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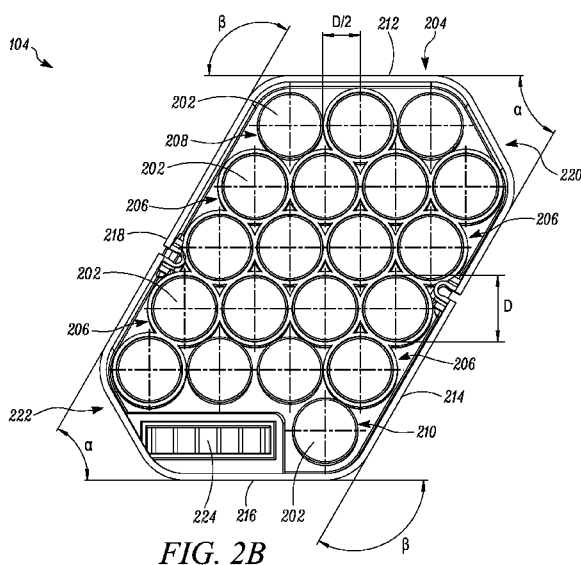
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(54) Title: BATTERY PACK FOR A BATTERY POWERED TOOL



(57) Abstract: The present invention relates to a battery pack (104) for a battery powered tool (100). The battery pack (104) includes a plurality of battery cells (202) provided in at least two rows (206) with at least two battery cells (202) in each row (206). The rows (206) are placed on top of each other and each row (206) is displaced relative to each closest row, such that a parallelogram shaped cross-section of the battery pack (104) is formed. The battery pack (104) further includes at least one end row (208, 210) provided as the last row of battery cells on top or below the at least two rows (206), such that the at least one end row (208, 210) includes at least one battery cell (202) less than each of the at least two rows (206).



Battery pack for a battery powered tool

Technical field

The present invention relates to a battery pack. In particular, the present invention relates to a battery pack for a battery powered tool.

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Background

Battery powered hand held tools such as, but not limited to, chainsaws, line trimmers, hedge trimmers, rotary saws, or the like, are well known in the art. A detachable battery pack is usually used to provide electric energy to a prime mover (for example an electric motor) of a battery powered hand held tool.

Typically, the battery pack includes multiple cylindrical cells encased within a battery housing. In prior art battery packs, the cells are usually arranged in rows and columns in a substantially square or rectangular shape within the battery housing. However, such an arrangement may not provide a compact battery pack and the number of cells for a given volume within the battery housing may also not be optimally utilized. Moreover, a power transfer connector, which electrically connects the cells to electrical terminals provided on the battery powered tool, are provided on an outer surface of the battery housing and this further reduces the compactness of the battery pack. Such a battery pack, when attached to the battery powered tool, may result in poor handling and low ergonomics of the battery powered tool.

U.S. Patent No. 7,019,666 granted on March 28, 2006, titled "Adapter for a meter" and assigned to Tantalus Systems Corp., discloses a battery pack for an adapter of an electric meter. The U.S. Patent No. 7,019,666 further discloses battery cells being arranged such that the battery pack has a parallelogram shape. The parallelogram shape permits the battery pack to be inserted into a corresponding battery bay in only two orientations as opposed to four orientations in a square shaped battery pack. In this case, the

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parallelogram shape results in an effective configuration to electrically connect and disconnect the battery pack within the battery housing. Further, U.S. published application No. 2009/0226803 published on September 10, 2009, titled "Battery, battery pack and method of manufacturing connection terminal used therein", discloses a fire resistant battery pack. The battery pack disclosed in the U.S. published application No. 2009/0226803 has a parallelogram shape. However, the arrangements of battery cells disclosed in the aforementioned patent and published patent application may not be spatially optimal and not lead to a compact battery pack.

In light of the foregoing, there is a need for a compact battery pack, for a battery powered tool, with an optimum arrangement of battery cells.

Summary

In view of the above, it is an objective to solve or at least reduce the problems discussed above. In particular, the objective is to provide a compact battery pack, for a battery powered tool, with an optimal arrangement of cells.

