Title: VEHICLE BATTERY SERVICE SYSTEM FOR AN ELECTRIC VEHICLE

Abstract: The present disclosure provides a vehicle battery service assembly operable in replacement, storage and charging of vehicle batteries, comprising a plurality of functional modules, at least some of said functional modules being constructed from pre-assembled units a priori contained within separate shipping containers and engageable to one another to form said assembly.
VEHICLE BATTERY SERVICE SYSTEM FOR AN ELECTRIC VEHICLE

FIELD AND BACKGROUND

This invention relates to an electric vehicle service system for electric vehicles including a battery switch station that can function in the replacement, storage and charging of vehicle batteries.

Electric vehicle service stations including battery switch stations for switching batteries of electric (i.e. at least partially electric) vehicles, for example as disclosed in WO 2010/033883 assigned to the assignee of the present application, stand as a promising equipment to enable large scale development of electrically powered vehicles.

GENERAL DESCRIPTION

In order to ensure proper service to electrical vehicles, large scale deployment of battery service stations is required which creates significant logistical challenges. Indeed, building a battery service station requires integration of a large number of complex mechanical and electrical systems. The term "electric vehicles" used herein refers to vehicles that derive at least a major portion of its energy during transport from batteries, including "entirely electric" or "hybrid" vehicles.

The present invention is based on realization that a battery service station can efficiently and cost-effectively be constructed from modules that are pre-assembled at the site of manufacture, each in a separate transport container; and then brought in this manner to the construction site of a battery service station and engage together on-site in a functional manner, to permit the modules to perform their functions within the station's operation in the replacement, storage, charging of batteries of electric vehicles.

The invention provides by one of its aspects a vehicle battery service assembly operable in replacement, storage and charging of vehicle batteries, comprising a plurality of functional modules, at least some of said functional modules being
constructed from pre-assembled units a priori contained within separate shipping containers and engageable to one another to form said assembly. The containers may be custom made containers which are used for shipping.

The invention also provides, by another of its aspects, a vehicle battery service station, comprising functional modules, each of the modules being linked to other modules of the station in a functional manner for their function in the replacement, storage and charging of vehicle batteries, being characterized in that the functional modules are being pre-assembled within shipping containers of at least one standard size. The containers may be custom made containers which are used for shipping.

Further provided by the invention is a process for assembling a vehicle battery service station operable in replacement, storage and charging of vehicle batteries, comprising providing shipping containers containing pre-assembled functional modules of said station; and placing them in a pre-determined arrangement and linking the modules with other modules of the station in a functional manner for their function in the replacement, storage and charging of vehicle batteries.

The invention also provides a process for assembling a vehicle battery service station comprising functional modules, each of the modules being linked to other modules of the station in a functional manner for their function in the replacement, storage and charging of vehicle batteries, the process being characterized in that the functional modules are being pre-assembled within shipping containers of at least one standard size.

Provided by the invention are also modules of a battery service station pre-assembled within containers of at least one standard size, for their assembly at a site of station construction being linked to one another in a functional manner for their function in the replacement, storage and charging of vehicle batteries.

By one embodiment of the invention, portions of one or more of said containers constitute at least part of the assembly or the station support structure. By another embodiment, all of said containers constitute at least part of the walls of the assembly or station, which may be external side walls, bottom, top as well as internal walls.

Shipping containers have standardized sizes, conventionally used in international shipping. The two most common sizes used in land and sea transport are so called (i) 20 footers; and (ii) 40 footers; the former container having a volume of 33.2 m³; and the latter of 67.6 m³.
The modules, in accordance with the invention, may be pre-assembled and contained within shipping containers of standardized sizes, or some may be contained in shipping containers of one standardized size and others in shipping containers of another standardized size. In some cases, custom made shipping containers complying with the standard size of a standard shipping container may be used. In this way, the modules can be effectively pre-assembled at the site of manufacture, shipped as a sealed container to the site of assembly and relatively easily and effectively assembled together to form said assembly or station. As will be appreciated, such functional modules may be prepared already with pre-fitted engagement elements or connecting elements for engaging or connecting, respectively, to respective elements of adjacent modules. The containers may also serve as the structural elements of the station. For example, one or more wall of a container or the roof of a container may act as station walls and roof.

