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(54) **Title:** A FUNCTIONAL MODULE AND A VEHICLE ASSEMBLED FROM A SET OF MODULES

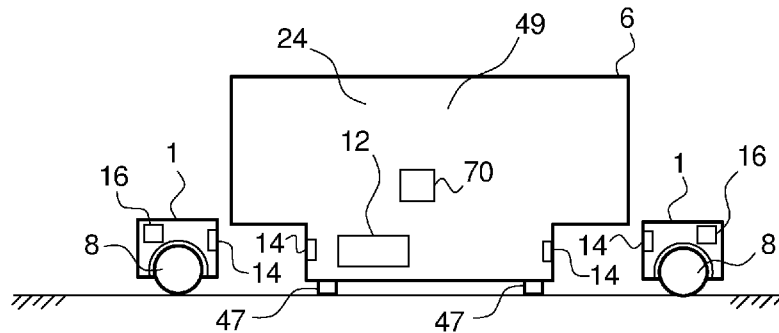


Fig. 3b

(57) **Abstract:** The invention relates to a functional module (6), adapted to be connected to a drive module (1) for forming an assembled vehicle (2), the drive module (1) comprising at least a pair of wheels (8) and being configured to be autonomously operated and drive the assembled vehicle (2). The functional module (6) comprising at least one leg (47) for supporting the functional module (6) on a ground surface (54); and a control device (16, 70) configured to control the at least one leg (47) between an extended position in which it supports the functional module (6), and a retracted position. The invention also relates to a vehicle (2) assembled from a set of modules (1, 6).



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A functional module and a vehicle assembled from a set of modules

TECHNICAL FIELD

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The invention relates to a functional module and a vehicle assembled from a set of modules according to the appended claims.

BACKGROUND

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Vehicles of today are typically manufactured for a specific purpose, e.g. a bus is manufactured for transporting people and a truck is manufactured for transporting goods. Such vehicles are typically manufactured and completely assembled in a factory or they may be partly assembled in a factory and completed at a body manufacturer.

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Once the vehicle is assembled, the vehicle may be used for the specific purpose. Thus, a bus may be used as a bus and a garbage truck may be used as a garbage truck. Different vehicles are thus needed for different purposes, which may require a large fleet of vehicles and which may be very costly. It may therefore be desired to be able to customize a vehicle depending on different missions. The vehicle may be provided with electric engines for the propulsion of the vehicle and also be provided with energy storage units, which provides the electric engines with electric power. The energy storage units must be charged with electric power.

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There are, for example, known solutions where a truck can be rebuilt by changing a concrete mixer to a loading platform. This increases the flexibility and two different functions can be achieved by means of one single vehicle. Also, document US-2016/0129958 A discloses a modular electric vehicle using interchangeable vehicle assembly modules. The user can thereby disassemble and reassemble the vehicle for use in different applications. Disassembling and reassembling such a vehicle would, however, be a very cumbersome and time consuming work. Furthermore, when a failure occurs in one of the known vehicle modules it may be difficult to replace the failing module, which may result in that the vehicle may be unusable for a considerable period of time. It may also be cumbersome to transport the replacing module to the site of the vehicle with the failing module.

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SUMMARY

Despite known solutions in the art, it is desired to develop a functional module, which enables simple and fast connection to and disconnection from other modules, which enables a secure transportation of goods, and which enables a simple and safe charging of energy storage units.

An object of the invention is therefore to achieve a functional module, which enables simple and fast connection to and disconnection from other modules.

Another object of the invention is to achieve a functional module, which enables a secure transportation of goods.

Another object of the invention is to achieve a functional module, which enables a simple and safe charging of energy storage units.

The herein mentioned objects are achieved with a functional module according to the appended claims.

According to an aspect of the invention a functional module is provided, adapted to be connected to a drive module for forming an assembled vehicle, the drive module comprising at least a pair of wheels and being configured to be autonomously operated and drive the assembled vehicle, the functional module comprising at least one leg for supporting the functional module on a ground surface and a control device configured to control the at least one leg between an extended position in which it supports the functional module, and a retracted position.

The above-mentioned objects are also achieved by a vehicle assembled from a set of modules according to the appended claims.

According to an aspect of the invention a vehicle assembled from a set of modules is provided, the vehicle comprising at least one drive module; the vehicle further comprising a functional module according to any one of the preceding claims.

