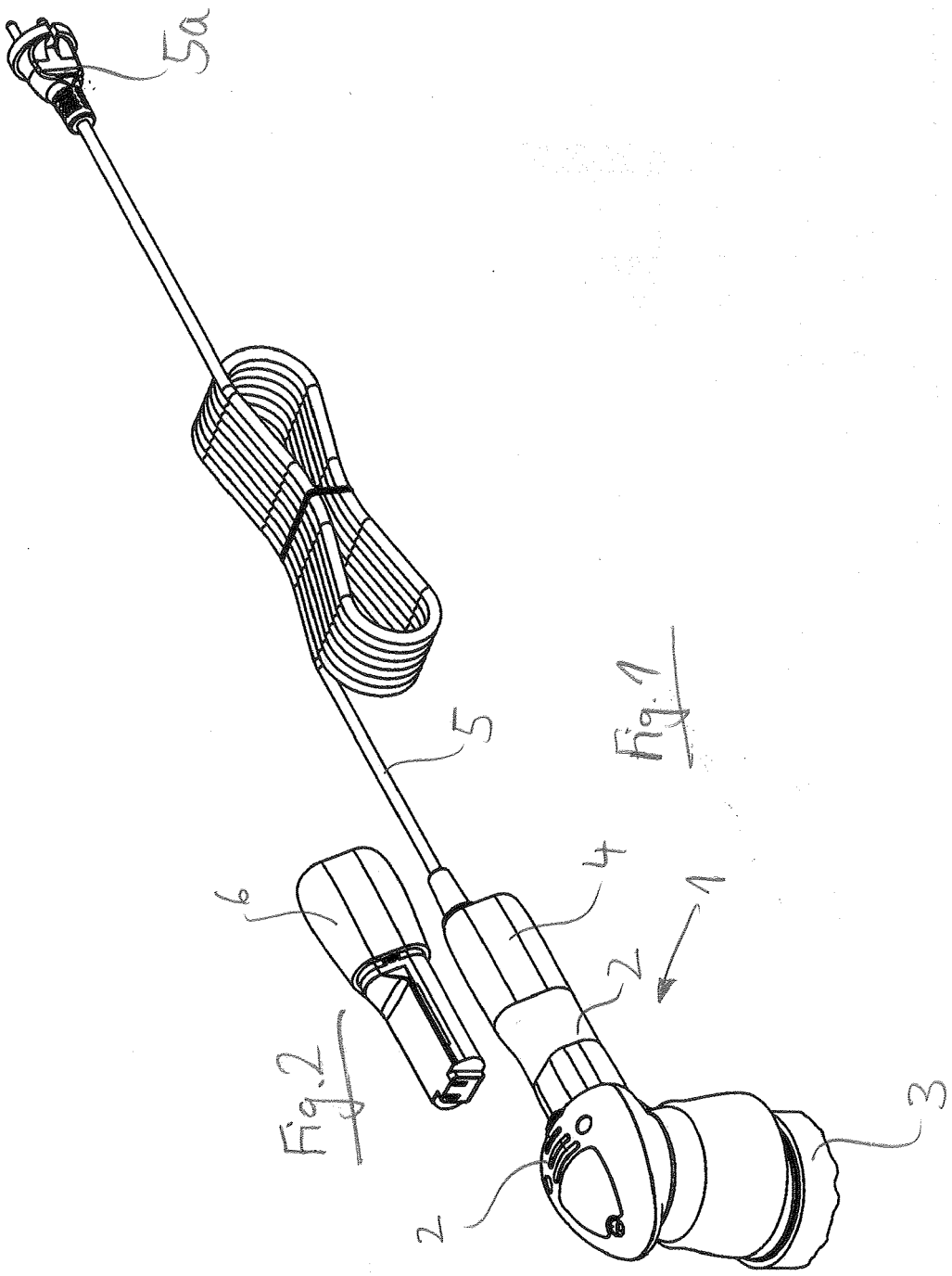

Fig.1

Fig.2

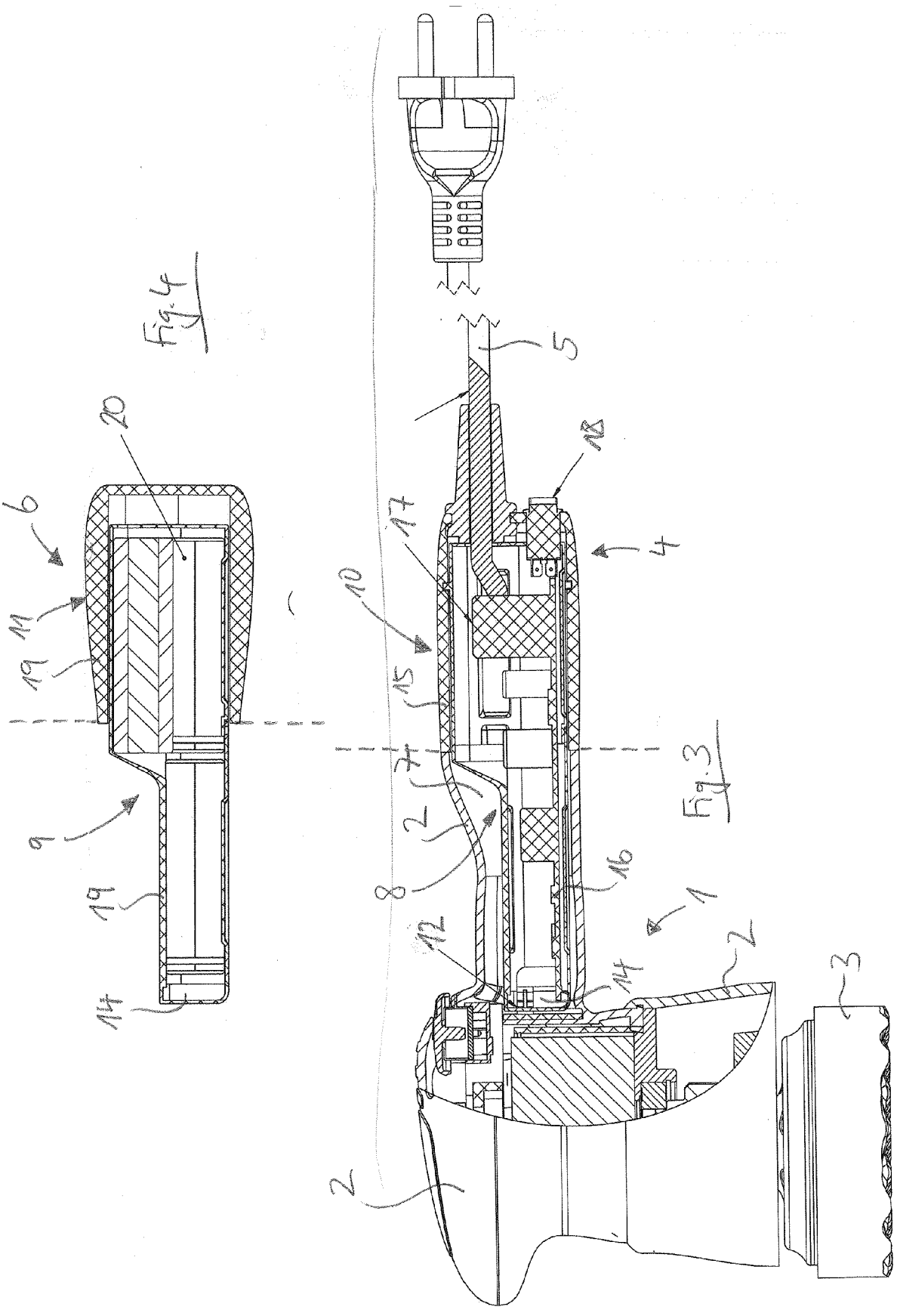