Building a BSS, like any other multi-discipline machine, requires quite a bit of integration time. The integration process can only be completed after assembly process was completed. In traditional BSS, assembly of the BSS is done in the field, thus requiring considerable amount of skilled workers' time to assemble and integrate the system in environmental conditions which may impose delays. The pre-assembled BSS, is assembled in the production facilities and may be integrated and tested by skilled team of workers which do the work in the assembly plant, having the benefit of immunity to environmental effects or lack of suitable testing equipment. After assembly, integration and testing are completed in the assembly plant, the BSS may be separated to small number of pre-assembled modules. The process of deploying the BSS in the field is very short and simple since it may only involve joining back few pre-assembled modules. In this way, many BSS can be deployed in the field in short time without large number of skilled workers. The preassembled BSS does not require additional structures to be built in the field, since the structure is contained within the pre-assembled module.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:
Fig. 1 is a flow diagram illustrating steps of a process for assembling a vehicle battery service station including a battery switch station according to an embodiment of the invention.

Fig. 2 illustrates a perspective view of some elements of a vehicle battery service station including a battery switch station according to an embodiment of the present invention.

Fig. 3 illustrates elements of a modular battery exchange unit of a vehicle battery service station according to an embodiment of the invention.

Fig. 4 illustrates elements of a modular control unit of a vehicle battery service station according to an embodiment of the invention.

Fig. 5 illustrates elements of a battery transport unit of a vehicle battery service station according to an embodiment of the invention.

Fig. 6 illustrates elements of a battery storage unit and of an air conditioned unit of a vehicle battery service station according to an embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

It is noted that the term "upper wall", "bottom wall", "lateral wall" are used herein for designating certain surfaces of a container with reference to a standard position of the container and/or with reference to a system contained in the container, the system being held in an appropriate position in view of its assembly and use in the vehicle battery service station.

Further, a container comprises generally a frame structure supporting four lateral walls, a bottom wall and an upper wall. A portion of a shipping container may therefore be any combination of a portion of the frame structure and a portion of one or more walls. As a definition, containers may be generally described as standardized re-sealable transportation box for unitized freight handling with standardized equipment. It is recalled that two most common sizes are used in ground and sea (surface) transportation: (1) Twenty-footer also called 20-foot container which have a typical capacity of 33.2 cubic meter or 1172 cubic feet and a maximum payload of 28180 kilogram or 62130 pounds and (2) Forty-footer also called 40-foot container which have a typical capacity of 67.7 cubic meter or 2392 cubic feet and a maximum payload of 28750 kilogram or 63380 pounds. The typical dimensions of a 20-foot container are:
internal length 5.90 meter (19 feet 4 inches), internal width 2.35 meter (7 feet 9 inches), internal height 2.40 meter (7 feet 10 inches). The typical dimensions of a 40-foot container are: internal length 12.03 meter (39 feet 6 inches), internal width 2.35 meter (7 feet 9 inches), internal height 2.4 meter (7 feet 10 inches). There are other types of standard containers like open-roof containers which do not include a roof (ceiling) and tall containers which have a standard length and width but are higher than standard 20-footers or 40-footers.

The term assembly may be used in the following to refer to the vehicle battery service station as a kit of modular units as opposed to the vehicle battery service station as a finished product, i.e. after the modular units have been engaged/assembled together to form the station.

Traditionally, the installation of the plurality of elements of a vehicle service station is performed at an installation site. The installation site comprises an infrastructure (walls, ceiling, etc.) intended to receive the plurality of elements of the vehicle service station in an appropriate configuration. The calibration of the elements with respect to one another can therefore only be achieved on the installation site, when the infrastructure is finalized. Indeed, the positioning of the elements depends on the infrastructure of the station since certain elements may be attached to the infrastructure (ceiling, floor...) and some elements may require a precise relative positioning.