By such a functional module a simple and fast connection to and disconnection from other modules are enabled. When the functional module is disconnected from a drive module and parked on a ground surface at least one leg arranged on the functional module supports the functional module. A control device is configured to control the at least one leg between an extended position in which it supports the functional module, and a retracted position. When the functional module is disconnected from a drive module and parked on a ground surface, the at least one leg is controlled to the extended position. After the functional module has been connected to a drive module, the at least one leg is controlled by the control device to the retracted position. The functional module enables a secure transportation of goods. In case of an emergency situation, wherein the assembled vehicle immediately must be stopped, the at least one leg may be controlled to the extended position, so that the leg reaches the ground surface. As a result, the leg will drag into the ground surface and thus brake the assembled vehicle. The functional module enables a simple and safe charging of energy storage units. A first contact element may be adapted to be arranged at the at least one leg and configured for transmitting electric power from an external power source to at least one energy storage unit in the functional module and/or in the drive module. When the functional module is parked on a ground surface, the at least one leg is controlled to the extended position, so that the leg reaches the ground surface. At the ground surface the first contact element will rest on and be connected to the external power source for charging the at least one energy storage unit in the functional module and/or in the drive module.

Providing the vehicle assembled from a set of modules, a simple and fast connection and disconnection of the modules is enabled. After the modules has been connected to an assembled vehicle, the at least one leg is controlled by the control device to the retracted position. When the assembled vehicle should be disassembled, the at least one leg of the functional module is controlled to the extended position. The assembled vehicle enables a secure transportation of goods. In case of an emergency situation, wherein the assembled vehicle immediately must be stopped, the at least one leg may be controlled to the extended position, so that the leg reaches the ground surface. As a result, the leg will drag into the ground surface and thus brake the as-

sembled vehicle. A simple and safe charging of energy storage units in the assembled vehicle is enabled. A first contact element may be adapted to be arranged at the at least one leg and configured for transmitting electric power from an external power source to at least one energy storage unit in the assembled vehicle. When the assembled vehicle is parked on a ground surface, the at least one leg is controlled to the extended position, so that the leg reaches the ground surface. At the ground surface the first contact element will rest on and be connected to the external power source for charging the at least one energy storage unit in the assembled vehicle.

10 At least one drive module may be used together with different functional modules. The functional modules may be designed for specific purposes. Therefore, by combining a drive module with a suitable functional module, it is possible to customize a vehicle depending on different missions. A functional module may be prepared to perform a specific function and the drive module, which may be autonomously operated, may connect with the functional module to achieve an assembled vehicle customized for a certain mission. The at least one functional module may be configured with a passenger compartment for accommodating passengers and may thus function as a bus when being assembled with the at least one drive module. The at least one leg for supporting the functional module on a ground surface may be configured and adapted for different types of functional modules in order to provide a simple and fast connection to and disconnection from other modules, for enabling a secure transportation of goods in different types of functional modules, and for enabling a simple and safe charging of energy storage units in different types of functional modules.

25 Additional objectives, advantages and novel features of the invention will be apparent to one skilled in the art from the following details, and through exercising the invention. While the invention is described below, it should be apparent that the invention may not be limited to the specifically described details. One skilled in the art, having access to the teachings herein, will recognize additional applications, modifications and incorporations in other areas, which are within the scope of the invention.

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BRIEF DESCRIPTION OF THE DRAWINGS

Below is a description of, as examples, preferred embodiments with reference to the enclosed drawings, in which:

Figure 1a schematically illustrates a side view of an assembled vehicle according to an embodiment;

Figure 1b schematically illustrates a side view of a drive module and a functional module according to an embodiment;

Figure 2 schematically illustrates a section view of a drive module according to an embodiment;

Figure 3a schematically illustrates a side view of an assembled vehicle according to an embodiment;

Figure 3b schematically illustrates a side view of two drive modules and a functional module according to an embodiment;

Figures 4a and 4b schematically illustrates a section view of a leg to an embodiment;

Figures 5a and 5b schematically illustrates a section view of a leg to an embodiment;

Figures 6a and 6b schematically illustrates a section view of a leg to an embodiment;

Figures 7a and 7b schematically illustrates a section view of a leg to an embodiment;

Figures 8a and 8b schematically illustrate side views of a functional module according to an embodiment; and

Figures 9a and 9b schematically illustrates a section view of a leg to an embodiment.

DETAILED DESCRIPTION

Modularised vehicles are typically assembled at the customer's premises and the customer may thus buy a set of modules from a manufacturer. The assembled vehicle
5 may comprise at least two modules including at least one drive module and at least one functional module. Such a modularised vehicle is applicable on all sorts of road vehicles and may thus relate to heavy vehicles, such as buses, trucks etc., which may be used on public roads. The at least one drive module may have at least one electric engine as a propulsion source.

