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(56) Documents Cited:
GB 2405998 A **US 6270313 B1**
US 6074296 A **US 20030202879 A1**

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INT CL **F04D, H02J, H05K**
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(54) Abstract Title: **Charging apparatus fan filter**

(57) Charging apparatus comprises a housing which has at least one bladed fan, an air inlet opening, and a filter 16 which is arranged at the air inlet opening and has a plurality of openings 17 which are at least half as large as the minimum spacing S_{min} of the fan blades 22. The ratio of the diagonal cross-section O_{max} of each filter opening 17 to the blade spacing S_{min} may be between 0.5 and 1.5, and may further be between 1 and 1.3. The filter 16 may be grid shaped, of unitary construction, and formed integrally with at least part of the housing. The filter 16 may also be coated to have a self-cleaning effect. The charging apparatus may be for a battery of an electric hand tool.

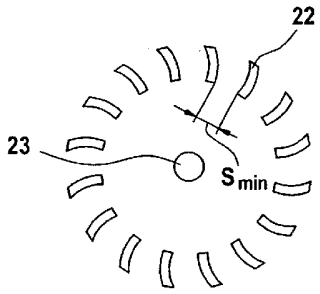

Fig. 3a

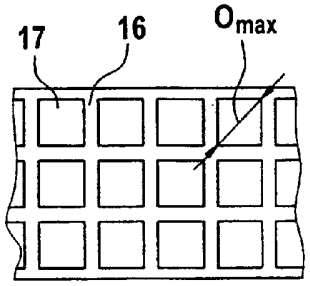

Fig. 3b

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Fig. 1

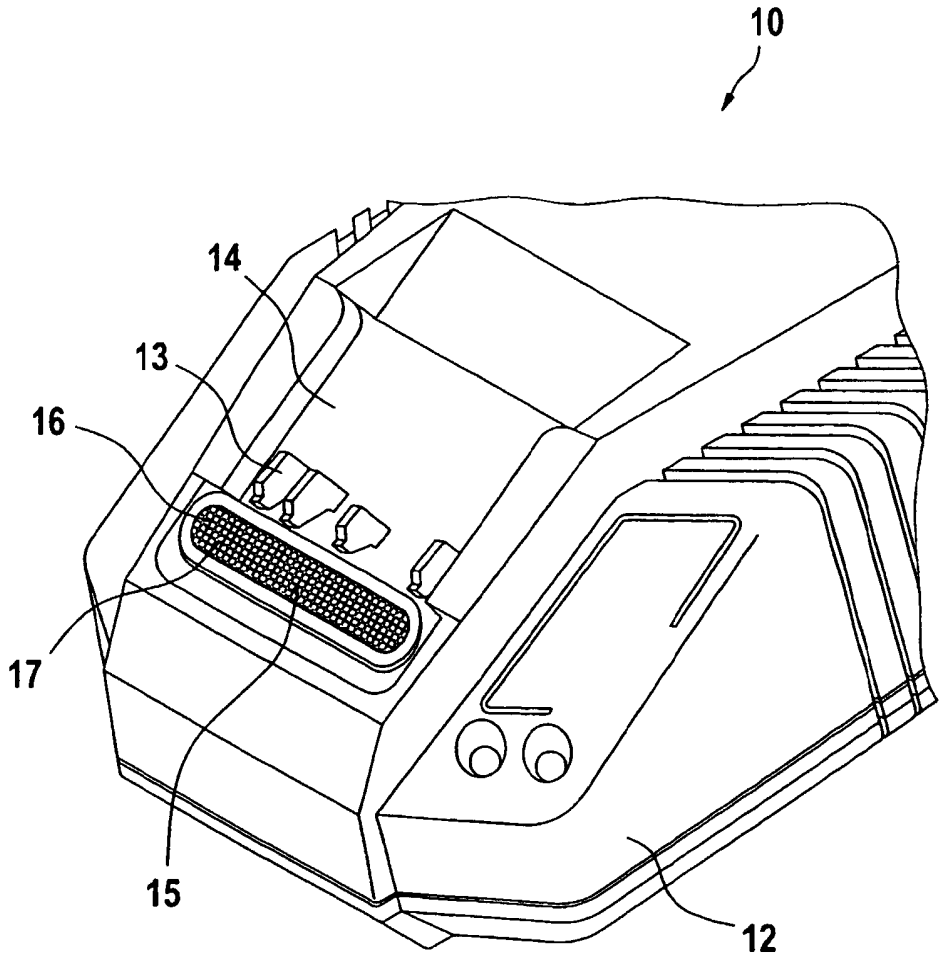
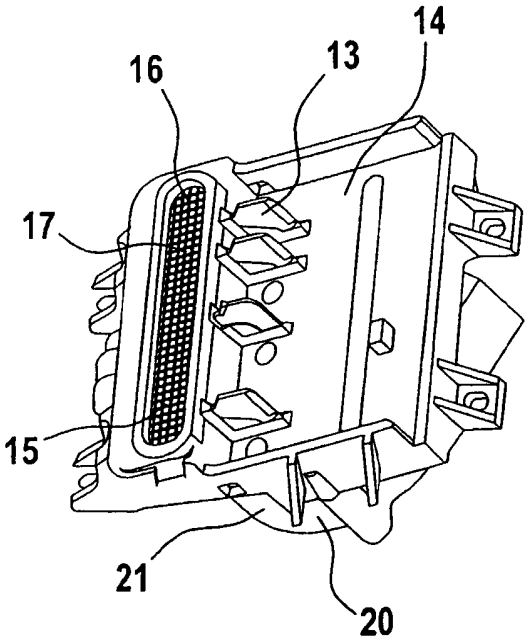


