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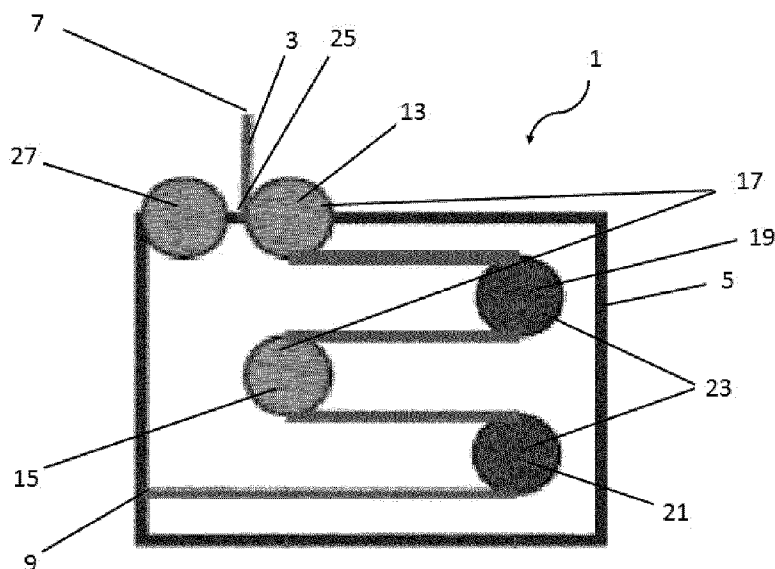


Fig. 2

(57) Abstract: Embodiments of the present invention provide a vehicle charging cable storage assembly configured to receive a vehicle charging cable. The vehicle charging cable storage assembly comprises a first guide and a second guide. A route of the vehicle charging cable is at least partially positionally constrained by the first and second guides. At least one of the first and second guides is a relocatable guide which is relocatable with respect to the other of the first and second guides to thereby, in use, retract at least a portion of the vehicle charging cable.



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CHARGING CABLE STORAGE ASSEMBLY

TECHNICAL FIELD

- 5 The present disclosure relates to a charging cable storage assembly and particularly, but not exclusively, to a vehicle charging cable storage assembly. Aspects of the invention relate to a vehicle charging cable storage assembly and a vehicle.

BACKGROUND

10

For simplicity, the following background is provided in the context of cable storage on board a battery electric car. This is not however intended to be limiting and it will be appreciated that the disclosures herein may equally be applied to other cable storage applications, for example cable storage provided on board other vehicles (e.g. caravans, boats and aircraft), on an
15 installation or structure e.g. a building or charging point or to portable cable stores not necessarily associated with a vehicle and/or installation/structure.

It may be beneficial to provide a storage means for a charging cable on board a battery electric car. This may mean that a charging cable can be available wherever the car is located and
20 that therefore the car can be charged at any suitable charging point, whether or not a charging cable is present. It may also mean that a cable that is particularly suited to the charging of the relevant car can be specifically provided.

Existing storage solutions for such cables are known that take the form of a simple bag and/or
25 a designated storage bay or cubby location for the cable. In such examples, the user tends to have to bundle the cable, which may be inconvenient and lead to transfer of dirt from the cable (which may well have dragged on the floor) to the user and/or his/her clothing. The bundling, especially if rushed, may also tend to lead to twisting or knotting of the cable. With a view to solving these difficulties, some cars employ a cable stored via means of a cable reel mounted
30 to the car. A cable reel tends however to be relatively bulky (often having not only significant length and width, but also depth). This may limit the locations that the reel can be mounted on or within the car. Accordingly, specific design adaptations to the car may be required and/or space that is conventionally used for other purposes (e.g. boot space) may be compromised. Additionally, disorganised winding of the cable onto the reel may result in twisting of the cable
35 and even jamming of the reel mechanism. Furthermore, the winding of the charging cable into a coil about the reel may mean that if some charging cable remains wound about the reel, during charging, the cable will produce a magnetic field and generate heat as current passes

through it. The generated heat may reduce the efficiency of the energy transfer through the charging cable and the heat may damage other materials/components in the vehicle and/or give rise to discomfort.

- 5 It is an object of embodiments of the invention to at least mitigate one or more of the problems of the prior art.

SUMMARY OF THE INVENTION

- 10 Aspects and embodiments of the invention provide a vehicle charging cable storage assembly, and a vehicle as claimed in the appended claims.

According to an aspect of the invention there is provided a charging cable storage assembly configured to receive a charging cable, the charging cable storage assembly comprising a first
15 guide and a second guide wherein a route of the charging cable is at least partially positionally constrained by the first and second guides and where further at least one of the first and second guides is a relocatable guide which is relocatable with respect to the other of the first and second guides to thereby, in use, retract at least a portion of the charging cable when provided, to be thereby stored by the vehicle charging cable storage assembly.

20

According to another aspect of the invention there is provided a vehicle charging cable storage assembly configured to receive a vehicle charging cable, the vehicle charging cable storage assembly comprising a first guide and a second guide wherein a route for the vehicle charging cable is at least partially positionally constrained by the first and second guides and where
25 further at least one of the first and second guides is a relocatable guide which is relocatable with respect to the other of the first and second guides to thereby, in use, retract at least a portion of the vehicle charging cable when provided, to be thereby stored by the vehicle charging cable storage assembly. At least one of the first and second guides may be moveable from a first configuration to a second configuration such that, when the vehicle cable is
30 provided, a greater length of vehicle charging cable is retained between the first and second guides in the second configuration than in the first configuration. In particular it may be that at least a portion (and optionally the majority) of the relocation of the relocatable guide is away from the other of the first and second guides to thereby, in use, retract at least a portion of the vehicle charging cable when provided.

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The arrangement may provide a distinct packaging arrangement and footprint for a vehicle charging cable in a retracted configuration, which may assist with storing the vehicle charging

cable storage assembly in particular locations (e.g. within or on a vehicle). In particular, it may be that by storing a run or length of vehicle charging cable between the first and second guides, the distance between the first and second guides can be used to take up the vehicle charging cable, rather than the circumference about a reel for instance. The arrangement may
5 lend itself to a narrower storage assembly (e.g. having a greater ratio of width and/or height to depth) by comparison with a reel type arrangement. The arrangement also has the potential to store a vehicle charging cable in a manner that is not prone to give rise to twisting or knotting, which may be more likely where a cable is stored relatively loosely e.g. loosely in a bag or storage zone. The arrangement may also give rise to a reduction or elimination in
10 coiling of the vehicle charging cable (e.g. by comparison with a reel-based system). Therefore, the charging cable storage assembly may reduce heat generation as a result of magnetic fields.