It should be understood that in order to service at least partially electric vehicles there should be a large number of vehicle battery service stations along the roads, at least because the typical battery has a limited charge level resulting in too limited maximal distance the vehicle can drive with such battery. Accordingly, deployment of vehicle battery service stations requires accurate and fast procedure. In order to improve the building of vehicle battery service stations for servicing at least partially electric vehicles, the present disclosure generally proposes a vehicle battery service assembly comprising a plurality of modular units engageable to one another to form a vehicle battery service station, wherein at least one modular unit comprises a supporting structure (that may include for example an exterior structure of the BSS such as exterior walls) formed by (or comprising) at least a portion of a shipping container thereby enabling said modular unit to be preassembled (and/or integrated) within the shipping container. This enables to preassemble and integrate said at least one modular unit at the fabrication site so as to be "ready-to-be-engaged". This further enables to limit the
amount of waste in building a vehicle battery service station. The portion of the shipping container forming the structure may collaborate with one or more elements of the modular unit. For example, elements of the modular unit may be attached to the supporting structure. Further, the portion of the shipping container may comprise one or more walls of the shipping container or a frame of the shipping container. The term "pre-assembled" may refer to the feature that the modular unit may be composed of a plurality of elements which are preliminary mounted (assembled) together and/or to the supporting structure formed by said portion of the container. Since the setting (assembly) of the elements relatively to each other and to the structure is preliminary performed, for example on the manufacturing site, only the setting (assembly) of the plurality of the modular units relatively to one another may still be performed on an installation site where the vehicle battery service station is to be installed. The vehicle battery service assembly may advantageously comprise several such modular units preassembled in separate shipping containers. Preferably, all the modular units may be configured for fitting into one type or different types of shipping containers. For example, the type of shipping container into which a modular unit may fit is a 20-foot a 40-foot, an open-roof or a tall container type. Modular unit may also be configured to fit custom made containers complying with standard definition of shipping containers. This way, all the modular units may be transported easily. The present disclosure also concurrently provides a vehicle battery service station comprising a plurality of modular units engaged to one another to form the vehicle battery service station, wherein at least one modular unit comprises a supporting structure (for example exterior walls) formed by (or comprising) at least a portion of a shipping container thereby enabling said modular unit to be preassembled within the shipping container. The present disclosure also provides a modular unit of a vehicle battery service station comprising a supporting structure (for example exterior walls) formed by (or comprising) at least a portion of a shipping container thereby enabling said modular unit to be preassembled within the shipping container.

As explained, a vehicle battery service station/assembly may comprise a plurality of modular units. The modular units may be arranged as functional modules of the vehicle battery service station. For example, a vehicle battery service station may comprise a lane module (functional module for battery replacing) comprising a conveyer unit and a battery exchange unit; a storage module (functional module for
storing batteries) comprising a storage unit, an air conditioned unit, a battery transport
unit and one or more frame units; and a control module (functional module for
monitoring the vehicle battery service station) comprising a control unit. As explained,
a set of modular units intended to be arranged so as to form a vehicle battery service
station forms a kind of kit and may be referred to as a vehicle battery service assembly.

Fig. 1 is a flow diagram generally illustrating a process of assembling a vehicle
battery service station including a battery switch station according to an embodiment of
the present invention. In a first step S101, the process for assembling a vehicle battery
service station operable in replacement, storage and charging of vehicle batteries
includes providing shipping containers containing modular units of the vehicle battery
service station. Some modular units may comprise a supporting structure formed by a
portion of the shipping container containing said modular unit, i.e. some modular units
are preassembled within a shipping container. In some embodiments, the elements of a
modular unit are selected to be put in the same container (being pre-assembled or not) in
accordance with their functions and position in the station. In other words, these are
elements which are to be assembled and/or put adjacent to one another when in the
operation state of the station.

In a second step S102, the process may include placing the shipping containers
covering to said preassembled modular units in a predetermined arrangement.
Further, in a third step S103, the process may comprise linking the modular units in a
functional manner so as to form the vehicle battery service station. The linking may
comprise engaging portions of shipping containers containing preassembled modular
units to one another so as to form a global station supporting structure. The linking may
also include retaining walls of at least some of the shipping containers containing
modular units as external walls of the station. The linking may comprise connecting the
modular units (i.e. the support structures/shipping containers and/or the internal
machinery) by using a pre-arranged set of connectors and cables. It is noted that the
process may preliminary include a step of connecting, testing and calibrating all the
modular units at the factory site and a step disconnecting the units before shipping the
units into shipping containers so to provide them at the installation site. The connections
between modular units may be based on mechanical and electrical connections. The
mechanical connections includes alignment pins and bolt fasteners that align and
connect the modules. Electrical connections are standard high voltage (HV) and low
voltage (LV) electrical connectors which are joined when the BSS is deployed. This may further reduce the required on site installation time. Further, the process may also include a step of installing decorative covers on top of the modular units supports structures. This may enable to customize the look of the vehicle battery service station. Further the modular design may allow the operator of the BSS to configure the BSS in several different ways; for example with one or two small storage containers or one or two large storage containers. This allows the operator to customize (tailor made) the BSS to a specific installation site according to site size limitation and traffic volume expectations.