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According to an aspect of the present disclosure a functional module is provided, adapted to be connected to a drive module for forming an assembled vehicle, the drive module comprising at least a pair of wheels and being configured to be autonomously operated and drive the assembled vehicle, the functional module comprising
15 at least one leg for supporting the functional module on a ground surface and a control device configured to control the at least one leg between an extended position in which it supports the functional module, and a retracted position.

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The at least one leg arranged on the functional module supports the functional module on a ground surface. The control device is configured to control the at least one leg between an extended position in which it supports the functional module, and a retracted position. When the functional module is disconnected from a drive module and parked on a ground surface, the at least one leg is controlled to the extended position for supporting the functional module. After the functional module has been connected to a drive module, the at least one leg is controlled by the control device to
20 the retracted position. In the retracted position the at least one leg no longer supports the functional module on the ground surface. The at least one leg may also be controlled to the extended position when the functional module is connected to the at least one drive module and is transported by the at least one drive module as an assembled vehicle. The extended leg will drag into the ground surface and thus brake the assembled vehicle. This may be useful in an emergency situation. Also, the assembled vehicle may be provided with a burglar alarm. When there is an attempt to make unauthorized entry into the assembled vehicle, the burglar alarm may trigger a
25 loud noise and also trigger at least one of the legs to be controlled to the extended
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position, so that the extended leg rests on the ground surface. The extended leg may prevent any movement of the assembled vehicle and thus prevent an unauthorized person or a thief to steal the assembled vehicle. The at least one leg may also be controlled to the extended position when the assembled vehicle is parked on a sloping or an uneven ground surface. On such a sloping or uneven ground surface the parked vehicle may have a leaning position, which may prevent or hinder unloading from the vehicle. Therefore, the leg may be controlled to an extended length that horizontally aligns the vehicle.

10 According to an aspect of the present disclosure the at least one leg is configured as a rod, which is movably arranged in its longitudinal direction. The rod may in the retracted position be accommodated in the functional module. In the functional module the rod is protected from debris. Alternatively, the rod may in the retracted position be arranged on an outside wall of the functional module. In the extended position the rod will protrude out of the functional module and downward to the ground surface. In case the rod in the retracted position is arranged on the outside wall of the functional module, the rod may slide downwards at the outside wall of the functional module to the extended position. In the extended position the rod may support the functional module on the ground surface.

20 According to an aspect of the present disclosure the at least one leg is configured as a telescopic device. Due to the telescopic configuration the at least one leg may in the retracted position have small dimensions. Due to the small dimensions it will be simple to arrange the at least one leg at the functional module, since the at least one leg only need a small space in or at the functional module in the retracted position. In the extended position the at least one leg, configured as a telescopic device, may support the functional module on the ground surface.

30 According to an aspect of the present disclosure the at least one leg is foldably configured. In the retracted position the at least one leg may be folded to a position at the underside of the functional module. The at least one leg may in the retracted position extend in parallel to the underside of the functional module. This will make it simple to arrange the at least one leg at the functional module, since the at least one leg only need a small space at the functional module in the retracted position. In the

extended position the at least one leg, foldably configured, may support the functional module on the ground surface.

5 According to an aspect of the present disclosure the functional module may further comprise an actuator for moving the at least one leg between the extended position and the retracted position. The actuator may be arranged between a body of the functional module and the at least one leg. The actuator is activated when the at least one leg should be moved to the extended position and to the retracted position. The actuator is also activated when the at least one leg should be moved to a position
10 between the extended position and the retracted position. The at least one leg may be moved to a position between the extended position and the retracted position when maintenance should be performed on the at least one leg. The actuator may be activated or controlled by means of the control device. The actuator may be manually activated or controlled by an operator. One actuator may be configured to move several
15 legs between their extended and retracted positions.

According to an aspect of the present disclosure the actuator is hydraulically, pneumatically and/or electrically controlled. The actuator may be an electric motor, which is connected to the at least one leg and to the body of the functional module. The
20 electric motor is electrically controlled and is connected to an energy storage unit in the functional module and/or in the drive module. The actuator may be a hydraulically or pneumatically controlled piston and cylinder connected to the at least one leg and to the body of the functional module. The hydraulically or pneumatically controlled piston and cylinder is connected to the energy storage unit in the functional module
25 and/or in the drive module. The energy storage unit may thus provide the actuator with electric and/or pneumatic and/or hydraulic power.