In some embodiments, the relocatable guide is selectively relocatable towards the other of the
15 first and second guides to thereby, in use, permit dispensing of at least a portion of the vehicle charging cable. This may mean that it is possible to dispense or extract the vehicle charging cable following retraction (e.g. for re-use of the vehicle charging cable).

In some embodiments, the relocation of the relocatable guide comprises a linear movement.
20 This may give rise to more rapid retraction of the vehicle charging cable, for example for a given rate of repositioning of the relocatable guide(s).

In some embodiments, the vehicle charging cable storage assembly comprises an actuator arranged to drive the relocation of the relocatable guide with respect to the other of the first
25 and second guides to thereby, in use, retract at least a portion of the vehicle charging cable. The actuator could be manually operated (e.g. taking the form of a handle that is relocatable by a user) or powered (e.g. comprising a motor).

In some embodiments, the actuator is powered to allow, in use, automated retraction of the
30 vehicle charging cable. The actuator may be powered by a portable battery. The portable battery may form part of the vehicle charging cable storage assembly. Additionally, or alternatively the actuator may be powered by an external power source, including at least one of: an electrical, pneumatic and/or hydraulic system of a vehicle or charging station.

In some embodiments, the actuator comprises a motor and a linkage system being coupled
35 to the motor and to the relocatable guide. The linkage system could for instance comprise a rack and pinion mechanism for converting a rotational output from the motor to a linear output suitable for driving relocation of the relocatable guide(s).

In some embodiments, the vehicle charging cable storage assembly comprises an actuator over-stress preventer, arranged to at least partially decouple the actuator from the relocatable guide where the actuator generates a load that is greater than a pre-determined threshold.

5 The decoupling may be achieved by means of a clutch mechanism. Alternatively, the relocatable guide actuator over-stress preventer may discontinue actuator operation (e.g. by switching it off or breaking power delivery thereto) where operating the actuator for cable retraction generates a load on the actuator above a pre-determined threshold.

10 In some embodiments, the actuator is arranged to switch to an idle configuration when, in use, the vehicle charging cable is being dispensed, whereby the actuator is at least partially decoupled from the relocatable guide. This may allow the vehicle charging cable to be manually dispensed (e.g. by pulling on a free end thereof) without needing to overcome an additional load that might be generated if the actuator were to remain coupled to the
15 relocatable guide. The idle configuration may also prevent or substantially reduce damage to the actuator caused by otherwise forcing it to operate in a reverse direction.

In some embodiments, the actuator is arranged to drive the relocation of the relocatable guide towards the other of the first and second guides to thereby, in use, dispense at least a portion
20 of the vehicle charging cable. In this way there may be no need for a user to manually dispense the vehicle charging cable.

In some embodiments, at least one of the first and second guides comprises at least one retaining feature arranged, in use, to prevent decoupling of the vehicle charging cable from
25 the respective guide, for example when the relocatable guide relocates towards the other of the first and second guides. This may prevent the relocatable guide from relocating separately to the vehicle charging cable and/or from relocating without the path of the vehicle charging cable being constrained by the other of the first and second guides, either or both of which could result in a failure to dispense the vehicle charging cable. The retaining feature may limit
30 or prevent displacement of the vehicle charging cable away from the relocatable guide. Nonetheless, the retaining feature may provide sufficient clearance so as not to significantly impede the running of the cable through/past the relocatable guide. The retaining feature may comprise one or more loops, surrounding the vehicle charging cable. Alternatively, the retaining feature may, for example, comprise a hook configured to constrain movement of the
35 cable relative to the guide in a plane of the route and, optionally, transverse to the route. The hook may, for example, be flexible to receive the vehicle charging cable.

In some embodiments, the first guide is a non-relocatable guide. The non-relocatable guide may simply constrain the route of the vehicle charging cable, whilst the relocatable guide provides the required relocation to vary the length of vehicle charging cable that extends therebetween. By relocating only a sub-set of the guides, the remainder need not be relocated, this may be more energy efficient, reduce complexity, improve reliability and decrease manufacturing costs.

In some embodiments, the vehicle charging cable storage assembly comprises one or more additional guides which, in use, at least partially positionally constrain the route of the vehicle charging cable. The additional guides may allow an additional length of vehicle charging cable to be stored and in particular an additional length to be stored for a given footprint, shape and/or size of the vehicle cable storage assembly.

In some embodiments, at least one of the additional guides is also one of the relocatable guides which is relocatable with respect to at least one other of the guides. This may allow for more space efficient storage when the vehicle charging cable is retracted.

In some embodiments, the relocatable guides form a set of relocatable guides and each of the relocatable guides in the set of relocatable guides relocate in substantially the same direction. This may allow for more space efficient storage when the vehicle charging cable is retracted.

In some embodiments, the additional relocatable guide is relocatable with respect to at least one other of the guides to which it is adjacent in terms of the route of the vehicle charging cable.

In some embodiments, each of the relocatable guides in the set of relocatable guides relocate to substantially the same extent. This may allow for more space efficient storage when the vehicle charging cable is retracted.

In some embodiments, at least one of the additional guides is a non-relocatable guide and the multiple non-relocatable guides form a set of non-relocatable guides.

In some embodiments, non-relocatable and relocatable guides alternate along the route that the vehicle charging cable follows in use. This may allow for more space efficient storage when the vehicle charging cable is retracted.

In some embodiments, the guides are arranged to positionally constrain at least part of the route that the vehicle charging cable follows in use so that the vehicle charging cable follows

a meandering path when the vehicle charging cable is in a retracted state. Where the vehicle charging cable follows a tortuous path when retracted, the required footprint for the vehicle charging cable storage assembly may be reduced.

- 5 In some embodiments, the guides are arranged to positionally constrain at least part of the route that the vehicle charging cable follows in use so that the vehicle charging cable follows a concertinaed path when the charging cable is in a retracted state. A concertinaed or corrugated path may be particularly space efficient.
- 10 In some embodiments, when following the concertinaed path, the route that the vehicle charging cable follows includes multiple substantially parallel passes. This may be still more space efficient and may allow for a relatively compact and efficient actuator design to drive the relocatable guides.
- 15 In some embodiments, the vehicle charging cable storage assembly comprises multiple arrays of guides, wherein the guides within any one of the arrays are located in a substantially common plane and guides in different arrays are in different planes. Providing additional arrays of guides (potentially in parallel planes) may further increase the length of vehicle charging cable that can be stored and in particular the length that can be stored for a given
- 20 footprint, shape and/or size of the charging cable storage assembly. The arrays may be arranged in overlapping (i.e. stacked) layers, optionally, in substantially fully overlapping layers. The benefits may be further enhanced where the arrays are arranged in such overlapping layers.
- 25 In some embodiments, the vehicle charging cable storage assembly is arranged to positionally fix one end of the vehicle charging cable and to allow the other end to be a free end which is dispensable and retractable. As will be appreciated, the fixed end may be coupled (selectively detachably or not) to a charging point of a vehicle or charging station. For example, when the charging cable storage assembly forms part of a charging station, then the charging point may
- 30 be an output from a power source. When the charging cable storage assembly is used on board a vehicle then the charging point may, for example, be an input to a vehicle battery.