**Fig. 2** is a perspective view of a vehicle battery service station 100 comprising a first functional module for battery replacing, a second functional module for battery storing and a third functional module for monitoring the operation of the station 100.

The first functional module for battery replacing may comprise a lane unit 11 and a battery switch unit 13 (the support structure of the battery switch unit 13 is shown on **Fig. 2**, some other battery switch elements of the battery switch unit 13 are shown on **Fig. 3**). The lane unit 11 may be configured to fit in a 40-foot container and may be configured to be assembled at the top of the battery switch unit 13. The lane container may be an underground container comprising all structural elements to handle both shipping and installation in the site. The lane container structure may remain in the BSS. The lane unit 11 is configured and operable to position a vehicle in an appropriate position with respect to a certain sub-station (e.g. battery replacement) and possibly also move vehicle through different sub-stations (e.g. cleaning station, waiting area, battery replacement station, etc.).

The battery switch unit 13 may comprise a battery switch structure 131 and battery switch elements mounted to the battery switch structure 131. The battery switch structure 131 may be made of the frame and the bottom wall of a shipping container. The battery switch unit 13 may be preassembled within said shipping container which can be, for example, a 20-foot container. As can be seen on **Fig. 3**, the battery switch elements may comprise a lifter 132, a hydraulic system 133 and mechanical and electrical tools 134. The lifter may hold a dedicated battery switch tool that is capable of making contact with the battery and can remove or insert the battery into an electric vehicle positioned over the lifter 132. It is to be noted that different vehicle/battery types may require different tools for their removal and insertion to the vehicle or a
single flexible tool may also serve all vehicles. Further, the lifter 132 may move along a
single track between four distinct positions. One position may be used for temporarily
storage of a battery after removal from the vehicle, another position may be used for
picking the new battery from a robotic transport system (described hereinafter), a third
position may be a battery exchange position below the vehicle and the fourth position
may be next to a tool location area where different tools are provided for replacing
specific battery types. The elements of the battery switch unit 13 may be calibrated
(preassembled) with respect to each other and/or appropriately attached to the structure
131 at the fabrication site. Indeed, the respective position of the elements of the battery
switch unit with regard to the battery switch structure 131 can be set within the shipping
container. At the installation site, the battery switch unit 13 may be placed underground,
for example in an excavation adapted to receive the battery switch structure 131.

The second module for battery storing (battery storage and charging module)
may comprise a storage unit 21, an air conditioned unit 22, a battery transport unit 23
(the support structure of the battery transport unit 23 is shown on Fig. 2, some other
elements of the battery transport unit are shown on Fig. 5), a first frame unit 24 and a
second frame unit 25.

