(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
01 April 2021 (01.04.2021)

WIPO | PCT

(10) International Publication Number
WO 2021/061060 A1

(51) International Patent Classification:
B60L 53/80 (2019.01) *B60L 50/60* (2019.01)
B60K 1/04 (2019.01)

(21) International Application Number:
PCT/TR2019/050975

(22) International Filing Date:
19 November 2019 (19.11.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
TR2019/14788 27 September 2019 (27.09.2019) TR

(71) Applicant: **T.C. PIRI REIS UNIVERSITESI** [TR/TR]; Postane Mh. Eflatun Sk. No:8, 34940 Tuzla/Istanbul (TR).

(72) Inventor: **KAYAARASI, Tolunay**; Ethem Efendi Caddesi Sehit Sakir Elkovan Sokak Tekin Apartmani No:25 Daire:7 Erenkoy, 34738 Kadikoy/Istanbul (TR).

(74) Agent: **YILDIRIM, Mehmet Enes**; Bilim Patent Danismanlik Hizmetleri Ltd. Sti, Barbaros Mah. Uphill Towers A Kule Kat:1 Ofis:2, 34746 Atasehir/Istanbul (TR).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,

(54) Title: A BATTERY SWAP STATION

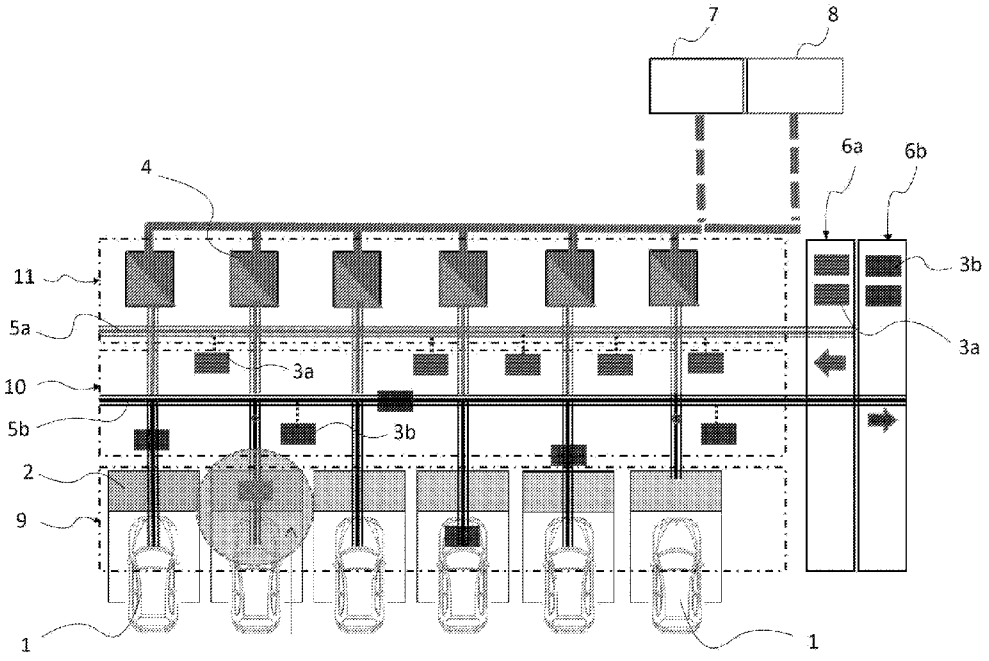


Figure-1

(57) Abstract: The invention is the swap stations for switching the power batteries (batteries) of electric vehicles; which is characterized as incorporating; - Identification and battery handling unit (2), which performs the vehicle (1) acceptance, vehicle (1) identification, bonnet(cap) opening and battery identification operations, - The transport and control unit (4) sending continue process command for a certain station, which is detected by the main PLC (8) and once vehicle (1) acceptance, vehicle (1) identification and bonnet opening procedures are approved, - Full battery conveyor belt (5a) carrying the full battery (3a) from the full battery storage (6a) to the vehicle (1), - Empty battery conveyor belt (5b) carrying the empty battery (3b) from the empty battery storage (6b) to the vehicle (1), - Full battery storage (6a), where full batteries (3a) are stored, - Empty battery storage (6b), where empty batteries (3b) are stored for charging, - Electrical panel (7), which ensures the controlled and safe operation of the electrical installation, - Main PLC (8) ensuring controlling

WO 2021/061060 A1

[Continued on next page]

SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

of all operations, - Battery replacement automation unit (9), which provides disassembly and movement operations, - Transmission line unit (10) in which transport of empty batteries (3b) removed from the vehicle (1) and full batteries (3a) to be installed in the vehicle (1) is carried out. - the battery replacement belt and the automation unit (11), located within the transport and control unit (4), - the battery charge controller (12) which controls the charge status of the batteries.