In some embodiments, the vehicle charging cable storage assembly is arranged to allow the vehicle charging cable to have both of its ends free, each being selectively dispensable and

35 retractable. In this way the vehicle charging cable storage assembly may be more portable, potentially being used to charge different vehicles and/or used for charging in different locations. In use, the vehicle charging cable storage assembly may, for example, be positioned between the vehicle and a charging station and the charging cable may be dispensed to allow

connection of one end of the charging cable to the vehicle and the other end to the charging station. In such embodiments, one or more of the relocatable guides may be relocatable to vary the length of the route that the vehicle charging cable follows so as to adjust a length of dispensed vehicle charging cable. The length of dispensed cable may be a total length of cable dispensed from the storage assembly considered from each end of the vehicle charging cable to the vehicle charging cable storage assembly.

In some embodiments, at least one of the guides is a wheel on which the vehicle charging cable runs. Such guides may allow for smoother retraction and/or dispensing of the vehicle charging cable reducing the likelihood of the vehicle charging cable jamming. One or more of the wheels may be rotatable or alternatively may be non-rotatable. The vehicle charging cable may, for example, slide over the non-rotatable wheels.

In some embodiments, the vehicle charging cable storage assembly comprises a cable store portion with a casing arranged in use to receive the vehicle charging cable when retracted and from which the vehicle charging cable may be dispensed. The casing may be provided in the form of a support structure upon/in which the guides are mounted or an enclosed housing (e.g. resembling a briefcase).

In some embodiments, at least one of the first and second guides comprises a port of the casing. As will be appreciated, such a port through which the vehicle charging cable passes may serve as a guide, constraining the route of the vehicle charging cable.

In some embodiments, the vehicle charging cable storage assembly comprises the vehicle charging cable.

According to yet another aspect of the invention there is provided a vehicle comprising a vehicle charging cable storage assembly according to either of the preceding aspects.

According to a further aspect of the invention there is provided a charging station comprising a vehicle charging cable storage assembly according to any of the preceding aspects.

Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination, unless such features are incompatible. The applicant reserves the right to change any originally filed claim

or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

5 BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the invention will now be described by way of example only, with reference to the accompanying drawings, in which:

10 Figure 1 shows a schematic cross-sectional view of a charging cable storage assembly, in accordance with an embodiment of the invention in a first configuration;

Figure 2 shows a schematic cross-sectional view of a charging cable storage assembly, in accordance with an embodiment of the invention in a second configuration;

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Figure 3 shows a schematic cross-sectional view of a charging cable storage assembly, in accordance with an embodiment of the invention in a first configuration;

Figure 4 shows a schematic cross-sectional view of a charging cable storage assembly, in
20 accordance with an embodiment of the invention in a second configuration;

Figure 5 shows a schematic cross-sectional view of a charging cable storage assembly, in accordance with an embodiment of the invention in a first configuration;

25 Figure 6 shows a schematic cross-sectional view of a charging cable storage assembly, in accordance with an embodiment of the invention in a second configuration; and

Figure 7 shows a vehicle in accordance with an embodiment of the invention.

30 DETAILED DESCRIPTION

Referring to Figures 1 and 2, a vehicle charging cable storage assembly is generally shown at 1. The assembly 1 has a vehicle charging cable 3 and a cable store portion (in this example a casing 5). In Figure 1, the assembly 1 is shown in a first configuration in which the cable 3
35 is dispensed from the casing 5. In Figure 2, the assembly 1 is shown in a second configuration in which the cable 3 is retracted into the casing 5. The cable 3 has a free end 7 (which is dispensable and retractable) and a positionally fixed end 9. The positionally fixed end 9 of the

cable 3 is secured to the casing 5 in a fixed position regardless of whether the assembly 1 arranged in the first or the second configuration. Each end of the cable 3 is provided with a plug or socket (not shown) suitable for engagement with a respective charging points so that a vehicle battery can be electrically charged from a power source via the cable 3.

5

In the example shown in Figures 1 and 2, the positionally fixed end 9 is electrically connected to a battery (not shown) of a vehicle 11 (shown in Figure 3). It shall be appreciated that the positionally fixed end 9 of the cable 3 may, for example, be connected to a charging point of the vehicle battery or that the positionally fixed end 9 of the cable 3 may connect to a socket
10 provided on the casing 5, which may provide a further connection to the vehicle battery. The casing 5 itself is mounted to the vehicle 11 beneath a body panel thereof.

Inside the casing 5, the assembly 1 has a first guide 13 which is a non-relocatable guide and an additional guide 15 which is also a non-relocatable guide. In the example shown in Figures
15 1 and 2, the first guide 13 and additional guide 15 are each in the form of a wheel. The wheels are non-rotatable and non-relocatable (that is they are positionally and rotationally fixed with respect to the casing 5). The first guide 13 and additional guide 15 together form a set of non-relocatable guides 17. In other examples of the invention, each non-relocatable guide may take other suitable forms, including that of a rod, a pulley or an alternative gripping or
20 restraining device.

Inside the casing 5, the assembly 1 additionally has a second guide 19 which is a relocatable guide and an additional guide 23 which is also a relocatable guide. In Figures 1 and 2, the second guide 19 and additional guide 23 are formed as wheels and are similar to the first
25 guide 13 (but for being relocatable). The second guide 19 and additional guide 21 are both relocatable but non-rotatable. The second guide 19 and additional guide 21 together form a set of relocatable guides 23. As with the non-relocatable guides, in other examples of the invention, each relocatable guide may take other suitable forms, including that of a rod, a pulley or an alternative gripping or restraining device.

30

All of the guides with respect to the embodiments of Figures 1 and 2 are provided in the same plane. Each guide of the set of relocatable guides 23 is mounted to a respective spindle (not shown) which also passes through a respective slotted guide (not shown). The slotted guides may be formed by, or mounted to, a surface of the casing 5. The extent and direction of the
35 slotted guides is indicated by arrows 24. Each slotted guide constrains and guides the relocation of each spindle (and therefore the associated relocatable guide mounted thereon) back and forth along a linear path. The linear path associated with each relocatable guide of

the set of relocatable guides 23 are substantially parallel and are substantially equal in length. Each spindle of each guide of the set of relocatable guides 23 is mounted to an arm (not shown) which is a protruding member from a rack of a rack and pinion mechanism (not shown). The pinion is connected to the output of a motor (not shown). The arm and the rack and pinion mechanism form part of a linkage system (not shown) and the linkage system, in combination with the motor, forms part of an actuator (not shown). The motor is powered by a battery of the vehicle 11 and can be selectively driven in forward and reverse directions.