The storage unit 21 may comprise a storage structure 211 made of portions of a
shipping container and a battery storage facility 212 mounted to the storage structure
211. As can be seen on Fig. 6, the battery storage facility 212 may be designed to have
different storage shelves 214 arranged to support a plurality of battery types 210 to
match different serviced EV types. The shelves 214 may form racks adapted to receive
the batteries of different types/sizes. In some embodiments, all racks (or generally at
least some of them) are configured to charge the batteries. A switching board may route
charging power to the racks which contain batteries that need to be charged. In some
embodiments, the batteries are shuffled between the rack configured to charge and the
racks configured to store the batteries. Each rack may be equipped with mechanical and
electrical interfaces that are specific to the particular type of battery that the rack
supports. For example, a rack may include a battery locating feature 215, a battery
presence sensor, a frame location hole, and a connector actuator arm 218. The storage
bin (rack) may be configured for a specific type of battery, but can be replaced with a
bin configured for a second type of battery. The storage bin includes mechanical,
electrical and thermal interfaces with the battery. Those interfaces are used to support,
charge and cool the battery. The battery locating feature may facilitate the positioning of a battery 210 in a specific location. Once the battery presence sensor senses that a battery 210 is in place, the connector actuator arm 218 may connect with the battery 210 and may start charging. In some embodiments, the connector actuator arm 218 may connect to the battery 210 at an electrical connection interface on the battery 210 which is also used to connect electrically the battery to the vehicle when in use. The elements of the storage unit 21 may be calibrated (preassembled) with respect to each other and/or appropriately mounted to the storage structure 211 at the fabrication. Indeed, the respective position of the elements of the battery storage facility 212 with regard to the storage structure 211 can be set within the shipping container. The container used for the storage structure 211 and for transporting the storage unit may be for example a 20-foot or a 40-foot container.

As can be seen on Fig. 5, the battery transport unit 23 may comprise a battery transport structure 231 and a robotic transport system 232 mounted to the battery transport structure 231. The battery transport structure 231 may be formed of portions of a shipping container such as a bottom wall and at least parts of the frame. The robotic transport system 232 may comprise a rail system 233 to enable a robot 234 to move through the battery transport structure 231. The battery transport unit 23 may be positioned so as to allow the robot 234 to collaborate with both the lifter 132 of the battery switch unit 13 and the storage shelves 214 of the battery storage facility 212. For example, the battery transport unit 23 may be positioned underground. The robot 234 may have a translation platform 235 and a main body 236. The robot 234 may have three axis of translation, which corresponds to three degrees of freedom. The robot 234 may travel along the rail system 233. In some embodiments the translation platform 235 may be slidable in a direction perpendicular to the direction of the rail. The translation platform 235 may also be mounted rotatable around an axis perpendicular to the bottom wall of the battery transport structure 231. This enables the translation platform to slide under a battery and to displace the battery from one location to another. The translation platform 235 can also travel vertically with respect to the bottom wall of the battery transport structure 231 by means of the central vertical rail 237 as shown. The ladder is part of an automatic storage and retrieval system (ASRS) which is an automatic forklift. The ladder may be attached to vertical guide rails of the ASRS for transportation purposes. The elements of the battery transport unit 23 may be calibrated
(preassembled) with respect to each other and/or appropriately mounted to the battery transport structure 231 at the fabrication. Indeed, the respective position of the elements of the robotic transport system 232 with regard to the battery transport structure 231 can be set within the shipping container. The container used for the battery transport structure 231 (and for transporting the battery transport unit 23) is of the same type as the container used for the storage structure 21.

The air conditioner unit 22 may comprise an air conditioner structure 221 and an air conditioner system 222. The air conditioner system 222 may be mounted to the air conditioner structure 221. The air conditioner structure 221 may be formed of portions of a shipping container such as a upper wall, at least parts of the frame and possibly some lateral walls. The air conditioner structure 222 may be linked to a top part of the storage structure 211 so as to form a single exterior cover structure for both the air conditioner system 222 and the battery storage facility 212. For example, an upper wall of the container containing the storage unit 21 and a bottom wall of the container containing the air conditioner unit 22 may be dismantled and the resulting container structures may be joined so as to form said rigid cover. The container used for the air conditioner structure 221 may be a flat 10-foot container. Such 10-foot container may be 10 feet long and with a height and width identical to the standard 20 and 40 feet containers.

A first frame unit 24 and second frame unit 25 may additionally be provided in order to provide an exterior cover structure for the battery transport unit 23. The first and second frame units 24, 25 may comprise first and second frame structures 241, 251 each made of portions of a shipping container. The first frame structure 241 may be formed of the lateral walls of a 20-foot container and the second frame structure 251 may be formed of an upper wall and lateral walls of flat 10-foot container. The battery transport structure 231, the first frame structure 241 and the second frame structure 251 may be linked so as to form a rigid cover for the robotic transport system 232.