A Battery Swap Station

Technical Field

The invention relates to swap stations for switching the power batteries (batteries) of electric vehicles.

Prior Art

The component that stores electrical energy by converting it into chemical energy and supplies it where necessary by converting such chemical energy into electrical energy is called battery (accumulator, battery, cell). All energy required for electric vehicles is supplied from batteries. The charging process of these batteries can take 2-3 hours.

The range of electric vehicles range has increased to 400 kilometers. Availability of limited number of charging stations together with long charging periods, prevent electric vehicles to be preferred. The fastest battery charging stations in the prior art can charge the batteries in 30-40 minutes. In these quick charging stations mentioned, the life span of the batteries decreases during quick charging.

A sliding door system for battery swap stations is mentioned in European Patent document No. EP2231447 available in prior art. For said sliding door system, the electric vehicle comprises a battery pack which can be replaced at a battery swap station. A battery which is at least partially exhausted in the battery swap station is replaced by a battery which is at least partially charged. A battery housing is

configured to be located on an underside of the electric vehicle. The battery housing includes a bezel that defines a slot. The slot is configured such that the battery pack is at least partially installed. The battery housing comprises at least one latch that can be pivoted about an axis substantially parallel to a plane formed by the underside of the vehicle. This latch is configured to lift the battery pack and keep it in the slot. How the battery is removed and transported from the vehicles is mentioned in this system. No battery and/or vehicle identification system exist.

Purpose of the Invention

The purpose of the invention is to provide automatic, fast and reliable replacement of electric vehicle batteries.

Another purpose of the invention is to obtain a station wherein the replaceable electric vehicle batteries can be charged by using renewable energy in addition to mains power.

Another purpose of the invention is to obtain a battery swap station in which fuel is saved.

Another purpose of the invention is to obtain a battery swap station in which the machine efficiency is increased.

Another purpose of the invention is to obtain a battery swap station, which allows practical replacement of vehicle batteries.

Another purpose of the invention is to obtain a modular battery swap station.

The battery swap station developed to realize the mentioned purposes is composed of the identification and battery handling unit (2), reading, transport and control unit (4), full battery conveyor belt (5a), empty battery conveyor belt (5b),

full battery s (6a), empty battery storage (6b), electrical panel (7), main PLC (8), battery swap automation unit (9), battery transmission line unit (10), battery swap belt and automation unit (11), battery charge controller (12), solar panel (13) the solar panel unit (14), the charge distribution unit (15), the solar panel battery (16) and the solar battery panel unit (17).

Description of Figures

Attached Figure-1 is the schematic view of the battery swap station.

Figure-2 is a schematic view of the charging and storage station of the batteries.

Figure-3 - is the simple flowchart of the battery swap station.

Figure-4 - is the detailed flowchart of the battery swap station.

Numbers and names of main parts mentioned in the figures are given below.

(1) Vehicle
(2) Identification and battery handling unit
(3a) Full battery
(3b) Empty battery
(4) Transport and control unit
(5a) Full battery conveyor belt
(5b) Empty battery conveyor belt
(6a) Full battery storage
(6b) Empty battery storage
(7) Electrical panel
(8) Main PLC
(9) Battery replacement and automation unit
(10) Battery transmission line unit
(11) Battery swap belt and automation unit
(12) Battery charge control unit
(13) Solar panel

(14) Solar Panel Unit

(15) Charging distribution unit

(16) Solar panel battery

(17) Solar panel battery unit

Detailed Explanation of the Invention

The invention relates to swap stations for switching the power batteries (batteries) of electric vehicles (1). The battery swap station subject to the invention is composed of the identification and battery handling unit (2), transport and control unit (4), full battery conveyor belt (5a), empty battery conveyor belt (5b), full battery storage (6a), empty battery storage (6b), electrical panel (7), main PLC (8), battery replacement and automation unit (9), battery transmission line unit (10), battery swap belt and automation unit (11), battery charge controller (12), solar panel (13) the solar panel unit (14), the charge distribution unit (15), the solar panel battery (16) and the solar battery panel unit (17). As an alternative to the solar panel unit (14) used in the swap station under the present invention, wind energy, biomass energy, hydroelectric energy, wave energy and etc. renewable energy sources can be used.