The actuator is provided with an over-stress preventer (not shown). The over-stress preventer monitors the power usage of the motor and temporarily short circuits power delivery to the motor if the power usage exceeds a predefined threshold value.

In both the first and second configurations of the assembly 1, the route of the cable 3 is partially positionally constrained by the guides (first, second and additional). The cable 3 passes through passages (not shown) provided on (e.g. around part of the outer circumference of) each of the guides. The retaining features are configured to substantially inhibit separation of the cable 3 from the guides and each of the retaining features may partially, substantially or fully enclose a cross-section of the cable 3, providing one or more sidewalls around the cable 3. In Figures 1 and 2, the retaining features provide enclosed passages that accommodate the cross-sectional dimensions of the cable, but with enough additional clearance so that the cable 3 is able to slide freely through each enclosed passage. The enclosed passages therefore prevent significant axial or radial displacement of the cable 3 relative to the guides and providing a retaining function. In the first configuration of the assembly 1, the enclosed passages are arranged so that they are not themselves responsible for any deviation from a straight-line path of the cable 3 from the positionally fixed end 9 of the cable 3 to a port 25 of the casing 5 through which the cable 3 passes. This may for instance be achieved by appropriately selecting the circumferential extent of each enclosed passage.

From its positionally fixed end 9, the cable 3 follows a route that passes between and then through the enclosed passages of successive guides, the successive guides being relocatable and non-relocatable in an alternating sequence. A final non-relocatable guide is provided at the port 25 of the casing 5 where a port guide 27 is also located such that the port 25 is provided between the final non-relocatable guide and port guide 27.

When the assembly 1 is in the second configuration, the route followed by the cable 3 as constrained by the guides is a meandering path, in this example concertinaed. Further the port 25, the guides and the positionally fixed end 9 define the ends of substantially parallel passes

of the cable 5, backwards and forwards within the casing 5. In the second configuration the cable 3 curves around the guides.

When the assembly 1 is arranged in the first configuration, the route followed by the cable 3 is still somewhat constrained by the guides, but is substantially straight from the positionally fixed end 9 to the port 25.

In use of the assembly 1, a user can selectively retract the cable 3 into and dispense the cable 3 from the casing 5 by operating a control device (not shown) which controls the operation of the motor in the forward and reverse directions. Where for instance the assembly 1 is in the first configuration and the user operates the control device to retract the cable 3, the motor rotates in a forward direction. One example control device comprises one or more switches or buttons actuatable by a user and which allow selective completion of one or more electrical circuits to supply current to the motor in different directions for forward and reverse operation. Alternatively, the control device could for example comprise a processor, which may receive data signal inputs indicative of user inputs sent via input devices (e.g. switch(es) or button(s)) and output data signals for controlling the motor in accordance with the user inputs.

The motor operates the linkage system to move the set of relocatable guides 23 to travel past and then away from the set of non-relocatable guides 17. The set of relocatable guides 23 are relocated at the same time, in the same direction and to the same extent until the spindles reach the end of their respective slotted guides furthest from the set of non-relocatable guides 17. During the movement of the set of relocatable guides 23, the cable 3 is retracted into the casing 5 (i.e. it is drawn in) as the route around successive relocatable and non-relocatable guides constrain an ever-increasing length of the cable 3. In order to allow this retraction, the cable 3 slides through the enclosed passages of the guides. The enclosed passages also help to prevent the cable 3 from slipping off of the guides. Once the spindles reach a distal end of their respective slotted guides (furthest from the set of non-relocatable guides 17), the motor operation is discontinued and the second configuration of the assembly 1 is reached, as shown in Figure 2. If at any point during the retraction of the cable 3 a force beyond a threshold is experienced resisting the retraction (e.g. in the event that the free end 7 of the cable 3 becomes trapped) operation of the motor operation is discontinued by the over-stress preventer until a reset procedure is performed. In this embodiment the reset procedure comprises performing at least a partial dispensing of the cable 3.

A user can selectively dispense the cable 3 from the casing 5 by operating the control device, to cause the motor to rotate in a reverse direction. The motor operates the linkage system to

move the set of relocatable guides 23 to travel towards and past the set of non-relocatable guides 17. The set of relocatable guides 23 are relocated at the same time, in the same direction and to the same extent until the spindles reach the end of their respective slotted guides nearest to the set of non-relocatable guides 17. During the movement of the set of relocatable guides 23, the cable 3 is dispensed from the casing 5 as the route around successive relocatable and non-relocatable guides constrain an ever-decreasing length of the cable 3. In order to allow this dispensation, the cable 3 slides through the enclosed passages of the guides. The enclosed passages prevent the cable 3 from being left behind by the relocatable guides as they move. Once the spindles reach a proximal end of their respective slotted guides (nearest to the set of non-relocatable guides 17), the motor operation is discontinued and the first configuration of the assembly 1 is reached as shown in Figure 1. Further retraction and dispense cycles repeating the above steps are possible.

Additional variations on the embodiment described with respect to Figures 1 to 3 are possible.

By way of example, the motor need not be operable in both forward and reverse directions. Instead it may be operable in only one direction (e.g. to retract the cable 3). In such an embodiment the cable 3 may be dispensed manually (e.g. by a user pulling on the free end 7). In such cases the motor may be at least partially disengaged from the relocatable guides during dispensation. Indeed, it may be that no motor is provided and that both dispensing and retraction are performed manually. Manual retraction could for instance be performed by turning a handle provided on the casing 5 which may have a pinion provided thereon which cooperates with a rack of the linkage system. As will be appreciated, many variations on the layout and number of guides (relocatable and/or non-relocatable) are envisaged. This includes provision of additional arrays of guides in different planes, which may overlap, all still used to guide the same cable 3. In other embodiments, the casing 5 need not be mounted into the vehicle 11 and could be an independent, portable unit, or mounted to another installation/structure (such as a building or charging point). Indeed, in some embodiments there may be no casing. The guides could for instance be mounted simply to a portion of the vehicle. Additionally, or alternatively, the cable 3 may not have a positionally fixed end 9 and may instead have two free ends, each of which is dispensable through respective casing ports or via the same casing port. The diameter of the guides may be adjusted according to specification of the cable 3. Where the specification of the cable 3 allows, the diameter may be decreased to allow for a more compact assembly 1. On the other hand, where the cable 3 specifications require an increase in the guide diameter in order to avoid beyond specification cable 3 stress, the guide size may be increased accordingly.

