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(54) Title: ELECTROSTATIC CLUTCH FOR POWER TOOL

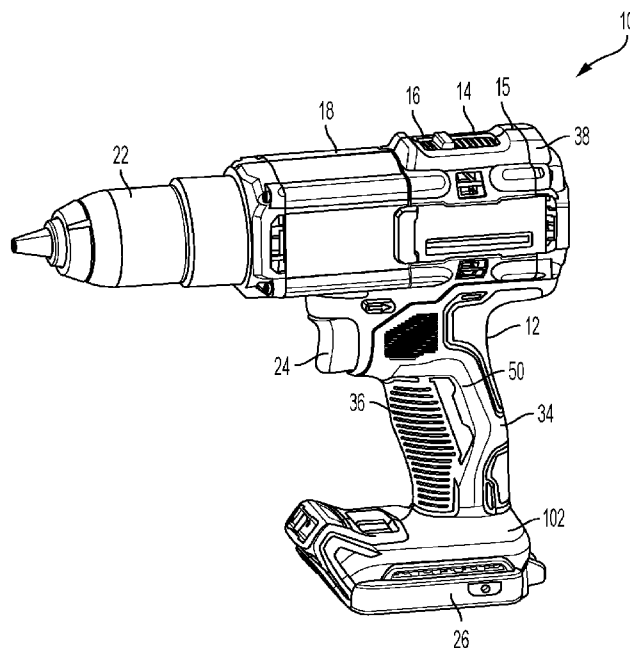


FIG. 1

(57) Abstract: A power tool includes an electrostatic clutch assembly disposed between a motor and an end effector. A control circuit causes a first voltage to be applied to a first electrode of the electrostatic clutch assembly and a second voltage to be applied to a second electrode of the electrostatic clutch assembly, the first voltage being different from the second voltage, generating a first attractive force between the first and second electrodes, causing a shaft and a clutch housing to be coupled to each other when a torque on one of the shaft or the clutch housing is less than or equal to a first threshold value, and allowing the one of the shaft or the clutch housing to rotationally slip relative to the other of the shaft or the clutch housing when the torque on the one of the shaft or the clutch housing exceeds the first threshold value.



NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO,
RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,
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ZA, ZM, ZW.

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INTERNATIONAL SEARCH REPORT

International application No

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A. CLASSIFICATION OF SUBJECT MATTER

INV. F16D28/00 B23B45/02 B25B23/147 H02N13/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F16D B23B B25B H02N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, 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 2019/107157 A1 (SCHMITZ AARON [US] ET AL) 11 April 2019 (2019-04-11)	1-15, 18-25, 54-56, 59-61
A	paragraphs [0037], [0055], [0056], [0058]; figures 8, 9, 10, 12, 21, 22	16, 17, 26-38, 57, 58, 62, 63
X	US 10 138 953 B1 (KOENIG KAREN SHAKESPEAR [US] ET AL) 27 November 2018 (2018-11-27) cited in the application	13-15, 19, 20, 22-25, 54-56, 59-61
A	column 4, lines 11-13 column 12, line 60 - column 13, line 17; figures 3a-3d	1, 16, 17



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2023/073828

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims;; it is covered by claims Nos.:
1-38, 54-63

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-38, 54-63

A power tool wherein the clutch housing is mounted to a ring gear.

2. claims: 39-53

A power tool comprising an impact mechanism.

3. claims: 64-70

A power tool comprising a switch circuit.

4. claims: 71-77

A method of operating a power tool with the step of controlling the motor to increase a torque.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2023/073828

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2019107157 A1	11-04-2019	EP 3695130 A1	19-08-2020
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