Fig.3

Fig.4

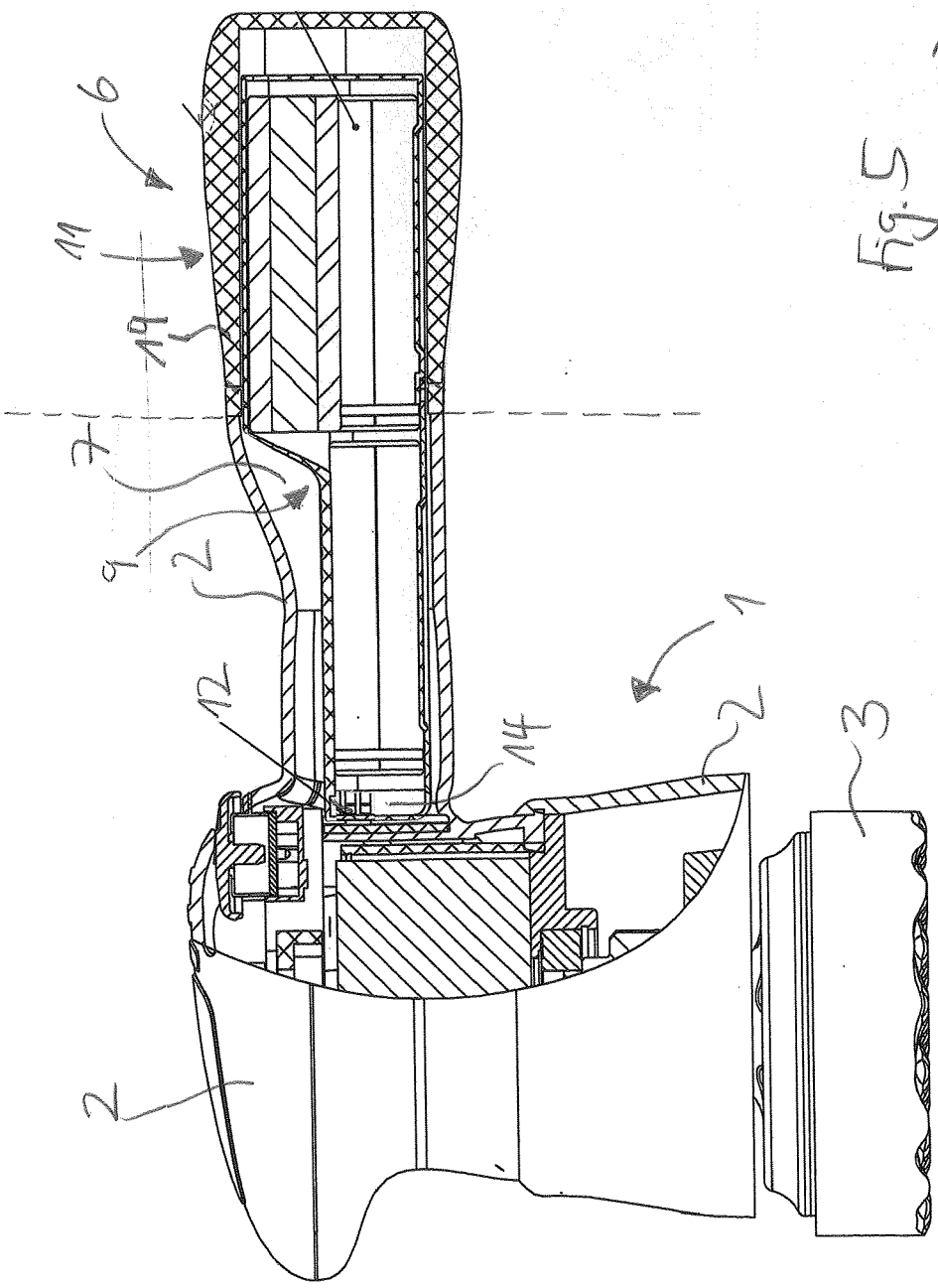

Fig. 5

