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(54) Title: SYSTEMS, DEVICES, AND METHODS FOR BALANCING MULTIPLE ENERGY SOURCES

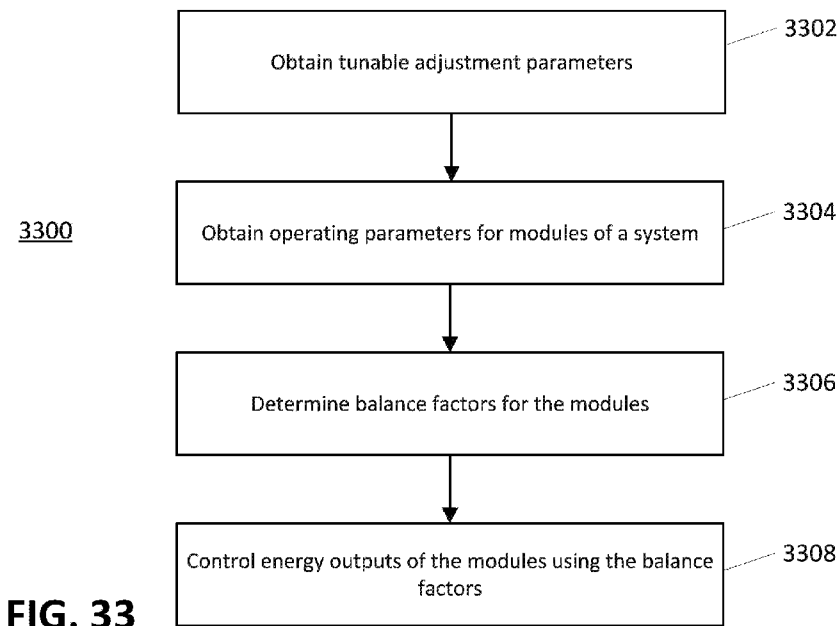


FIG. 33

(57) Abstract: Systems, devices, and methods for controlling source current in systems having two or more energy sources. The source current can be controlled in a manner that seeks balance in one or more operating parameters of the sources while meeting load demand. Examples of operating parameters can include charge, temperature, voltage, state of health, current, and others. Example embodiments are described that control, for each module, respective tunable balance factors for operating parameters of the one or more energy sources of the module such that each operating parameter of each energy source converges towards a balanced target value for the operating parameter, and control, for each module, energy outputs of each of the one or more energy sources based on the respective tunable balance factors for the module.



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INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. H01M 10/42 (2024.01)
ADD. H02J 7/00 (2024.01)

CPC - INV. H01M 10/4207, H02J 7/0014

ADD. H01M 10/441

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)

See Search History document

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

See Search History document

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

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2020/0313445 A1 (TAE TECHNOLOGIES, INC.) 01 October 2020 (01.10.2020) Fig 1A-1C, 2, 30, abstract, para [0067], [0068], [0088], [0203], [0244]	1-3, 27
A	US 2014/0239901 A1 (DE COCK) 28 August 2014 (28.08.2014) Fig 1, abstract, para [0015]	1-3, 27

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

"D" document cited by the applicant in the international application
"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

23 April 2024

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 23/82747

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.: 4-26, 28, 34-50, 52, 53
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 extra 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 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.:
1-3, 27

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.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 23/82747

Continuation of Box No III Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I: Claims 1-3 and 27 drawn to a method of controlling currents of an energy storage system or an energy storage system including details of controlling a tunable balance factor.

Group II: Claims 29-33 and 51 drawn to a method of controlling outputs of an energy storage system or an energy storage system including details of determining an aggression factor.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Special Technical Features:

Group I includes special technical features of details of controlling a tunable balance factor, not included in the other group.

Group II includes special technical features of details of determining an aggression factor, not included in the other group.

Common Technical Features:

The only technical features shared by Groups I-II that would otherwise unify the groups, are that both Groups are concerned with a method of controlling currents or outputs of an energy storage system including an array of modules and controlling, for each module, factors of an operating parameter of the one or more energy sources of the module such that each operating parameter of each energy source converges to achieve a balanced target value. However, these shared technical features do not represent a contribution over prior art, because the shared technical features are disclosed by US 2014/0239901 A1 to DE COCK (hereinafter 'DE COCK').

DE COCK discloses a method of controlling currents or outputs of an energy storage system including an array of modules and controlling, for each module, factors of an operating parameter of the one or more energy sources of the module such that each operating parameter of each energy source converges to achieve a balanced target value (abstract, "...a method of forming a balancing circuit for a plurality of battery cells..", para [0015], "...controller 48 forms a balancing circuit for cells 27-33...controller 48 is configured to selectively enable some of switches 36-40 and 42-46 to selectively pre-charge element 34 prior to transferring energy from element 34 to a particular cell such that the state of charge of the particular cell converges toward the target state of charge..").

As the shared technical features were known in the art at the time of the invention, they cannot be considered special technical features that would otherwise unify the groups.

Therefore, Groups I-II lack unity under PCT Rule 13.

Item 4. (contd) Claims 4-26, 28, 34-50, 52, 53 have been found to be unsearchable under Article 17(2)(b) because of defects under Article 17(2)(a) and therefore have not been included with any invention. 4-26, 28, 34-50, 52, 53