The objective is at least partially achieved with a novel battery pack for a battery powered tool according to claim 1. The battery pack includes a plurality of battery cells provided in at least two rows with at least two battery cells in each row. The rows are placed on top of each other and each row is displaced relative to each closest row, such that a parallelogram shaped cross-section of the battery pack is formed. The battery pack further includes at least one end row provided as the last row of battery cells on top or below the at least two rows, such that the at least one end row includes at least one battery cell less than each of the at least two rows. Such an arrangement of the battery cells may lead to a compact configuration of the battery pack. Therefore, the battery pack may improve the handling and ergonomics of the battery powered tool.

According to claim 2, the battery cells in the at least one end row may be located such that the parallelogram shape is provided with a truncated corner. The truncated corner may further result in a more compact

configuration of the battery pack by removing at least one sharp corner from the parallelogram shape of the battery pack.

According to claim 3, the battery cells may be cylindrically shaped. Further, according to claim 4, the rows may be displaced relative to each
5 closest row by a distance of half the diameter of a battery cell. A distance of half the diameter of a battery cell may provide the most compact arrangement of circular battery cells.

According to claim 5, two sides of the parallelogram shaped battery pack may form an angle of about 100-150 degrees, and preferably of about
10 110-130 degrees. Further, according to claim 6, two sides of the parallelogram shaped battery pack may form an angle of about 30-80 degrees, and preferably of about 50-70 degrees.

According to claim 7, two corners of the parallelogram shaped battery pack may be truncated. The two truncated corners may further result in a
15 more compact configuration of the battery pack by removing two sharp corners from the parallelogram shape of the battery pack.

According to claim 8, the diameter of a battery cell may be in the range of about 10-25 millimeters, preferably of about 15-20 millimeters, and more preferably of about 18 millimeters. Alternatively, according to claim 9, the
20 battery cells may have a length in the range of about 50-80 millimeters, and preferably of about 60-70 millimeters.

According to claim 10, one of the at least one end row may include more than one battery cell less than each of said at least two rows. Further, the end row may include a power transfer connector within the parallelogram
25 shaped battery pack. By providing the power transfer connector inside the battery pack, the battery pack may be more compact. Further, a power transfer connector within the parallelogram shaped battery pack may be more protected than a power transfer connector provided outside the battery pack.

According to claim 11, in another aspect of the invention, a battery
30 powered tool may be provided including a battery pack according to any of the claims 1-10. Moreover, according to claim 12, the battery powered tool may be a hand-held garden tool.

Brief description of the drawings

The invention will in the following be described in more detail with reference to the enclosed drawings, wherein:

- 5 FIG. **1** illustrates a perspective view of a chainsaw, according to an embodiment of the present invention;
- FIG. **2A** illustrates a perspective view of a battery pack, according to an embodiment of the present invention; and
- FIG. **2B** illustrates a sectional view of the battery pack, according to an embodiment of the present invention.

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Description of embodiments

The present invention will be described more fully hereinafter with reference to the accompanying drawings, in which example embodiments of the invention incorporating one or more aspects of the present invention are
15 shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. For example, one or more aspects of the present
20 invention can be utilized in other embodiments and even other types of devices. In the drawings, like numbers refer to like elements.

FIG. **1** illustrates a partial perspective view of an example battery powered chainsaw **100**, according to an embodiment of the present invention. The chainsaw **100** may be used in gardening or forestry applications.
25 However, the present invention may also be incorporated in any other battery powered tools, for example line trimmers, hedge trimmers, drills, reciprocating saws, rotary saws, power screw drivers, or other hand-held power or garden tools without departing from the essence of the present invention. In addition, any suitable size, shape or type of elements or materials could be used.

30 The chainsaw **100** includes a main body **102** which encloses a prime mover (not shown). In various other embodiments of the invention, the prime mover may be an electric motor, such as, but not limited to, an AC motor, a DC motor, or the like. The electric motor is selectively supplied with electrical

energy by a battery pack **104**. The activation or deactivation of the electric motor may be controlled by an on/off switch (not shown in FIG. **1**). Further, the chainsaw includes other control means, which may include one or more sensors to regulate various parameters of the drive motor, for example speed, torque etc. The rated power and other specifications of the electric motor may be selected based on various parameters, for example power requirements, expected life, cost, weight or dimensions.