According to an aspect of the present disclosure the at least one leg is adapted to carry or at least partly carry the load of the functional module. When the functional
30 module is disconnected from a drive module and parked on a ground surface, the at least one leg is controlled to the extended position for supporting the functional module. Thus, the at least one leg is adapted to carry or at least partly carry the load of the functional module. If several legs are arranged on the functional module they may together carry the load of the functional module. The load to be carried by the at least

one leg may be the weight of the functional module together with the weight of any load in the functional module.

According to an aspect of the present disclosure the functional module may comprising a charging device, which comprises a first contact element adapted to be arranged at the at least one leg and configured for transmitting electric power from an external power source to at least one energy storage unit in the functional module and/or in the drive module. The functional module enables a simple and safe charging of energy storage units. A first contact element may be adapted to be arranged at the at least one leg and configured for transmitting electric power from an external power source to at least one energy storage unit in the functional module and/or in the drive module. When the functional module is parked on a ground surface, the at least one leg is controlled to the extended position, so that the leg reaches the ground surface. At the ground surface the first contact element will rest on and be connected to the external power source for charging the at least one energy storage unit in the functional module and/or in the drive module.

According to an aspect of the present disclosure the functional module may further comprise a protective element, which at least partly surrounds the first contact element, wherein the protective element is arranged to be movable between a first and a second position in relation to the first contact element. The protective element, which at least partly surrounds the first contact element, protects humans and animals in the surroundings from coming in contact with electrically conductive parts of first contact element. The protective element also protects the first contact element from being exposed to debris from the surroundings, which may have an aggressive impact on the first contact element and thus reduce the transfer capabilities of electric power of the first contact element. The protective element is movable arranged on the first contact element.

According to an aspect of the present disclosure the first contact element is adapted to be connected to a second contact element connected to the external power source and which second contact element is arranged at the ground surface. The second contact element may have a shape of a flat plate or disc, which is arranged at a ground surface. The first contact element may rest on the second contact element

when the first contact element is adapted to be connected to a second contact element. When a load, resulting from the weight of the functional module, acts on the first contact element, and the first contact element rests on the second contact element, the second contact element may be adapted to bear or at least partly bear the weight of the functional module. Thus the second contact element may act as a combined platform and charging station for the first contact element when the first contact element acts as a stand for the functional module. The second contact element may be integrated in the external power source. Therefore, the first contact element may be connected directly to the external power source.

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According to an aspect of the present disclosure the functional module comprise four legs, adapted to be arranged one in each corner of the functional module. When the functional module is disconnected from a drive module and parked on a ground surface, the functional module is supported by four legs. Each leg is controlled to the extended position for supporting the functional module. The four legs may together carry the load of the functional module. The load to be carried by the four legs may be the weight of the functional module together with the weight of any load in the functional module. Each leg is arranged in one corner of the functional module, which will make the functional module stable on the ground surface.

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According to an aspect of the present disclosure the leg is adapted to be arranged centrally of the functional module. When the functional module is disconnected from a drive module and parked on a ground surface, the functional module is supported by one leg, which is centrally arranged of the functional module. The centrally arranged leg is controlled to the extended position for supporting the functional module. The centrally arranged leg may carry the load of the functional module. The load to be carried by the centrally arranged leg may be the weight of the functional module together with the weight of any load in the functional module. The centrally arranged leg may have a large diameter or with, which will make the functional module stable on the ground surface when supported by the centrally arranged leg.

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According to an aspect of the present disclosure a vehicle assembled from a set of modules is provided. The vehicle comprising at least one drive module. The vehicle

further comprising a functional module according to any one of the preceding claims. After the modules has been connected to an assembled vehicle, the at least one leg is controlled by the control device to the retracted position. When the assembled vehicle should be disassembled, the at least one leg of the functional module is controlled to the extended position.

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According to an aspect of the present disclosure the drive module comprises at least a pair of wheels and is configured to be autonomously operated and drive the assembled vehicle.

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The drive module may be autonomously operated and be connected with the functional module to achieve an assembled vehicle customized for a certain mission. The at least one functional module may be configured with a passenger compartment for accommodating passengers and may thus function as a bus when being assembled with the at least one drive module. The at least one leg may be configured and adapted for different types of functional modules in order to enable a simple and fast connection to and disconnection from other modules.

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A drive module with at least a pair of wheels may have good manoeuvring abilities. The drive module may turn about a vertical axis that extends between the two wheels. The design of the drive module may also be very compact when two wheels are arranged at the drive module. With the drive module having two wheels, typically two drive modules are needed to assemble a vehicle, depending on whether the functional module comprises wheels or not.