The electrical panel (7) provides necessary electrical energy from renewable energy sources in order to ensure continuous operation of the system. When renewable energy sources are insufficient and in case of interruption in the network.it draws necessary electrical energy from the grid.

In the battery swap station under the invention, a compensation unit panel is provided. The compensation unit is the unit on which the gauges, contactors, electrical fuses and capacitors are located to correct the cos Q of the operation. The compensation unit ensures efficient and controlled use of electrical energy.

The main PLC (8) unit (Programmable Logic Controller) is the unit where all other mechatronic commands and controlling of other units are performed. The

algorithm used in the main PLC (8) is made by the designer. All data processed by this unit are recorded in a black box in accordance with international norms due to administrative, financial, legal and technical needs.

Identification and battery handling unit (2) performs vehicle (1) acceptance, vehicle (1) identification, bonnet opening and battery identification operations. Once the vehicle (1) the battery of which will be changed is left in the station through the vehicle (1) acceptance process, it is brought to the area related to mechatronic methods for battery replacement. In order to keep administratively, legally, financially and technically necessary records during the vehicle (1) identification process, the vehicle (1) that will be subject to battery replacement process, is identified via RFID, optical, Automatic Passage System or Quick Toll System. Standard frame or battery cap manufactured according to international norms, is opened in suitable dimensions via the bonnet or cap opening process.

The transport and control unit (4) sends continue process command for a certain station, which is detected by the main PLC (8) and once vehicle (1) acceptance, vehicle (1) identification and bonnet opening procedures are approved.

With the battery identification process, the battery or cell of the vehicle (1) arriving at the station is identified. Identification is performed with barcode and RFID systems. The identification unit must be positioned precisely on the battery by means of an optical or position sensor in order to carry out the identification process in a proper way.

The battery of the vehicle (1) is removed from its place during the battery removal process and removed, i.e. empty batteries (3b) are delivered to the conveyor line through the dismantling conveyor line.

The transport process of the batteries, whose dismantling process is completed in the dismantling unit, is realized with the battery transmission line unit (10). Said battery transmission line unit (10) operates as a conveyor. The batery

transmission line unit (10) guides the battery removal unit. The battery removal unit is placed on the conveyor on the transmission line according to the vehicle (1) position reference points and the number of stations. The direction of the battery removal unit is adjusted by the main PLC (8) according to whether the vehicles (1) enter the stations continuously.

Battery installation sequence is composed of following process steps;

- Reading the identification label of the charged (gull) battery (3a) to be installed,
- Taking the battery identified from the shelf,
- Conveying the vehicle (1) to relevant section through the conveyor system and positioning it according to the reference points,
- Inserting the full battery (3a) into the vehicle (1),
- Closing the respective cap after the insertion process and verification of the closing process.

In the battery installation process, the conveyor runs as a system. The battery installation unit is placed on the conveyor according to the vehicle (1) position reference points and the number of stations. The direction of the installation procedure is adjusted by the main PLC (8) according to whether the vehicles (1) enter the stations continuously.

Unless the main PLC (8) in the battery swap station under the present invention lights up the “entry” signal, the vehicle (1) is not taken to the station for battery replacement. Again, unless such main PLC (8) lights up the "green light", the bonnet of the vehicle (1), which is subject to battery replacement process, cannot be closed manually. Unless the main PLC (8) gives "exit" signal, the vehicle (1) cannot leave the station.

Commanding and controlling signaling between all said units and processes are provided by software which is in compliance with the required algorithm. All

operations including commands, controls, warning and alarms (all kinds of smoke, fire, flare, flame, etc.) are controlled by such algorithm.