Further, the chainsaw **100** includes a working implement (not shown) coupled to the main body **102**. Typically, the working implement includes a guide bar with a continuous peripheral guiding slot to support a saw chain. Further, a drive sprocket and an idler sprocket may be present at a proximate end and a distal end of the guide bar respectively with respect to the main body **102**, such that the saw chain rides over them. During operation of the chainsaw **100**, the drive sprocket and thus, the saw chain may be driven by the electric motor via suitable transmission means (not shown in the figures) which may include for example (but are not limited to) one or more gears, belt drive, friction drive, or any combination of these. The transmission means may be utilized to selectively drive the drive sprocket at one or more speeds.

As illustrated in FIG. **1**, the main body **102** also includes a top handle **106** and a side handle **108** (partially shown in FIG. **1**). However, other types of handle configurations (for example a rear handle configuration) may be possible without departing from the scope of the present invention. The top handle **106** and/or the side handle **108** may include grip portions to aid in manual grasping of the chainsaw **100**. Further, a guard **110** is provided to safeguard a user during a cutting operation.

FIG. **2A** illustrates a perspective view of the battery pack **104**, according to an embodiment of the present invention, with a cover removed. The battery pack **104** may be detachably attached to the main body **102** of the chainsaw **100** to aid in charging, maintenance and/or storage. The battery pack **104** may include suitable releasable mechanical connections (not shown in the figures), for example, but not limiting to, snap-fit connections, mating recesses and grooves, connections with resilient members (for example springs), or a combination of any of these to mechanically connect the battery

pack **104** to the main body **102** of the chainsaw **100** without any special tools. However, in an alternative embodiment of the present invention, the battery pack **104** may be fixedly attached to the electric power tool **100**.

As illustrated in FIG. **2A**, the battery pack **104** includes a plurality of
5 battery cells **202** (hereinafter referred to as “the cells **202**”) encased in a battery housing **204**. Each of the cells **202** has a substantially cylindrical shape. However, any other shape of the cells **202** (for example cells with elliptic or rectangular cross-section) may be possible. Moreover, the cells **202** may be for example Lithium-Ion, Nickel-Cadmium, or the like based cells. The
10 number and type of the cells **202** may be selected based on various parameters, such as, but not limited to, power and charge requirements, cost, weight and dimensions of the electric power tool **100**.

As illustrated in FIG. **2A**, the cells **202** are arranged in at least two rows **206** with at least two cells **202** in each of the rows **206**. Further, the
15 battery pack **104** also includes at least one end row **208** or **210** provided as the last row of the cells **202** on top and/or below of the rows **206**. It may be noted that the positional terms “top” and “below” are used with respect to the orientation of the battery pack **104** as depicted in FIG. **2A**. Further, the end row **208** includes at least one cell **202** less than each of the rows **206**.
20 Moreover, at least one of the end rows **208** and/or **210** may include more than one cell **202** less than each of the rows **206**. By way of an example only, as illustrated in FIG. **2A**, each of the rows **206** includes four cells **206**. Moreover, the end row **208** provided at the top of the rows **206** includes three cells **206** while the end row **210** provided below the rows **206** includes one cell **202**.
25 The number of cells **202** and the number of rows **206**, as illustrated in FIG. **2A**, are for illustrative purposes only, and the battery pack **104** may include any number of cells **202** arranged in any number of rows **206** within the scope of the present invention. In various alternative embodiments of the present invention, two or more cells **202** may also be arranged adjacent to one
30 another in a direction substantially perpendicular to the plane of the paper. Further, each of the rows **206**, and/or end rows **208** and **210** are displaced relative to the closest row such that the battery pack **104** has a substantially parallelogram shaped cross-section (described in detail in conjunction with

FIG. **2B**). The parallelogram shaped cross-section of the battery pack **104** may lead to a compact arrangement of the cells **202**. Such a compact configuration of the battery pack **104** may improve the handling and the ergonomics of the chainsaw **100**. Further, the end rows **208** and/or **210** are provided with at least one cell **202** less than each of the rows **206** to result in a more compact configuration of the battery pack **104** (explained later in conjunction with FIG. **2B**).