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The pair of wheels may be arranged at the drive module, such that a centre axis of each wheel coincides with each other. Each wheel has a centre axis and may be arranged at the drive module so that each wheel may rotate about its centre axis. The centre axis of each wheel may thus be referred to as the rotational axis of each wheel. The centre axis of the wheels coinciding means that the centre axis of the wheels are aligned. By having the centre axis of each wheel coinciding with each other the drive module has good manoeuvring abilities. Also, the drive module may be able to make a pivoting movement about the coinciding centre axis of the two wheels. Thus, the drive module may be configured to pivot about the common centre axis of the two

wheels. This pivoting movement of the drive module may be useful when connecting and disconnecting the drive module with other modules. The control device configured to operate the drive module as an independently driven unit may be configured to control the pivoting movement of the drive module.

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The propulsion unit of the drive module may be an electric machine, connected to the wheels. The pair of wheels of the drive module may thus be referred to as drive wheels. In one example, the drive module comprises two electrical machines, one connected to each wheel. The electric machines may be arranged in the rim of the wheels. The wheels of the drive module may thus be driven independently of each other. The electric machines may also work as generators and generate electric energy when braking the wheels. The drive module may also comprise a steering system connected to the wheels. This way, the drive module is steerable. The drive module may also comprise a brake system for braking the wheels. The brake system may comprise a wheel brake for each wheel of the drive module. Redundancy is achieved in that the drive module can be steered by means of the electrical machines and/or the wheel brakes in the event that the steering system malfunctions.

The drive module being autonomously operated means that a control device of the drive module is configured to receive commands and instructions from an off-board system and to execute these commands/instructions. The autonomously operated drive module may thus be said to be self-operated based on received commands and instructions from the off-board system. The autonomously operated drive module may thus be self-operated without an on-board or off-board driver. The control device may be adapted to convert the commands to control signals for controlling the systems and components of the drive module and thereby control for example the steering and the propulsion of the drive module. This way, the drive module is self-driven based on the received commands and instructions. The control device may operate the drive module autonomously also based on data from the at least one sensor, taking situations that may happen during transportation into account.

According to an aspect of the present disclosure the vehicle comprises two drive modules.

Each drive module may then comprise one pair of wheels. By selecting the at least one functional module and two drive modules based on a function to be performed, a customized vehicle may be assembled, which is customized for the function to be performed. Also, an assembled vehicle may be achieved, which is adapted to the surroundings and the operating conditions of the vehicle. An assembled vehicle provided with two drive modules may have more power and may support larger and heavier vehicles than a vehicle provided with only one drive module. If one of the drive modules will lose power, the other drive module may take over and drive the vehicle.

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According to an aspect of the present disclosure one of the drive modules is configured to operate as a master and the other drive module and the functional module is configured to operate as a slave.

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A control device of one of the drive modules may be configured to operate the associated drive module as the master. A control device of the other drive module may be configured to operate the associated drive module as the slave. The master will decide how to operate the drive modules and thus how to operate the assembled vehicle. In addition, any further module, such as the functional module being connected to the drive module(s) and which comprises a control device, may become slave in the assembled vehicle. Each drive module is associated with a registration number but only one registration number should be shown on an assembled vehicle. In the event that the assembled vehicle comprises two drive modules, the first control device may appoint one drive module to be master and the other to be slave. Typically, the master will be commanded to show its registration number and the slave will not show its registration number. The first control device may thus transmit instructions regarding registration number to the second control device of the at least one drive module.

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The present disclosure will now be further illustrated with reference to the appended figures.

Figure 1a schematically illustrates a side view of an assembled vehicle 2 comprising a drive module 1 and a functional module 6 provided with at least one leg 47 according to an embodiment, for supporting the functional module 6 on a ground surface 54.