Referring now to Figures 3 and 4, a vehicle charging cable storage assembly is generally shown at 40. Figure 3 shows the assembly 40 in a first configuration in which a cable (were it to be provided) would be in a dispensed state. Figure 4 shows the assembly in a second configuration in which a cable (were it to be provided) would be in a retracted state. The assembly 40 is similar to the assembly 1, and similar features are provided with like reference numerals. The assembly 40 differs from the assembly 1 in that none of the casing 5, port 25, port guide 27 and non-relocatable guide at the port 25 are provided. Consequently, in this particular embodiment, there is only one non-relocatable guide 15. Additionally, the assembly 40 does not have a cable 3. A route 41 that may in use be followed by a cable if provided is shown. This embodiment demonstrates that the casing 5 may be omitted. The guides may instead simply be provided on a vehicle 11, charging point or structure. Further the positionally fixed end 9 may be fixed to said vehicle 11, charging point or structure. In use, the assembly 40 functions in a similar manner to the assembly 1.

Referring now to Figures 5 and 6, a vehicle charging cable storage assembly is generally shown at 60. Figure 5 shows the assembly 60 in a first configuration in which a cable 3 is in a dispensed state. Figure 6 shows the assembly 60 in a second configuration in which the cable 3 is in a retracted state. The assembly 60 is similar to the assembly 1, and similar features are provided with like reference numerals. The assembly 60 differs from the assembly 1 in that rather than having a positionally fixed end 9, the cable 3 has a second free end 61. Additionally, the casing 5 has a second port 63 at which an additional non-relocatable guide and an additional port guide 65 are provided. The additional non-relocatable guide forms part of the set of non-relocatable guides 17. The second port 63 is provided between the additional non-relocatable guide and additional port guide 65. The port 25 is associated with dispensation and retraction of the cable 3 at the free end 7, whilst the second port 63 is associated with dispensation and retraction of the cable 3 at the second free end 61.

An additional difference of the assembly 60 with respect to the assembly 1, is that the cable 3 is secured to one of the non-relocatable guides 15 so as to prevent sliding of the cable 3 with respect to that non-relocatable guide 15. In the assembly 60, the non-relocatable guide 15 is substantially at a middle (or half-way) distance of the route of the cable 3 inside the casing 5 between the port 25 and second port 63. In this way, during operation, each of the free end 7 and second free end 61 can be retracted and dispensed independently, without risk of influencing the other free end 7, 61 (e.g. loss of that other free end 7, 61 inside the casing 5). As will be appreciated, the arrangement of assembly 60 allows for each free end 7, 61 to be retracted and dispensed simultaneously as well as at different times. The same action (selected from among dispensation and retraction) can be performed simultaneously as well

as at different times with respect to the two free ends 7, 61. Further, opposite actions (selected from among dispensation and retraction) can be performed simultaneously as well as at different times with respect to the two free ends 7, 61.

- 5 In use, the assembly 60 functions substantially similarly to the assembly 1, though with independent powered dispensing and retraction provided for with respect to each free end 7, 61 of the cable 3. Such independent powered dispensing and retraction may be achieved with duplication of components such as the motor and linkage system, which may be independently operable to relocate only the re-locatable guide 19, 21 (or in other embodiments plurality of
- 10 re-locatable guides) associated with the route of the cable 3 for the respective part of the cable 3 associated with the relevant free end 7, 61. Alternatively, independent powered dispensing and retraction may be achieved by means of additional linkage system components suitable for gearing and/or reversing and/or splitting and/or selectively disengaging drive from a single motor. As will be appreciated the control system would also be suitably adjusted to suit the
- 15 arrangement selected. In other similar embodiments it will be appreciated that dispensing and/or retracting for one or both of the parts of the cable respectively associated with the free ends 7, 61 may be performable manually rather than by means of the motor and linkage system.
- 20 As will be appreciated, similar functionality to that of assembly 60 is also achievable where two cables are provided, (rather than a single cable 3) each having a positionally fixed end (e.g. fixed to the casing 5 or to a non-relocatable guide substantially at a middle (or half-way) distance as previously described.
- 25 All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.
- 30 Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.
- 35 The invention is not restricted to the details of any foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one,

or any novel combination, of the steps of any method or process so disclosed. The claims should not be construed to cover merely the foregoing embodiments, but also any embodiments which fall within the scope of the claims.

CLAIMS

1. A vehicle charging cable storage assembly configured to receive a vehicle charging cable, the vehicle charging cable storage assembly comprising a first guide and a second guide wherein a route for the vehicle charging cable is at least partially positionally constrained by the first and second guides and where further at least one of the first and second guides is a relocatable guide which is relocatable with respect to the other of the first and second guides to thereby, in use, retract at least a portion of the vehicle charging cable when provided, to be thereby stored by the vehicle charging cable storage assembly.
2. A vehicle charging cable storage assembly according to claim 1, wherein the relocatable guide is selectively relocatable towards the other of the first and second guides to thereby, in use, permit dispensing of at least a portion of the vehicle charging cable.
3. A vehicle charging cable storage assembly according to claim 1 or claim 2 wherein the relocation of the relocatable guide comprises a linear movement.
4. A vehicle charging cable storage assembly according to any preceding claim comprising an actuator arranged to drive the relocation of the relocatable guide with respect to the other of the first and second guides to thereby, in use, retract at least a portion of the vehicle charging cable.
5. A vehicle charging cable storage assembly according to claim 4 wherein the actuator is powered to allow, in use, automated retraction of the vehicle charging cable.
6. A vehicle charging cable storage assembly according to claim 4 or claim 5 wherein the actuator comprises a motor and a linkage system being coupled to the motor and to the relocatable guide.
7. A vehicle charging cable storage assembly according to any of claims 4 to 6 comprising an actuator over-stress preventer, arranged to at least partially decouple the actuator from the relocatable guide where the actuator generates a load that is greater than a pre-determined threshold.
8. A vehicle charging cable storage assembly according to any of claims 4 to 7 wherein the actuator is arranged to switch to an idle configuration when, in use, the vehicle charging cable is being dispensed, whereby the actuator is at least partially decoupled from the relocatable guide.