FIG. **2B** illustrates a sectional view of the battery **104**, according to an embodiment of the present invention. As illustrated in FIG. **2B** each of the cells **202** has a diameter D . Further, each of the rows **206**, and the end rows **208** and **210** are displaced relative to the closest row by substantially a distance equal to about half of the diameter D of a cell **202**, i.e. $D/2$. This results to a substantially parallelogram shaped cross-section of the battery pack **104**. Further, the relative displacement by the distance equal to about $D/2$ provides an optimum arrangement of the cells **202**, i.e. a maximum number of cells **202** can be accommodated in a given volume of the battery pack **104**. Consequently, an output power of the battery pack **104** may be maximized for a given volume or size of the battery pack **104**.

In an embodiment of the present invention, the diameter D of a cell **202** is substantially in a range from about 10 millimeters to about 25 millimeters, and preferably in a range of about 15 millimeters to about 20 millimeters, and more preferably of about 18 millimeters. Additionally, in an embodiment of the present invention, a length of each of the cells **202** is substantially in a range from about 50 millimeters to about 80 millimeters, and preferably in a range from about 60 millimeters to about 70 millimeters. It may be apparent to a person skilled in the art that the dimensions of the cells **202** are purely exemplary in nature and the cells **202** may have any other dimensions without departing from the essence of the present invention.

Further, as illustrated in FIG. **2B**, two sides **212** and **216** of the battery housing **204** are substantially parallel to each other and two sides **214** and **218** of the battery housing **204** are substantially parallel to each other. As illustrated in FIG. **2B**, the two sides **212** and **214** of the battery housing **204** form an angle α between them. Moreover, an angle between the sides **216**

and **218** is substantially equal to the angle α due to the parallelogram shaped cross-section of the battery pack **104**. In an embodiment of the present invention, the angle α may lie substantially in a range from about 30 degrees to 80 degrees, and preferably from about 50 degrees to 70 degrees. Further, as illustrated in FIG. **2B**, the two sides **212** and **218** of the battery housing **204** form an angle β between them. Moreover, an angle between the sides **214** and **216** is substantially equal to the angle β due to the parallelogram shaped cross-section of the battery pack **104**. In an embodiment of the present invention, the angle β is substantially in a range from about 100 degrees to 150 degrees, and preferably in a range from about 110 degrees to 130 degrees. The ranges of the angles α and β may result in a more compact configuration of the battery pack **104**. However, it may be apparent to a person skilled in the art that the ranges of the angles α and β are purely exemplary in nature and the angles α and β may have any values without departing from the essence of the present invention. Moreover, the sides **212**, **214**, **216** and **218** of the battery housing **204** may be of any length or thickness.

Further, the cells **202** in the end row **208** are arranged such that the parallelogram shaped cross-section of the battery pack **104** is provided with a first truncated corner **220** between the sides **212** and **214** of the battery housing **204**. By way of an example, the end row **208** has at least one cell **202** less than each of the rows **206** to enable the formation of the first truncated corner **220**. Further, the cells **202** in the end row **210** are arranged such that the parallelogram shaped cross-section of the battery pack **104** is provided with a second truncated corner **222** between the sides **216** and **218**. By way of an example, the end row **210** has at least one cell **202** less than each of the rows **206** to result in the formation of the second truncated corner **222**. The first truncated corner **220** and/or the second truncated corner **222** may result in an even more compact configuration of the battery pack **104** by removing at least one sharp corner from the parallelogram shaped cross-section of the battery pack **104**.

As illustrated in FIG. **2B**, the end row **210** may include a power transfer connector **224** which is situated within the battery housing **204**. By way of an

example, the power transfer connector **224** is accommodated within the battery housing **204** by providing the end row **210** with at least two cells **202** less than each of the rows **206**. The power transfer connector **224** may include one or more terminals made of an electrically conducting material.

5 The power transfer connector **224** may electrically connect the cells **202** to one or more tool electric terminals (not shown in the figures) provided on the main body **102** of the chainsaw **100**. Further, the battery pack **104** may include one or more electrical conductors (not shown in the figures) to electrically connect poles of the cells **202** to the power transfer connector **224**.