The drive module 1 comprises a pair of wheels 8 and is configured to be autonomously operated, which means that the assembled vehicle 2 is configured to be autonomously operated. The functional module 6 may be provided with wheels 8, but generally a functional module 6 cannot move on its own. Instead, the functional module 6 needs to be connected to at least one drive module 1 to be able to move. The functional module 6 may accommodate or supporting a load. The at least one functional module 6 may be configured for transporting goods and may thus function as a truck when being assembled with at least one drive module 1. In fig. 1a the drive module 1 and the functional module 6 are physically connected to each other, so that interfaces 14 arranged on the drive module 1 and the functional module 6 are physically connected to each other. A control device 16, 70 is comprised in any of the two modules 1, 6. The drive module 1 may comprise a control device which hereinafter will be referred to as a first control device 16. The functional module 6 may comprise a control device, which hereinafter will be referred to as a second control device 70. The second control device 70 may be configured to control the at least one leg 47 between an extended position in which it supports the functional module 6, and a retracted position. However, the first control device 16 in the drive module 1 may be configured to control the at least one leg 47 between an extended position in which it supports the functional module 6, and a retracted position. In fig. 1a the at least one leg 47 is in a retracted position. At least one energy storage unit 12 may be arranged in the functional module 6 and/or in the drive module 1. The functional module 6 may be provided with a number of legs 47.

Figure 1b schematically illustrates a side view where the drive module 1 has been physically disconnected from the assembled vehicle 2 and thus from the functional module 6, so that the drive module 1 and the functional module 6 are separated. In fig. 1b also the drive module 1 has been moved in direction away from the functional module 6, which is the remaining module of the assembled vehicle 2. The at least one leg 47 is adapted to bear or at least partly bear the load of the functional module 6. A load resulting from the weight of the functional module 6, acts on the at least one leg 47. The at least one leg 47 is adapted to act as a stand for the functional module 6.

Fig. 2 schematically illustrates a drive module 1 in a section view. The drive module 1 may comprise a pair of wheels 8. The wheels 8 may be arranged at the first and second sides 28, 30 of the drive module 1. One wheel 8 may be arranged at the first side 28 and the other wheel 8 may be arranged at the second side 30. A steering unit 40 may be connected to the wheels 8. The steering unit 40 may make the drive module 1 steerable. The pair of wheels 8 may be so arranged at the drive module 1 that a centre axis 43 of each wheel 8 coincides with each other. Each wheel 8 has a centre axis 43 and may be arranged at the drive module 1 so that each wheel 8 may rotate about its centre axis 43. When the centre axis 43 of each wheel 8 coincides with each other the drive module 1 has good manoeuvring abilities. Also, the drive module 1 may be configured to enable a pivoting movement about the coinciding centre axis 43 of the two wheels 1. This pivoting movement of the drive module 1 may be useful when connecting and disconnecting the drive module 1 with other modules 6. The first control device 16 configured to operate the drive module 1 as an independently driven unit may control the pivoting movement of the drive module 1.

The drive module 1 may comprise at least two interfaces 14 for transferring electric energy and/or transmitting electric signals, and for physically connection.

The drive module 1 may comprise at least one propulsion unit 10 connected to the pair of wheels 8. The propulsion unit 10 may be an electric machine connected to the wheels 8. Two electric machines may be arranged as propulsion units 10 in the drive module 1. One electric machine 10 may be connected to one wheel 8 and the other electric machine 10 may be connected to the other wheel 8. The electric machines 10 may be arranged in the rim 42 of the wheels 8. The wheels 8 may thereby be driven independently of each other. The electric machines 10 may also work as generators and generate electric energy when braking the wheels 8. Instead of electric machines 10 as a propulsion unit 10, the at least one propulsion unit 10 may be an internal combustion engine, such as an otto engine or a diesel engine connected to the wheels 8.

The drive module 1 may comprise at least one energy storage unit 12 for providing the propulsion unit 10 with energy. In the case where the propulsion unit 10 is an electric engine, the energy storage unit 12 may be an electric battery. The electric battery may

be recharged with electric energy. Alternatively, when the electric battery is discharged, the electric battery may be replaced by another charged electric battery. In the case where the propulsion unit 10 is an internal combustion engine, the energy storage unit 12 may be a fuel tank with fuel suitable for the internal combustion engine.

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The drive module 1 may comprise a separate closed cooling system 22, for cooling the at least one propulsion unit 10 and the at least one energy storage unit 12. Provided with a separate closed cooling system 22 the drive module 1 may be operated as an independently driven unit, without any need of an external cooling arrangement. Also, the drive module 1 does not have to be connected to a cooling system of a functional module 6. The separate closed cooling system 22 may be based on a liquid coolant or based on a forced flow of cooling air.