Fig. 2



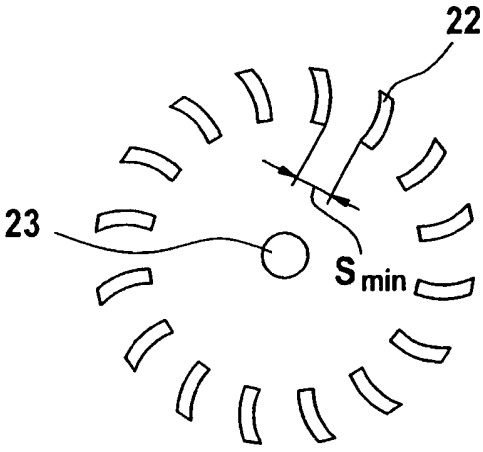


Fig. 3a

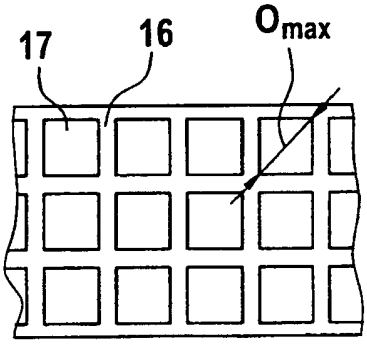


Fig. 3b

CHARGING APPARATUS WITH FILTERED COOLING FLOW

The present invention relates to charging apparatus, particularly for a battery pack.

Charging apparatus comprising a fan which blows, for example, cooling air into and through a coolable battery pack plugged into the apparatus are known from the state of the art. The reverse flow direction, in which the cooling air flows through an inlet opening into the battery pack and is sucked by the fan through the battery pack, is also known. Moreover, charging apparatus are known in which the electronic components of the charging apparatus are cooled.

The housing of the charging apparatus has for this purpose air inlet and air outlet openings in order to suck in air from outside the housing and blow it out again. During the induction of air, dust and dirt particles are also sucked in which, according to their size, can damage the fan. In order to prevent dirt particles or the like penetrating into the fan housing, filters are usually provided at the air inlet openings. Very fine filters in the form of a fine net, tissue, mesh or the like of metal or other material are usually used as filters. This has the disadvantage that after a certain time the filters are blocked by dirt and dust particles and have to be cleaned or exchanged. Moreover, these fine filters have the disadvantage that they are thin and flexible.