The invention relates to an operation method for the swap stations for switching the power batteries (batteries) of electric vehicles (1), which is composed of following process steps:

- The vehicle (1) enters to the station and it is placed into the mechatronically correct position by the main PLC (8) *(S2001)*,
- The number plate of the vehicle (1) is identified through the number plate reading system *(S2002)*,
- The bonnet of the vehicle (1) or cap is opened, the opening process is scanned optically (S2003),
- The battery label scanner and battery removal robot is directed by the main PLC (8) (S2004),
- The vehicle (1) battery is scanned via barcode or RFID (S2005),
- Switching the replacement control to the transport and control unit (4) for performing the status and stock check of the battery through the main PLC (8) (S2006),
- Instruction given by the transport and control unit (4) to the battery replacement and automation unit (9) to move and disassemble (S2007),
- Taking the removed battery on the empty battery conveyor belt (5b) and transporting it to the empty battery storage (6b) (S2008),
- Informing the main PLC (8) by the transport and controlling unit (4) and the battery replacement and automation unit (9) on the transport process *(S2009)*,
- Command is given by the main PLC (8) to scan the next full battery (3a) in the full battery storage (6a) via RFID or barcode system and loading command is given to the transport and control unit (4) *(S2010)*,

- Instruction is given by the transport and control unit (4) to the battery replacement and automation unit (5) to retrieve, transport and install the full battery (3a) from the full battery storage (6a)*(S2011)*,
- Instruction is given by the transport and control unit (4) to bring the full battery (3a) to the vehicle (1) through the battery conveyor belt (5a) *(S2012)*,
- Completing the installation of the full battery (3a) to the vehicle (1) and manually closing the universal bonnet of the vehicle (1) after said installation is completed and optically verifying that it is closed (S2013),
- The main PLC (8) warns the station management on the empty battery storage (6b) by the rack occupancy alarm (S2014),
- The main PLC (8) warns the station management on the full battery storage (6a) by the rack occupancy alarm (S2015),

In the swap station according to the invention, each process is recorded. The transactions are recorded in accordance with international norms.

The empty batteries (3b) in the empty battery storage (6b) at the battery swap station are charged by using solar panels (13). The unit accommodating all solar panels (13) is called the solar panel unit (14). The energy generated by the solar panels (13) is stored in the solar panel batteries (16). The unit accommodating all solar panel batteries (16) is called the solar panel battery unit (17). The solar panel unit (14) is provided with a charge distribution unit (15) which ensures that the generated energy is delivered to the battery swap station in a smooth and controlled manner.

The battery swap station draws the energy required for its operation primarily from the solar panel unit (14). In case of insufficient energy, it can automatically draw electricity from the grid. In alternative embodiments of the invention, wind energy, bioenergy, and etc. renewable energy systems in addition to solar energy can be used integrated into the battery station.

CLAIMS

1. An operating method for the swap stations for switching the power batteries (batteries) of electric vehicles; characterized in that; it comprises the following process steps,

- The vehicle (1) enters to the station and it is placed into the mechatronically correct position by the main PLC (8) *(S2001)*,
- The number plate of the vehicle (1) is identified through the number plate reading system*(S2002)*,
- The bonnet of the vehicle (1) or cap is opened, the opening process is scanned optically (S2003),
- The battery label scanner and battery removal robot is directed by the main PLC (8) (S2004),
- The vehicle (1) battery is scanned via barcode or RFID (S2005),
- Switching the replacement control to the transport and control unit (4) for performing the status and stock check of the battery through the main PLC (8) and recording the data sent (S2006),
- Instruction given by the transport and control unit (4) to the battery replacement and automation unit (9) to move and disassemble (S2007),
- Taking the removed battery on the empty battery conveyor belt (5b) and transporting it to the empty battery storage (6b) (S2008),
- Informing the main PLC (8) by the transport and controlling unit (4) and the battery replacement and automation unit (9) on the transport process *(S2009)*,
- Command is given by the main PLC (8) to scan the next full battery (3a) in the full battery storage (6a) via RFID or barcode system and loading command is given to the transport and control unit (4) *(S2010)*,

- Instruction is given by the transport and control unit (4) to the battery replacement and automation unit (5) to retrieve, transport and install the full battery (3a) from the full battery storage (6a)*(S2011)*,
- Instruction is given by the transport and control unit (4) to bring the full battery (3a) to the vehicle (1) through the full battery conveyor belt (5a) *(S2012)*,
- Completing the installation of the full battery (3a) to the vehicle (1) and manually closing the universal bonnet of the vehicle (1) after said installation is completed and optically verifying that it is closed (S2013),
- The main PLC (8) warns the station management on the empty battery storage (6b) by the rack occupancy alarm (S2014),
- The main PLC (8) warns the station management on the full battery storage (6a) by the rack occupancy alarm (S2015).