- 5 9. A vehicle charging cable storage assembly according to any of claims 4 to 7 wherein the actuator is arranged to drive the relocation of the relocatable guide towards the other of the first and second guides to thereby, in use, dispense at least a portion of the vehicle charging cable.
- 10 10. A vehicle charging cable storage assembly according to claim 10 wherein at least one of the first and second guides comprise at least one retaining feature arranged, in use, to prevent decoupling of the vehicle charging cable from the respective guide when the relocatable guide relocates towards the other of the first and second guides.
- 15 11. A vehicle charging cable storage assembly according to any preceding claim comprising one or more additional guides which, in use, at least partially positionally constrain the route of the vehicle charging cable.
- 20 12. A vehicle charging cable storage assembly according to claim 11 wherein at least one of the additional guides is also one of the relocatable guides which is relocatable with respect to at least one other of the guides.
- 25 13. A vehicle charging cable storage assembly according to claim 12 wherein the relocatable guides form a set of relocatable guides and wherein each of the relocatable guides in the set of relocatable guides relocate in substantially the same direction.
- 30 14. A vehicle charging cable storage assembly according to claim 14 wherein each of the relocatable guides in the set of relocatable guides relocate to substantially the same extent.
- 35 15. A vehicle charging cable storage assembly according to any of claims 12 to 15 wherein at least one of the additional guides 15 is a non-relocatable guide and the multiple non-relocatable guides form a set of non-relocatable guides.
16. A vehicle charging cable storage assembly according to any of claims 11 to 15 wherein non-relocatable and relocatable guides alternate along the route that the vehicle charging cable follows in use.
17. A vehicle charging cable storage assembly according to any of claims 11 to 16 wherein the guides are arranged to positionally constrain at least part of the route that the vehicle charging cable follows in use so that the vehicle charging cable 3 follows a meandering path when the vehicle charging cable is in a retracted state.

18. A vehicle charging cable storage assembly according to any of claims 11 to 17 wherein the guides are arranged to positionally constrain at least part of the route that the vehicle charging cable follows in use so that the vehicle charging cable 3 follows a
5 concertinaed path when the charging cable is in a retracted state.

19. A charging cable storage assembly according to any of claims 11 to 18 comprising multiple arrays of guides, wherein the guides within any one of the arrays are located in a substantially common plane and guides in different arrays are in different planes.

10 20. A vehicle charging cable storage assembly according to any preceding claim arranged to positionally fix one end of the vehicle charging cable and to allow the other end to be a free end 7 which is dispensable and retractable.

15 21. A vehicle charging cable storage assembly according to any of claims 1 to 19 arranged to allow the vehicle charging cable to have both of its ends free, each being selectively dispensable and retractable.

20 22. A vehicle charging cable storage assembly according to any preceding claim comprising a cable store portion with a casing arranged in use to receive the vehicle charging cable when retracted and from which the vehicle charging cable may be dispensed.

25 23. A vehicle charging cable storage assembly according to any preceding claim comprising the vehicle charging cable.

24. A vehicle comprising a vehicle charging cable storage assembly according to any of claims 1 to 23.

30 25. A charging station comprising a vehicle charging cable storage assembly according to any of claims 1 to 23.