According to the present invention there is provided charging apparatus comprising a housing, which has at least one fan with fan blades, an air inlet opening and a filter, which is arranged at the air inlet opening, with a plurality of openings, wherein the openings are at least half as large as the minimum spacing of the fan blades.

Charging apparatus embodying the invention includes a housing, which has at least one fan with fan blades, an air inlet opening and a filter with a plurality of openings, the filter being arranged at the air inlet opening. The charging apparatus is particularly suitable for a battery pack, especially a battery pack for an electric handtool. The fan serves for cooling the charging apparatus by conveying air from within to outside the charging apparatus. Cold air enters the interior of the charging apparatus via the air inlet opening. The filter is of such a kind that the openings are at least as half as large as the minimum spacing of the fan blades. This has the advantage that the filter openings do not block up as quickly as conventional, very fine filters, since only coarser dirt particles, which are of

such a size that they could possibly damage the fan, remain caught at the filter. Finer dirt particles can pass through the filter openings and are centrifuged away by the fan blades so that the fan is not damaged notwithstanding the dirt and dust particles.

In a preferred embodiment the ratio of opening cross-section to fan blade spacing is at least 0.5 and at most 1.5, preferably at least 1 and at most 1.3, ideally 1.2. It is thereby possible to block only the dirt particles or the like which are too large for the fan, whereas other, smaller dirt particles are admitted by the filter and are blown through by the fan and out again. Consequently, the filter openings do not block up as quickly as with conventional filters. Since the filter openings are larger than usual filter openings, the filter can be constructed as a stable component. The filter is therefore more robust and cannot be damaged as easily as, for example, a filter consisting of a thin wire net or a fabric.

The filter is, for preference, grid-shaped or grill-shaped. By grid-shaped filter there is understood not only a filter in the form of a grid with rectangular filter openings, but also a filter with openings having, in principle, any geometric shape, for example, round, triangular, honeycomb, rectangular or lozenge-shaped. The respective maximum dimension of the opening is regarded as the opening cross-section. In the case of a rectangular opening this is, for example, the diagonal.

The filter is preferably of unitary construction. Thus, for example, the filter can be produced from plastics material by means of injection moulding or from metal by means of punching. Alternatively, however, the filter can be of two-part or multi-part construction, for example in that two filter elements with slot-shaped filter openings are arranged one above the other, the slot-shaped openings being perpendicular to one another so that a grid-shaped filter is formed.

The filter is preferably constructed integrally with at least a part of the housing. The housing or a housing part of the fan as well as the filter can, for example, be of plastics material. The ventilation grid can, for example, be formed integrally with the housing of the charging apparatus so that the housing and grid can be produced together in an injection moulding method. If the grid is moulded directly at the housing of the apparatus it does not have to be mounted on the housing in a separate production step, for example by screwing, gluing or clamping. Moreover, the integrally moulded filter has a sufficient inherent stability so that it does not have to be additionally stabilised, for example by

means of a frame.

In a further embodiment of the invention the filter is coated in such a manner that it has a self-cleaning effect (lotus flower effect).

An embodiment of the present invention will now be more particularly described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of part of charging apparatus embodying the invention;

Fig. 2 is a view of a fan and filter assembly incorporated in the apparatus of Fig. 1;

Fig. 3a is a schematic illustration of fan blades of a fan of the assembly, showing the blade spacing; and

Fig. 3b is a schematic illustration, to enlarged scale, of filter openings of a filter of the assembly, showing the filter opening maximum dimension.

Referring now to the drawings, part of charging apparatus 10 embodying the invention is illustrated in Fig. 1 in perspective view. The charging apparatus 10 is suitable for, for example, charging exchangeable battery packs for electric tools. The charging apparatus 10 comprises a housing 12 which can be single-part or multi-part, for example can consist of a lower and an upper housing shell (not illustrated). The housing has a plug-in shaft for reception of a battery pack (not illustrated). Disposed in the region of the shaft 14 are contact elements 13 for electrical contact-making of the battery pack with the charging apparatus 10.