2. The process step concerning "Completing the installation of the full battery (3a) to the vehicle (1) and manually closing the universal bonnet of the vehicle (1) after said installation is completed and optically verifying that it is closed (S2013)" mentioned in clam 1, characterized in that; it comprises following subprocess steps,

- Reading the identification label of the charged (full) battery (3a) to be installed,
- Taking the battery identified from the shelf,
- Conveying the vehicle (1) to relevant section through the conveyor system and positioning it according to the reference points,
- Inserting the full battery (3a) into the vehicle,
- Closing the respective cap after the insertion process and verification of the closing process.

3. A swap station for switching the power batteries (batteries) of electric vehicles characterized in that; it comprises,

- Identification and battery handling unit (2), which performs the vehicle (1) acceptance, vehicle (1) identification, bonnet(cap) opening and battery identification operations,
- The transport and control unit (4) sending continue process command for a certain station, which is detected by the main PLC (8) and once vehicle (1) acceptance, vehicle (1) identification and bonnet opening procedures are approved,
- Full battery conveyor belt (5a) carrying the full battery (3a) from the full battery storage (6a) to the vehicle (1),
- Empty battery conveyor belt (5b) carrying the empty battery (3b) from the empty battery storage (6b) to the vehicle (1),
- Full battery storage (6a), where full batteries (3a) are stored,
- Empty battery storage (6b), where empty batteries (3b) are stored for charging,
- Electrical panel (7), which ensures the controlled and safe operation of the electrical installation,
- Main PLC (8) ensuring controlling of all operations,
- Battery replacement automation unit (9), which provides disassembly and movement operations,
- Transmission line unit (10) in which transport of empty batteries (3b) removed from the vehicle (1) and full batteries (3a) to be installed in the vehicle (1) is carried out.
- the battery replacement belt and the automation unit (11), located within the transport and control unit (4),
- the battery charge controller (12) which controls the charge status of the batteries.

4. A battery swap station mentioned in claim 2, characterized in that; it comprises,

- The solar panel unit (14) comprising at least one solar panel (13) and said solar panels (13) providing the energy required for the system,
- The charge distribution unit (15), which provides the energy obtained from the solar panel unit (14) to be transferred to the battery swap station in a regular and controlled manner,
- The solar panel battery (16) in which the energy generated by the solar panels (13) is stored and the solar panel battery unit (17) accommodating said solar panels (13).

5. A battery swap station mentioned in claim 2, characterized in that; it comprises, a compensation unit that ensures efficient and controlled use of electrical energy from the grid and / or from the solar panel battery unit (17).

6. A battery swap station mentioned in claim 2, characterized in that; it comprises, RFID, optical, OGS and / or HGS recognition systems which enable keeping administratively, legally, financially and technically necessary records.

7. A battery swap station mentioned in claim 2, characterized in that; it comprises, an optical and/or position sensor, which must be positioned precisely on the battery in order to carry out the identification process in a proper way.