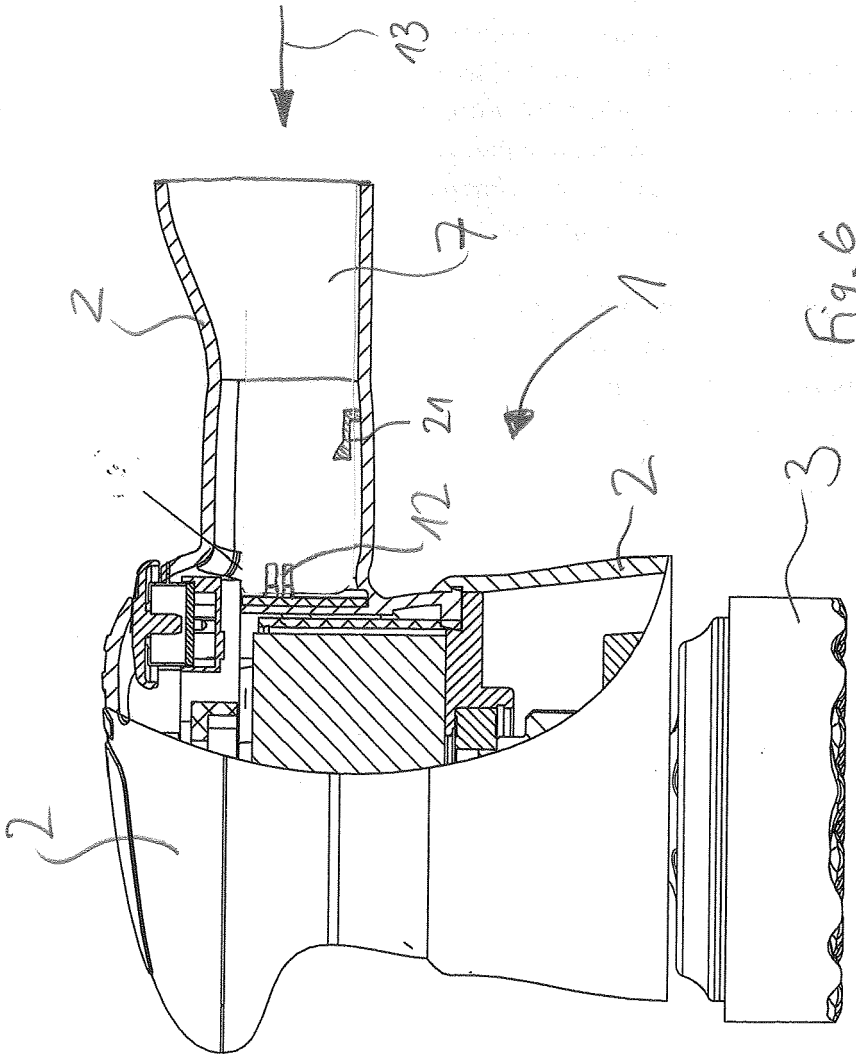

Fig. 6

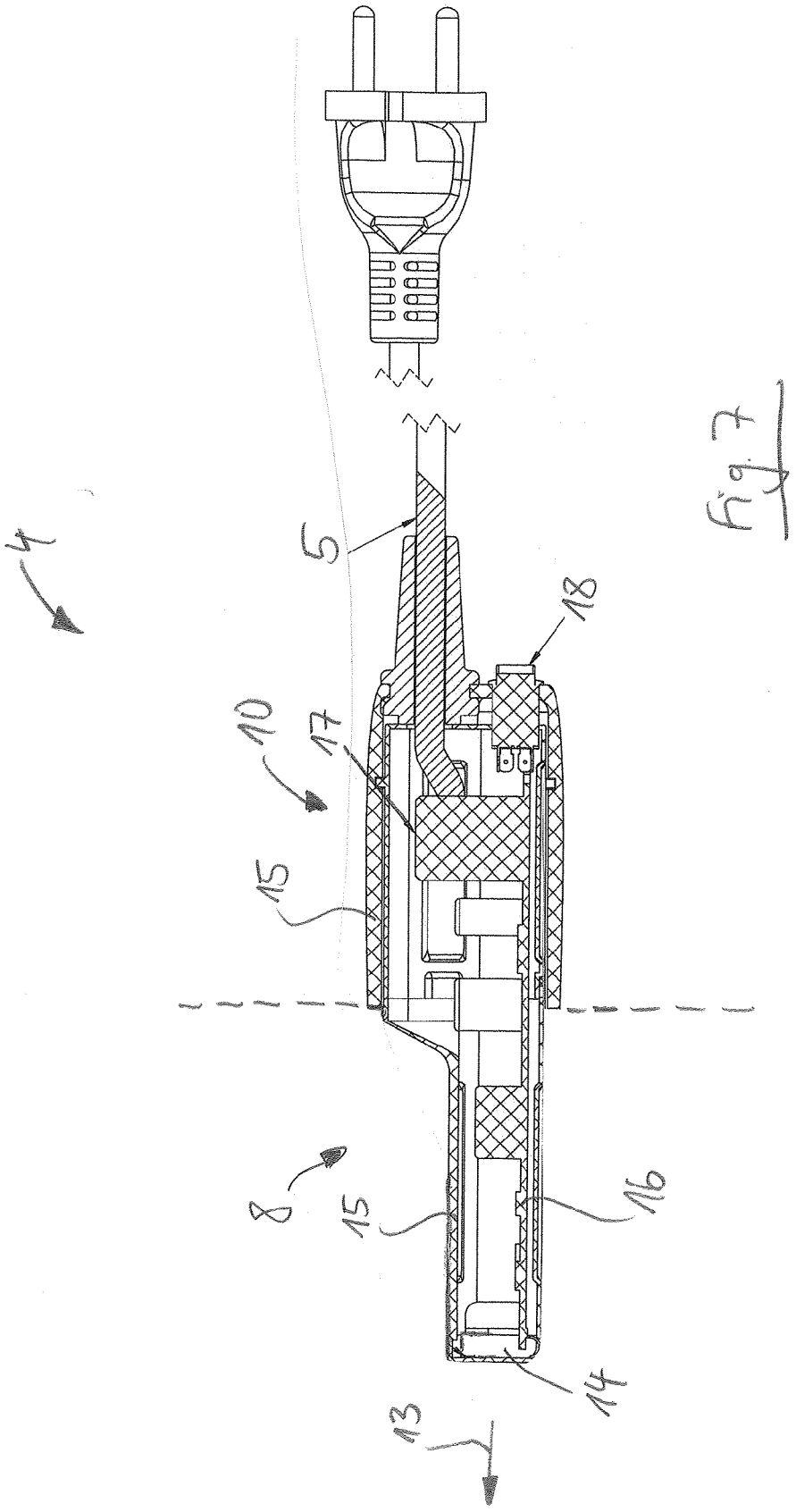

Fig. 7