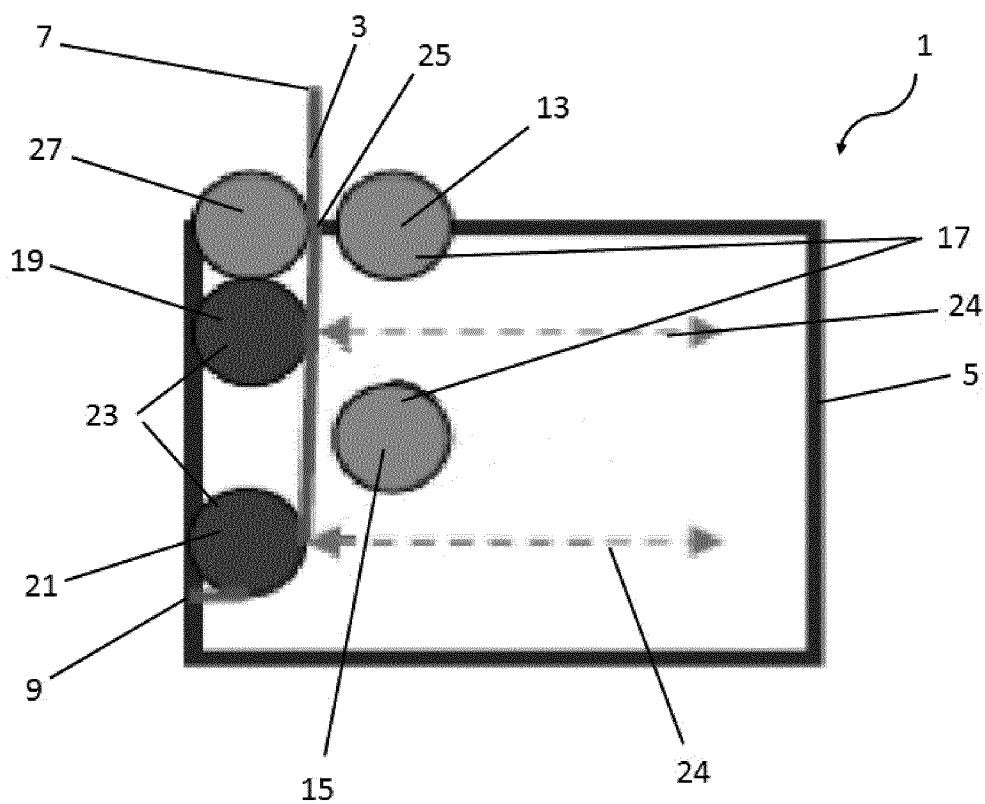


Fig.1

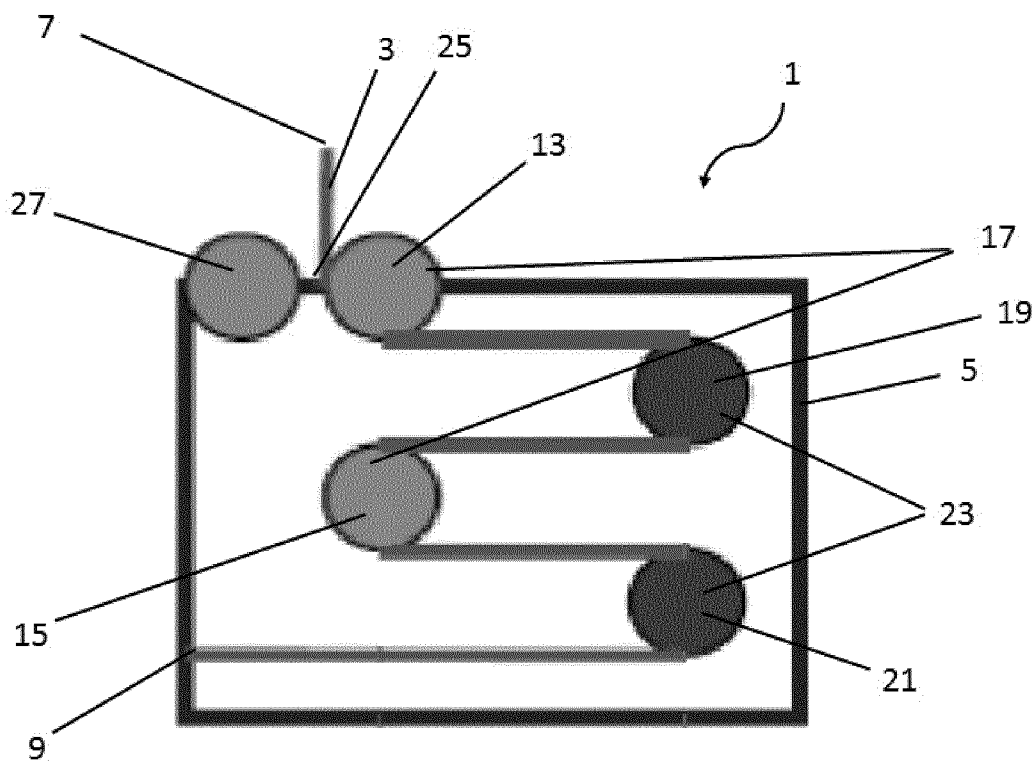


Fig. 2

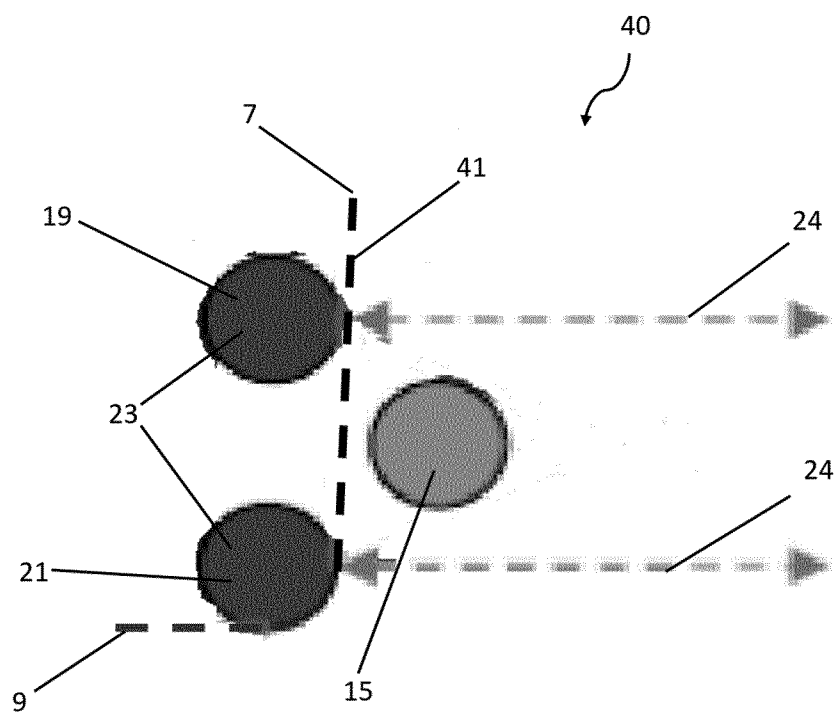


Fig. 3

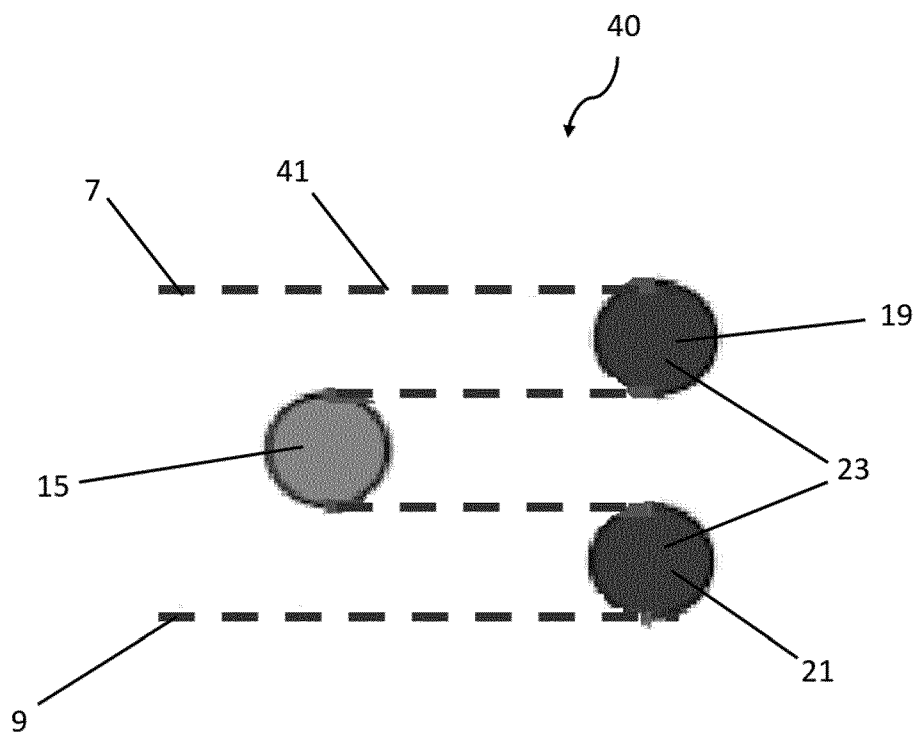


Fig. 4

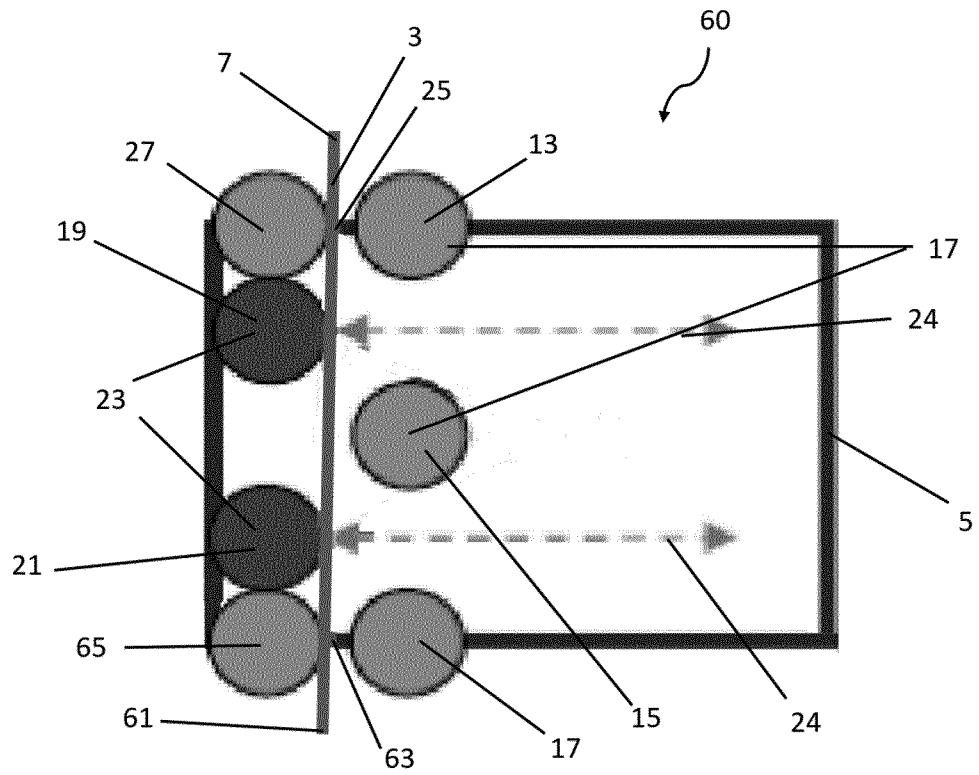


Fig. 5

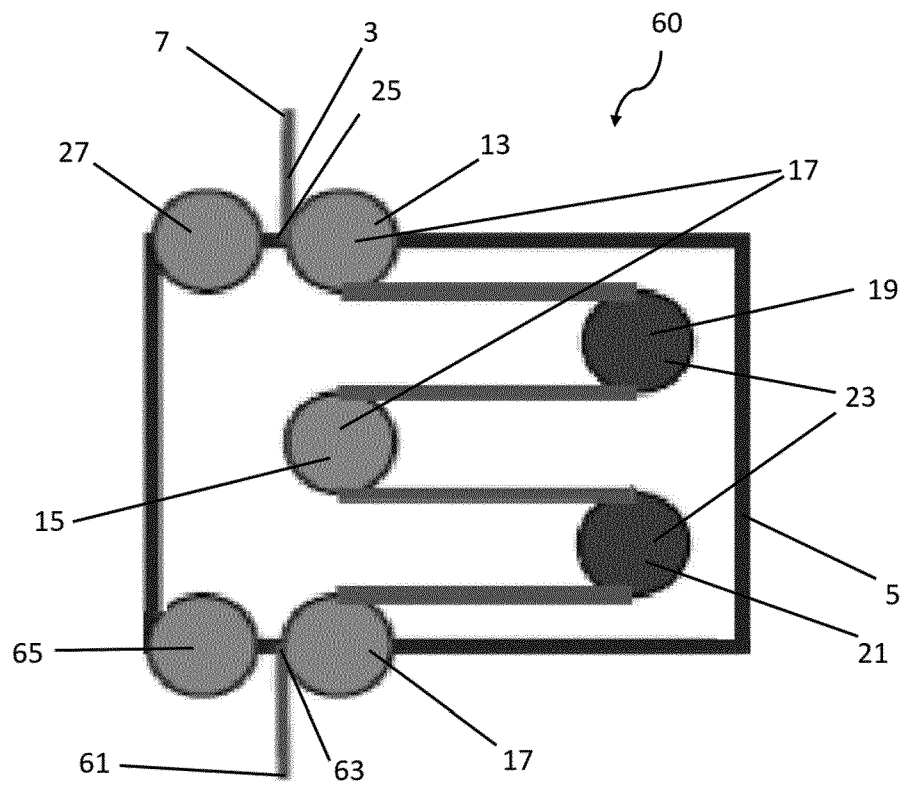


Fig. 6

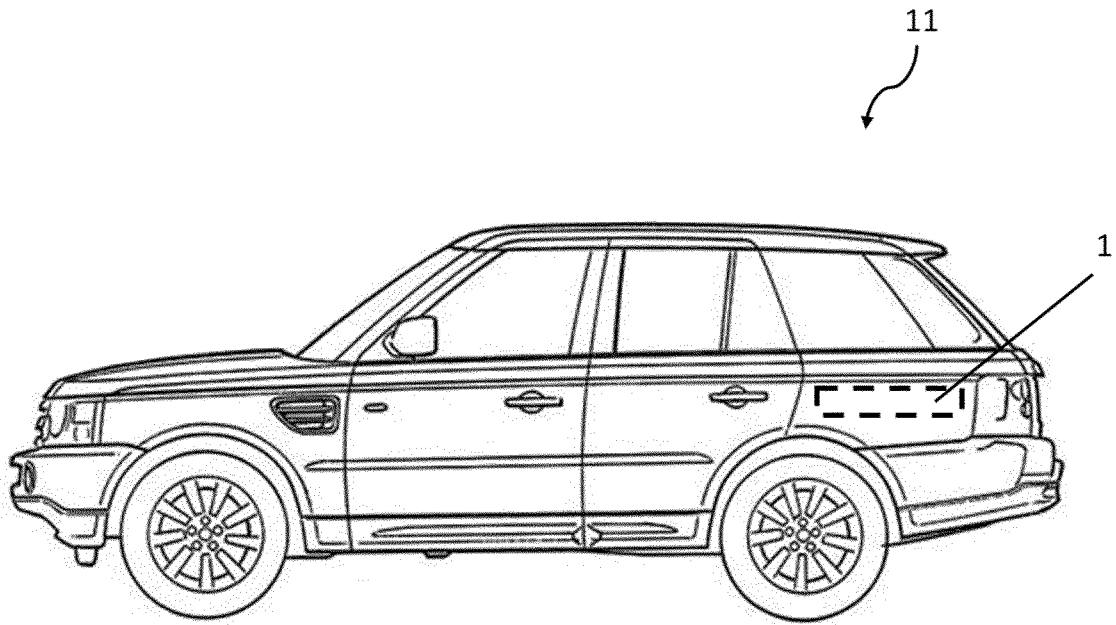


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/078399

A. CLASSIFICATION OF SUBJECT MATTER

INV. B60L53/16 B65H75/34 B65H75/42 H02G11/00
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)

B60L B65H H02G

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

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X	----- GB 2 485 544 A (ECOTRICITY GROUP LTD [GB]) 23 May 2012 (2012-05-23)	1-3, 11-16, 19-25
A	abstract; figure 4 pages 1-4 pages 6-11	4-10, 17, 18
X	----- CN 108 544 929 A (SHENZHEN NAISHIDI TECH DEVELOPMENT CO LTD) 18 September 2018 (2018-09-18) the whole document	1-3, 11-25
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

10 January 2020

Date of mailing of the international search report

17/01/2020

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2019/078399

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