10 Moreover, the power transfer connector **224** may also be utilized to charge the cells **202** from an external power source. By providing the power transfer connector **224** inside the battery housing **204**, instead of mounting the power transfer connector **224** on an outer surface of the battery housing **204**, the battery pack **104** may be more compact. Additionally, the power transfer

15 connector **224** may be safeguarded from corrosive elements (For example, moisture) and mechanical damage during handling.

In the drawings and specification, there have been disclosed preferred embodiments and examples of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for

20 the purpose of limitation, the scope of the invention being set forth in the following claims.

Claims

1. A battery pack (104) for a battery powered tool (100), wherein the battery pack (104) comprises;

5 a plurality of battery cells (202) provided in at least two rows (206) with at least two battery cells (202) in each row (206), wherein the rows (206) are placed on top of each other and wherein each row (206) is displaced relative to each closest row, such that a parallelogram shaped cross-section of the battery pack (104) is formed,

10 **characterized in that** the battery pack (104) further comprises at least one end row (208, 210) provided as the last row of battery cells on top or below said at least two rows (206), which at least one end row (208, 210) comprises at least one battery cell (202) less than each of said at least two rows (206).

15 2. The battery pack (104) according to claim 1, wherein the battery cell/s (202) in the at least one end row (208, 210) is located such that the parallelogram shape is provided with a truncated corner (220, 222).

20 3. The battery pack (104) according to claim 1 or 2, wherein the battery cells (202) are cylindrically shaped.

25 4. The battery pack (104) according to claim 3, wherein the rows (206, 208, 210) are displaced relative to each closest row by a distance of half the diameter (D) of a battery cell (202).

30 5. The battery pack (104) according to any of the preceding claims, wherein two sides (212, 218) of the parallelogram shaped battery pack (104) forms an angle (β) of about 100-150 degrees, and preferably of about 110-130 degrees.

6. The battery pack (104) according to any of the preceding claims, wherein two sides (212, 214) of the parallelogram shaped battery pack forms an angle (α) of about 30-80 degrees, and preferably of about 50-70 degrees.

7. The battery pack (**104**) according to any of the claims 2-6, wherein two corners (**220**, **222**) of the parallelogram shaped battery pack (**104**) are truncated.

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8. The battery pack (**104**) according to claim 3, wherein the diameter (**D**) of a battery cell (**202**) is in the range of about 10-25 millimeters, preferably of about 15-20 millimeters, and more preferably of about 18 millimeters.