The third module for monitoring the operation of the vehicle battery service station 100 may comprise a control unit 31. The control unit 31 may comprise a control structure 311 and a control system 312. The control structure 311 may be formed of portions of a shipping container. As can be seen on Fig. 4, the control system 312 may include vehicle sensor to detect what kind of electric vehicle/battery is to be serviced and data communication rack 316 to communicate with the robotic transport system 232.
so as to retrieve from the battery storage facility 212 a battery that matches the electric vehicle type. The data communication rack 316 may also communicate with the battery switch elements in order to adapt the battery switch elements to the type of electric vehicle/battery to be serviced. The control system 312 may also include a smoke exhaust controller 313, a fire alarm controller 314, an electrical box 315 and other control and connection equipments, for example a main electrical board 317.

The above examples and description have of course been provided only for the purpose of illustration, and are not intended to limit the invention in any way. As will be appreciated by the skilled person, the invention can be carried out in a great variety of ways, employing more than one technique from those described above, all without exceeding the scope of the invention.
CLAIMS:
1. A vehicle battery service assembly operable in replacement, storage and charging of vehicle batteries, comprising a plurality of functional modules, at least some of said functional modules being constructed from pre-assembled units a priori contained within separate shipping containers and engageable to one another to form said assembly.
2. The assembly of claim 1, wherein portions of one or more of said containers are at least a part of the assembly's support structure.
3. The assembly of claim 1, wherein walls of one or more of said containers are at least a part of the assembly's walls.
4. The assembly of claim 1, wherein the shipping containers are all of one standard size.
5. The assembly of claim 1, wherein the shipping containers comprise containers of different standard sizes.
6. The assembly of claim 1, wherein said functional modules comprise one or more of the following: battery storage and charging module, battery switch module with a robotic transport system, vehicle interfacing module, electric power module, control module.
7. A vehicle battery service station, comprising functional modules, each of the modules being linked to other modules of the station in functional manner for their function in the replacement, storage and charging of vehicle batteries, being characterized in that the functional modules are being pre-assembled within shipping containers of at least one standard size.
8. The station of claim 7, wherein at least some of the shipping containers are engaged with one another to form at least a part of the station's support structure.
9. The station of claim 7, wherein at least some of the walls of the containers are arranged to form walls of the station.
10. A process for assembling a vehicle battery service station operable in replacement, storage and charging of vehicle batteries, comprising providing shipping containers containing pre-assembled functional modules of said station; and
placing them in a pre-determined arrangement and linking the modules with other modules of the station in functional manner for their function in the replacement, storage and charging of vehicle batteries.

11. The process of claim 10, comprising engaging portions of adjacent containers to one another to form a station support structure.

12. The process of claim 10, comprising retaining walls of at least some of said containers as external walls of the station.

13. The process of claim 10, wherein the shipping containers are all of one standard size.

14. The process of claim 10, wherein the shipping containers comprise containers of different standard sizes.

15. The process of claim 10, wherein said functional modules comprise one or more of the following: battery storage and charging module, battery replacement module with a robotic transport system, vehicle interfacing module, electric power module, control module.

16. A process for assembling a vehicle battery service station comprising functional modules, each of the modules being linked to other modules of the station in functional manner for their function in the replacement, storage and charging of vehicle batteries, the process being characterized in that the functional modules are being pre-assembled within shipping containers of at least one standard size.

17. Modules of a battery service station pre-assembled within containers of at least one standard size, for their assembly at a site of station construction being linked to one another in a functional manner for their function in the replacement, storage and charging of vehicle batteries.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

*IPC(8) - B65G 67/00 (2013.01)*  
*USPC - 320/1 09*

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(8) - B60K 1/00; B60L 1/00; B60S 5/00; 5/06; B65G 1/04, 67/00 (2013.01)*  
*USPC - 174/541; 180/63.1, 68.5; 307/9.1; 320/109*

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

*CPC - B01L 2200/028; B60L 11/1822, 11/1827 (2013.01)*

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

Google Patents, Google Scholar, Patbase

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US 201 1/0209132 A1 (KILIBARDA et al) 01 September 2011 (01.09.2011) entire document</td>
<td>1-17</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.

**Date of the actual completion of the international search**

01 July 2013

**Date of mailing of the international search report**

10 JUL 2013

**Name and mailing address of the ISA/US**

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents  
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

**Authorized officer:**

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)