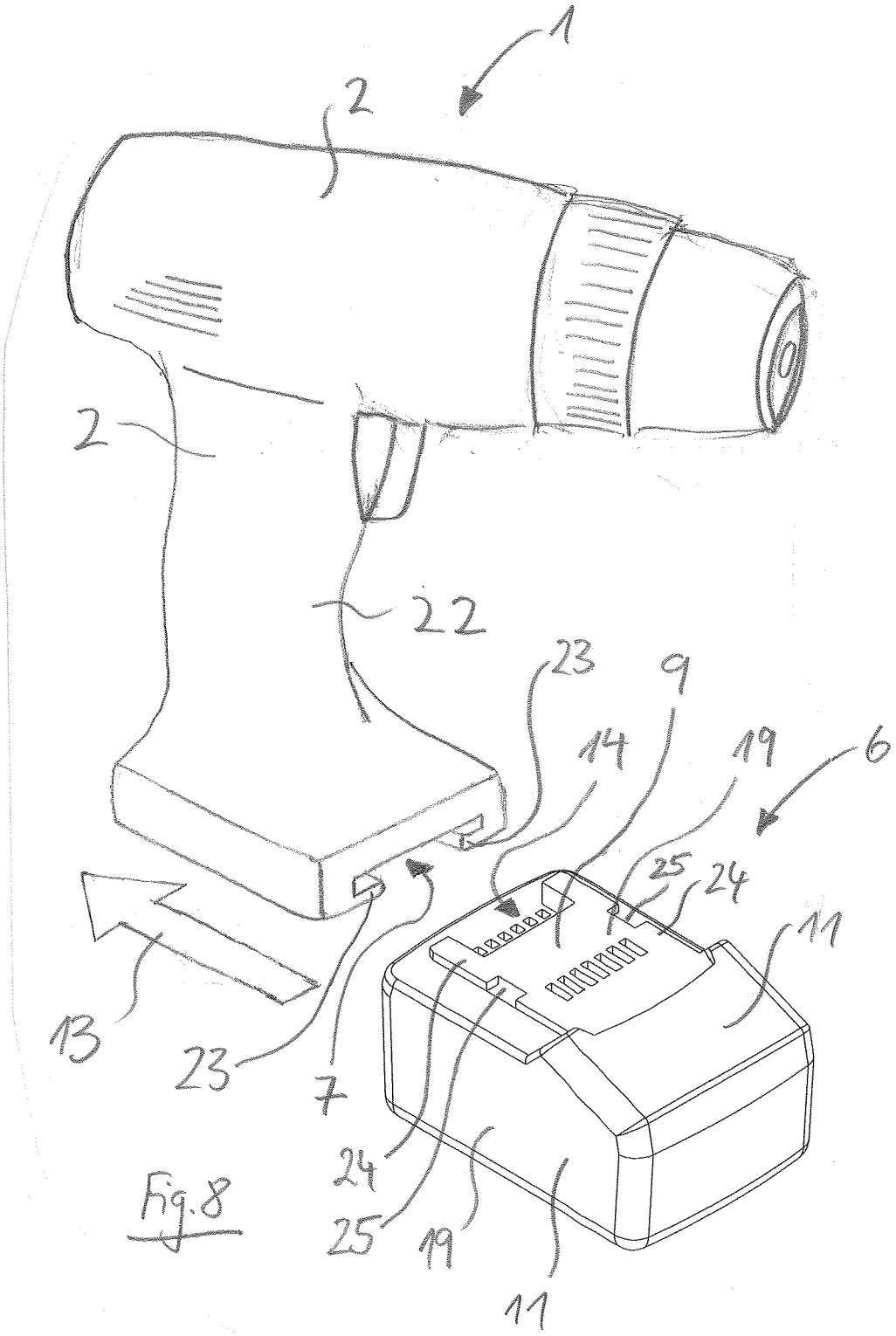

Fig.8

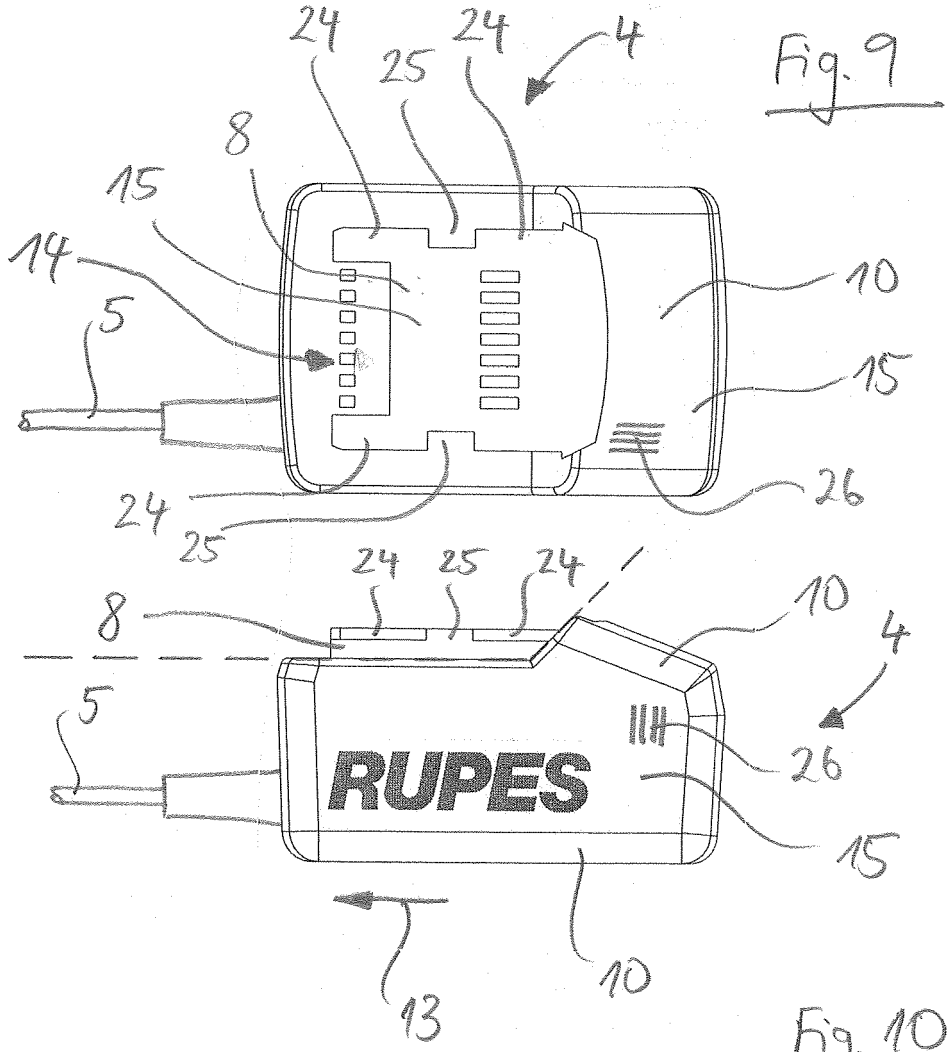

Fig. 9

Fig. 10

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Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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