As can be inferred from the enlarged detail according to Fig. 2, a fan 20 in a fan housing 21 is provided in the interior of the apparatus 10 below the shaft 14. Air from outside enters the interior of the apparatus by way of an air inlet opening 15. The air is blown out via an air outlet opening (not illustrated) with the help of the fan 20.

In order to prevent dust, dirt and other particles penetrating into the apparatus 10 a filter 16 with a plurality of openings 17 is arranged at the air inlet opening 15. The filter 16 is in that

case selected so that the openings 17 are at least half as large as the minimum spacing S_{min} of the fan blades 22. The minimum spacing S_{min} of the fan blades 22 is shown in Fig. 3a. By minimum fan blade spacing there is understood the minimum spacing between two adjacent fan blades 22. This is present at those ends of the adjacent blades 22 which face a rotational axle 23 of the fan 20. The cross-section O_{max} of an opening 17, which in the case of a square opening 17 (as shown in, for example, Fig. 3b) corresponds with the diagonal, is regarded as the size of the opening 17. Analogous opening cross-sections are taken into account in other geometric shapes of openings 17. The ratio of opening cross-section O_{max} to fan blade spacing S_{min} is at least 0.5 and at most 1.5, preferably at least 1 and at most 1.3, ideally 1.2. This has the advantage that the filter openings do not block as quickly as with conventional, very fine filters, since only coarser dirt particles are retained at the filter 16, whereas finer dirt particles can pass through the filter openings 17 and are centrifuged away by the fan blades 22. In the charging apparatus 10 the opening cross-section O_{max} and the fan blade spacing S_{min} are matched to one another in such a manner that coarse dirt particles, which could damage the fan 20, are caught at the filter 16, whereagainst fine dirt particles, which cannot damage the fan 20, are let through by the filter 16. If a finer filter able to also catch finer dirt particles were to be used, the filter would block up to quickly and would have to be exchanged. The concept of the present invention consists in eschewing use of a fine filter, which also retains fine particles, and instead employing a coarser filter 16 which allows passage of fine particles which cannot damage the fan 20.

CLAIMS

1. Charging apparatus including a housing with a fan having a plurality of fan blades, an air inlet opening, and a filter arranged at the inlet opening, the filter having a plurality of openings each at least half as large as the minimum spacing of the blades.

2. Apparatus as claimed in claim 1, wherein the ratio of the cross-section of each filter opening to the blade spacing is at least 0.5 and at most 1.5.

3. Apparatus as claimed in claim 2, wherein the ratio is at least 1 and at most 1.3.

4. Apparatus as claimed in any one of the preceding claims, wherein the filter is grid-shaped.

5. Apparatus as claimed in any one of the preceding claims, wherein the filter is of unitary construction.

6. Apparatus as claimed in any one of the preceding claims, wherein the filter is formed integrally with at least a part of the housing.

7. Apparatus as claimed in any one of the preceding claims, wherein the filter is coated to have a self-cleaning effect.

INTELLECTUAL PROPERTY OFFICE

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Application No: GB0815690.3 **Examiner:** Alex Swaffer

Claims searched: 1-7 **Date of search:** 8 December 2008

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-6	US6270313 B1 (Delta Electronics Inc): See filter 125 in figure 2A.
X	1-3, 5, 6	US6074296 A (Delta Electronics Inc): See filter 51 in figure 5.
X	1-3, 5, 6	US2003/202879 A1 (Delta Electronics Inc): See filter 206 in figures 4-6.
X	1-3	GB2405998 A (Tsai): See filter 123 in figures 2 & 3.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[X] :

F1C

Worldwide search of patent documents classified in the following areas of the IPC

F04D; H02J; H05K

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
F04D	0029/42	01/01/2006
H02J	0007/00	01/01/2006
H05K	0007/20	01/01/2006