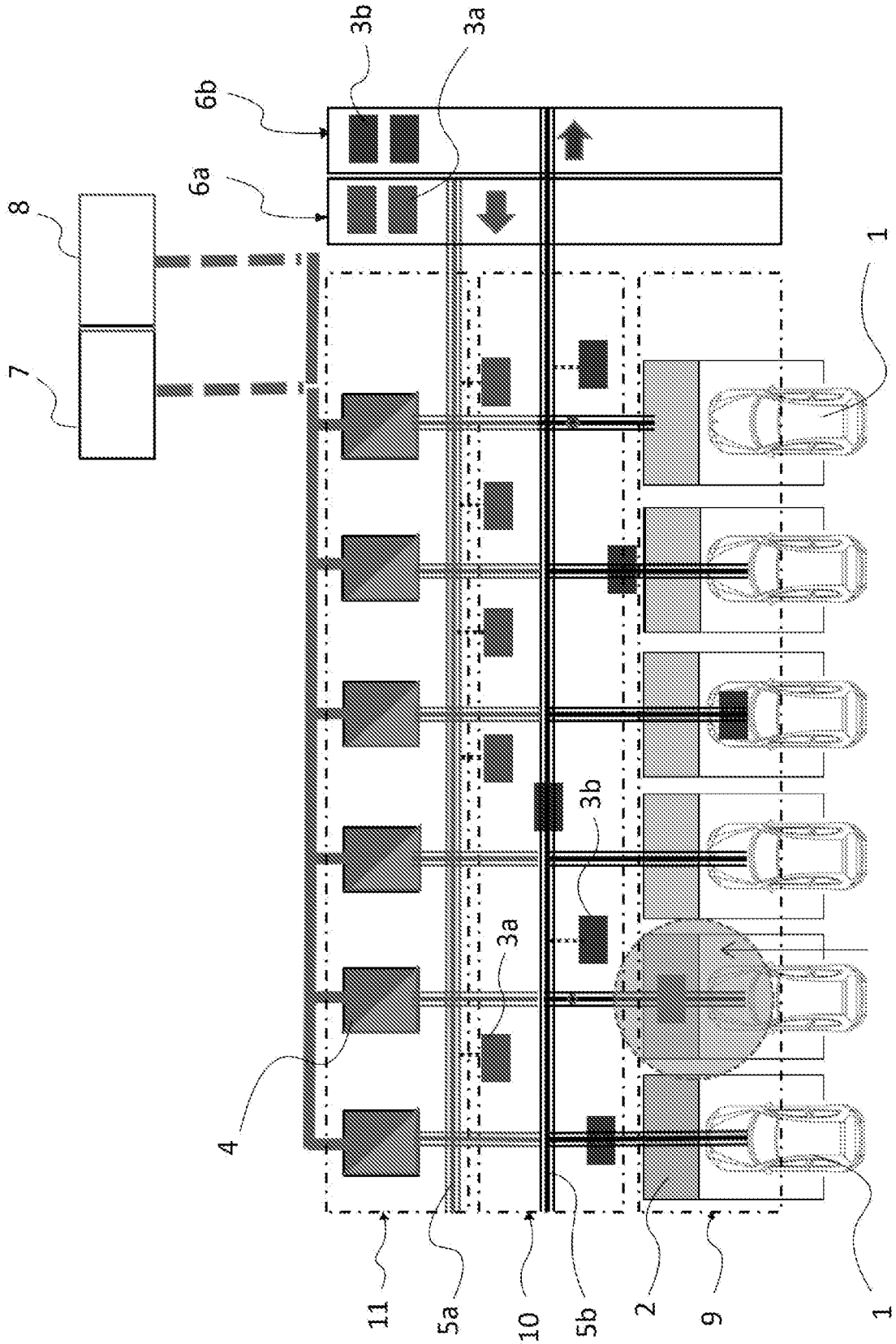


Figure-1

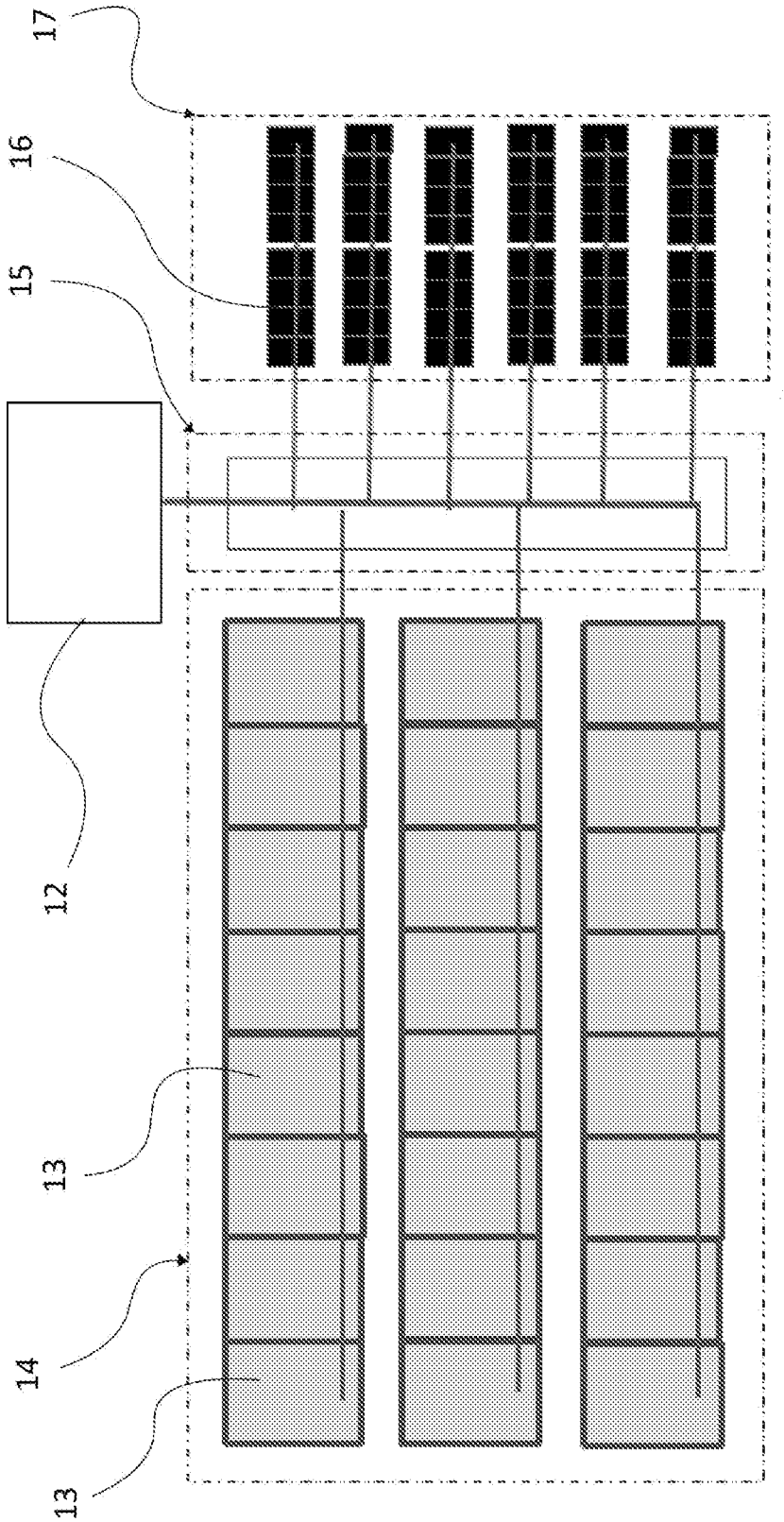


Figure-2

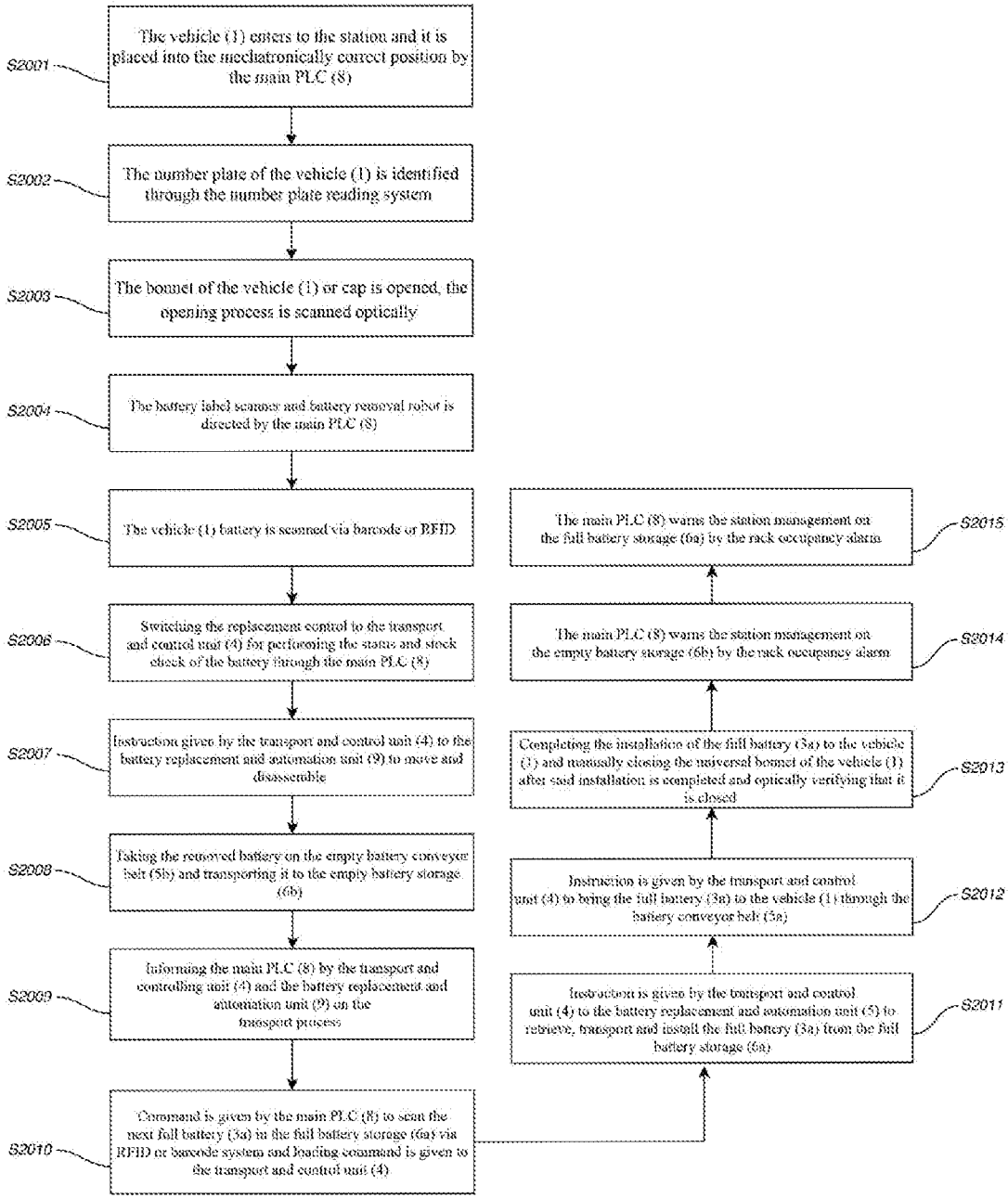

S2001
The vehicle (1) enters to the station and it is placed into the mechatronically correct position by the main PLC (8)
S2002
The number plate of the vehicle (1) is identified through the number plate reading system
S2003
The bonnet of the vehicle (1) or cap is opened, the opening process is scanned optically
S2004
The battery label scanner and battery removal robot is directed by the main PLC (8)
S2005
The vehicle (1) battery is scanned via barcode or RFID
S2006
Switching the replacement control to the transport and control unit (4) for performing the status and stock check of the battery through the main PLC (8)
S2007
Instruction given by the transport and control unit (4) to the battery replacement and automation unit (9) to move and disassemble
S2008
Taking the removed battery on the empty battery conveyor belt (5b) and transporting it to the empty battery storage (6b)
S2009
Informing the main PLC (8) by the transport and controlling unit (4) and the battery replacement and automation unit (9) on the transport process