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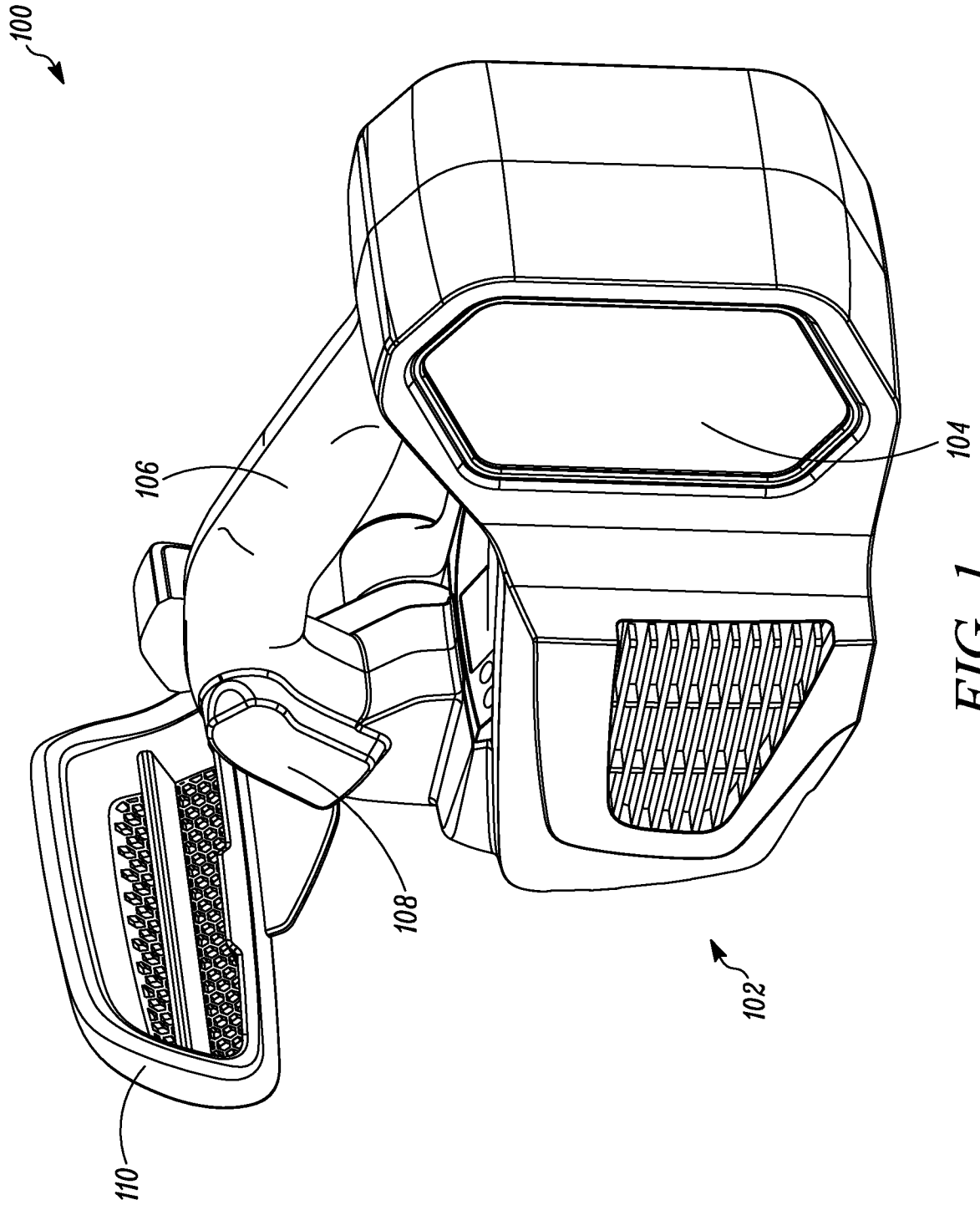
9. The battery pack (**104**) according to any of the preceding claims, wherein the battery cells (**202**) have a length in the range of about 50-80 millimeters, and preferably of about 60-70 millimeters.

10. The battery pack (**104**) according to any of the preceding claims, wherein one of the at least one end row (**210**) comprises more than one battery cell less than each of said at least two rows (**206**), wherein the end row (**210**) comprises a power transfer connector (**224**) within the parallelogram shaped battery pack (**104**).

20

11. A battery powered tool (**100**) comprising the battery pack (**104**) according to any of the claims 1-10.

12. The battery powered tool (**100**) according to claim 11, wherein the battery powered tool (**100**) is a hand-held garden tool.