As mentioned above the drive module 1 may comprise a first control device 16. The first control device 16 may be configured to operate the drive module 1 as an independently driven unit. The drive module 1 may transport itself without any external driven unit such as a towing vehicle 2. The drive module 1 may transport itself by means of the at least one propulsion unit 10. The drive module 1 may be configured to be autonomously operated. Thus, the first control device 16 may be configured to control the operation of the drive module 1. The first control device 16 may be configured to transmit control signals to the various systems and components of the drive module 1 for controlling for example the steering and the propulsion of the drive module 1. The first control device 16 may be adapted to operate the drive module 1 autonomously based on received commands. The first control device 16 may thus be adapted to receive commands from a remotely located off-board system or a control centre and to convert the command into control signals for controlling the various systems and components of the drive module 1. The first control device 16 may also be configured to receive data about the surroundings from at least one second sensor element 45, and based on this data control the drive module 1. The first control device 16 may be implemented as a separate entity or distributed in two or more physical entities. The first control device 16 may comprise one or more computers. The first control device 16 may thus be implemented or realised by the first control device 16 comprising a processor and a memory.

As mentioned above, the drive module 1 may be configured to constitute a part of an assembled vehicle 2. Such a vehicle 2 assembled from a set of modules 1, 6. The assembled vehicle 2 may comprise at least one functional module 6. The assembled vehicle 2 may further comprise at least one drive module 1 as disclosed in figures 1a and 1b. The assembled vehicle 2 may comprise two drive modules 1. The drive module 1 may be adapted to be configured based on a function to be performed by the drive module 1 itself or as an assembled vehicle 2. However, the drive module 1 may itself thus constitute a vehicle.

10 The drive module 1 may be adapted to be releasably connected to either a second drive module 1 and/or a functional module 6 for forming an assembled vehicle 2. At least one of the sides of the drive module 1 may thus have a shape that allows the drive module 1 to be releasably connected to the second drive module 1 and/or the functional module 6.

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The at least two interfaces 14 may be physical interfaces 14, arranged to physically connect the drive module 1 with the second drive module 1 and/or the functional module 6.

20 The drive module 1 may comprise at least two interfaces 14, each arranged on different sides of the drive module 1. The interfaces 14 of the drive module 1 may be releasably connectable to a corresponding interface 14 of the second drive module 1 and/or the functional module 6. Thus, each module in the set of modules 1, 6 may comprise at least one interface 14, which may be releasably connectable to a corresponding interface 14 on another module.

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The at least two interfaces 14 may be electric interfaces 14, arranged for transferring electric power and/or transmitting electric signals between the drive module 1 and the second drive module 1. The electrical interface 14 may be a wireless interface 14 or a conductive interface 14. By connecting the drive module 1 and the functional module 6 electrically the modules 1, 6 may transfer power between each other and also share information. The drive module 1 may, for example, control parts of the functional module 6, such as opening and closing of doors, heating and cooling.

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The drive module 1 may comprise at least one second sensor element 45 for detecting and registering objects in the surrounding of the drive module 1. The at least one second sensor element 45 may be a proximity sensor for detecting and registering the distance to objects, such as vehicles, pedestrians, traffic lights and/or buildings. Based on information from at least one second sensor element 45, the drive module 1 may be operated such that a safe distance to the surrounding objects is maintained and accidents avoided. The at least one second sensor element 45 may be a radar, a lidar or a camera.

Figure 3a schematically illustrates a side view of an assembled vehicle 2 comprising two drive modules 1 and a functional module 6 provided with at least one leg 47 according to an embodiment, for supporting the functional module 6 on a ground surface 54. The at least one functional module 6 may be configured with a passenger compartment 49 for accommodating passengers and may thus function as a bus 41 when being assembled with the drive modules 1. It is to be understood that the shape of the two drive modules 1 may be identical and are configured as the drive module 1 described above. In fig. 3a the drive modules 1 are connected to the functional module 6 and the interfaces 14 of the drive modules 1 and the functional module 6 are thus connected with each other. Two legs 47 are disclosed in fig. 3a. However, there may be a leg 47 arranged in each corner of the functional module 6. Thus, four legs 47 may be arranged on the functional module 6. In fig. 3a the legs 47 are in a retracted position.

By selecting the at least one functional module 6 and two drive modules 1 based on a function to be performed a customized vehicle 2 can be assembled, which may be suitable for a function to be performed. Also, an assembled vehicle 2 may be achieved, which is adapted to the surroundings and the operating conditions of the vehicle 2. Different configurations of the drive module 1 may be required when the drive modules 1 form part of the assembled vehicle 2 performing the function of transporting people, transporting goods, shovelling snow etc. The drive modules 1 may also be adapted to be dynamically configured based on the surroundings in which the assembled vehicle 2 will perform its function.