S2010
Command is given by the main PLC (8) to scan the next full battery (3a) in the full battery storage (6a) via RFID or barcode system and loading command is given to the transport and control unit (4)
S2011
Instruction is given by the transport and control unit (4) to the battery replacement and automation unit (5) to retrieve, transport and install the full battery (3a) from the full battery storage (6a)
S2012
Instruction is given by the transport and control unit (4) to bring the full battery (3a) to the vehicle (1) through the battery conveyor belt (5a)
S2013
Completing the installation of the full battery (3a) to the vehicle (1) and manually closing the universal bonnet of the vehicle (1) after said installation is completed and optically verifying that it is closed
S2014
The main PLC (8) warns the station management on the empty battery storage (6b) by the rack occupancy alarm
S2015
The main PLC (8) warns the station management on the full battery storage (6a) by the rack occupancy alarm

Figure-3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/TR2019/050975

A. CLASSIFICATION OF SUBJECT MATTER

B60L 53/80 (2019.01)i; B60K 1/04 (2019.01)i; B60L 50/60 (2019.01)i

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)

B60L; B60K

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

TURKPATENT DATABASE

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

EPODOC, WPI, EPO FULLTEXT DATABASE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2010033883 A1 (BETTER PLACE GMBH [US]) 25 March 2010 (2010-03-25) Abstract, Paragraph 0014,0107,0111	1-7
Y	US 5711648 A (UNLIMITED RANGE ELECTRIC CARS [US]) 27 January 1998 (1998-01-27) Abstract, Column 5	1-7
A	WO 2009092343 A1 (FISCHER INA [DE]) 30 July 2009 (2009-07-30) Abstract	1

☐ 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	Date of mailing of the international search report
23 June 2020	**23 June 2020**

Name and mailing address of the ISA/TR
Turkish Patent and Trademark Office (Turkpatent)
Hipodrom Caddesi No. 13
06560 Yenimahalle
Ankara
Turkey
Telephone No. **(90-312) 303 11 82**
Facsimile No. **+903123031220**

Authorized officer
Fikri HANGÜL
Telephone No. **+903123031639**