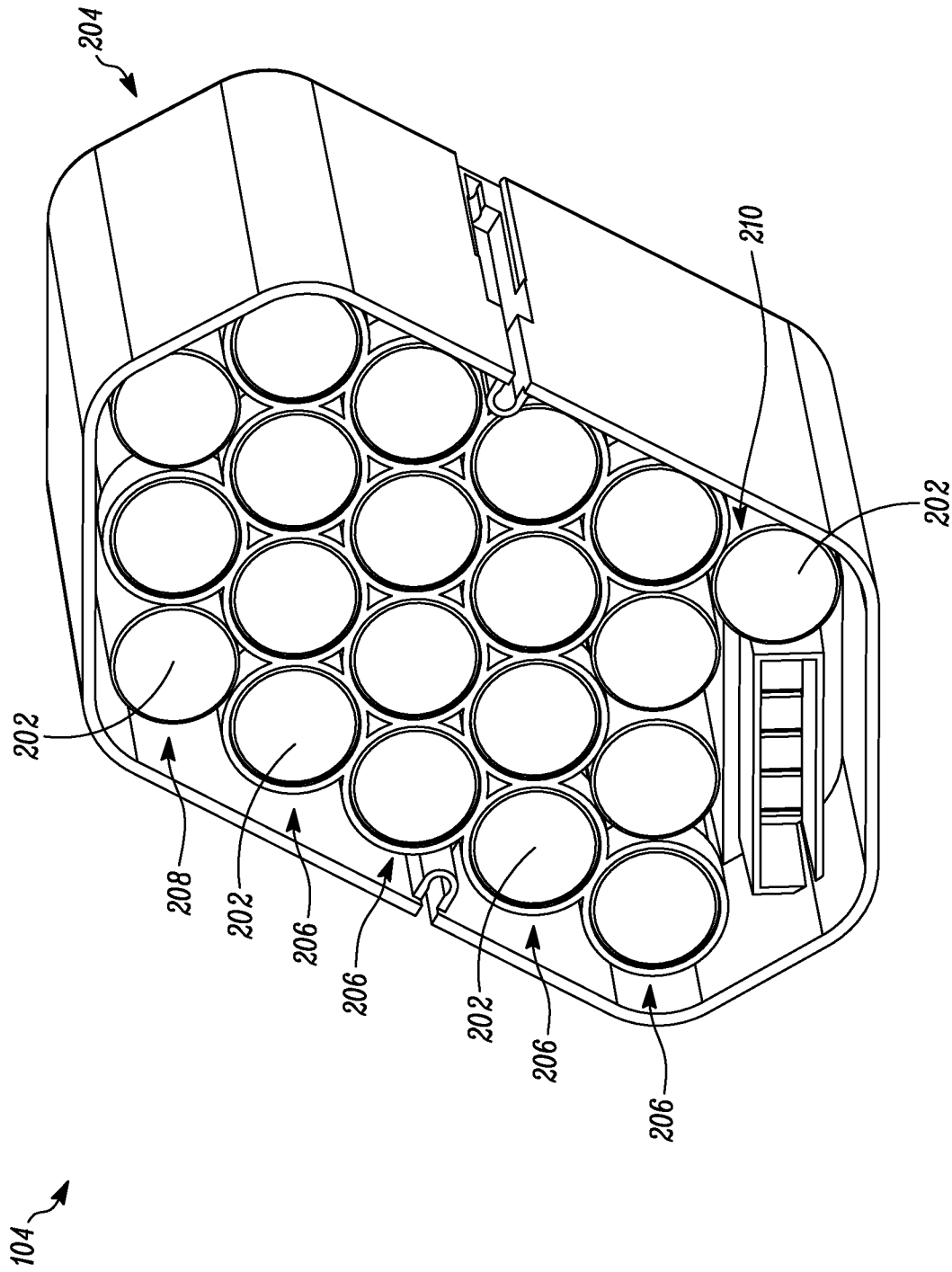


FIG. 2A

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2011/050308

A. CLASSIFICATION OF SUBJECT MATTER		
IPC: see extra sheet		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC: B25F, H01M		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE, DK, FI, NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
EPO-Internal, PAJ, WPI data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5208525 A (LOPIC FRANZ ET AL), 4 May 1993 (1993-05-04); column 1, line 11 - line 15; column 8, line 43 - column 9, line 37; figure 3; abstract --	1-12
X	DE 9209104 U1 (MY HAND INDUSTRIAL CO.), 17 September 1992 (1992-09-17); figure 3 --	1-12
A	US 20040029426 A1 (LUI TAT NIN ET AL), 12 February 2004 (2004-02-12); figure 3; abstract --	1-12
A	US 20050221654 A1 (PHILLIPS STEVEN J ET AL), 6 October 2005 (2005-10-06); figure 4A; abstract --	1-12
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
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Date of the actual completion of the international search 22-11-2011		Date of mailing of the international search report 24-11-2011
Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86		Authorized officer Ulrika Nilsson Telephone No. + 46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2011/050308

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5553675 A (PITZEN JAMES F ET AL), 10 September 1996 (1996-09-10); figure 2; abstract -- -----	1-12

Continuation of: second sheet

International Patent Classification (IPC)

B25F 5/02 (2006.01)

H01M 2/10 (2006.01)

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Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2011/050308

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