In fig. 3b the drive modules 1 and the functional module 6 have been physically disconnected from the assembled vehicle 2 and thus from the functional module 6, so

that the drive modules 1 and the functional module 6 are separated from each other. In fig. 3b the drive modules 1 have been moved in direction away from the functional module 6 and the control device 16, 70 has controlled the legs 47 to the extended position in which they support the functional module.

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Figures 4a and 4b show a leg 47 according to an embodiment. The leg 47 is configured as a rod, which is movably arranged in its longitudinal direction. In fig. 4a the leg 47, configured as a rod, is in the extended position. In the extended position the leg 47 will protrude out of the functional module 6 and downward to the ground surface 54. In the extended position the rod may support the functional module 6 on the ground surface 54. In fig. 4b the leg 47, configured as a rod, is in the retracted position. The rod may in the retracted position be accommodated in the functional module 6.

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An actuator 48 is configured for moving the at least one leg 47 between the extended position and the retracted position. The actuator 48 may be arranged between a body 51 of the functional module 6 and the leg 47. The actuator 48 is activated when the leg 47 should be moved to the extended position and to the retracted position. The actuator 48 is hydraulically, pneumatically and/or electrically controlled. The actuator 48 may be an electric motor, which is connected to the leg 47 and to the body 51 of the functional module 6.

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Figures 5a and 5b show a leg 47 according to an embodiment. The leg 47 is configured as a rod, which is movably arranged in its longitudinal direction. In fig. 5a the leg 47 is in the extended position. In the extended position the rod may support the functional module 6 on the ground surface 54. In fig. 5b the leg 47 is in the retracted position. The rod may in the retracted position be accommodated in the functional module. The rod may be provided with an external screw thread 53. The body 51 of the functional module may be provided with a threaded opening 55 in which the rod is arranged. By rotating the rod, a longitudinal displacement of the rod is achieved. The actuator 48 is configured for moving the leg 47 between the extended position and the retracted position by rotating the rod. A transmission 57, such as gear wheels, may be arranged between the rod and the actuator 48.

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Figures 6a and 6b show a leg 47 according to an embodiment. The leg 47 is configured as a telescopic device. In fig. 6a the leg 47 is in the extended position. In the extended position the leg 47, configured as a telescopic device may support the functional module on the ground surface. In the extended position the leg 47, configured as a telescopic device, may support the functional module on the ground surface. In fig. 6b the leg 47 is in the retracted position. Due to the telescopic configuration the leg 47 may in the retracted position have small dimensions.

Figures 7a and 7b show a leg 47 according to an embodiment. According to an aspect of the present disclosure the leg 47 is foldably configured. In fig. 6a the leg 47 is in the extended position. In the extended position the rod may support the functional module on the ground surface. In the extended position the leg 47, foldably configured, may support the functional module on the ground surface. In fig. 6b the leg 47 is in the retracted position. The leg 47 may in the retracted position extend in parallel to the underside of the functional module.

Figure 8a and 8b schematically illustrate side views of a functional module 6 according to an embodiment. The functional module 6 is provided with a charging device 50. Two charging devices 50 are shown in the embodiment. Each charging device 50 may comprise a first contact element 52 adapted to be arranged at the functional module 6 and configured for transmitting electric power from an external power source 56 to at least one energy storage unit 12 in the functional module 6 and/or in the drive module 1 (fig. 2). The first contact element 52 may be connected to the energy storage unit 12 by means of cables 59. A protective element 58, which at least partly surrounds the first contact element 52, protects humans and animals in the surroundings from coming in contact with electrically conductive parts of first contact element 52. The protective element 58 also protects the first contact element 52 from being exposed to debris from the surroundings, which may have an aggressive impact on the first contact element 52 and thus reduce the transfer capabilities of electric power of the first contact element 52.

The first contact element adapted to be arranged at the at least one leg 47 and configured for transmitting electric power from the external power source to the at least one energy storage unit in the functional module 6 and/or in the drive module 1. In

fig. 8a two legs 47 are disclosed and the legs 47 are in the retracted position. The drive modules 1 has been excluded in fig. 8a, but after the functional module has been connected to drive modules 1 the legs 47 have been controlled to the retracted position.

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In fig. 8b the functional module is parked on a ground surface and the legs 47 are in the extended position, so that the each leg 47 reaches the ground surface 54.

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The legs 47 of the functional module 6, provided with the first contact element 52 are adapted to bear or at least partly bear the weight of the functional module 6. Load resulting from the weight of the functional module 6 may act on the first contact element 52.

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The first contact element 52 is adapted to be connected to a second contact element 60 connected to the external power source 56 and which second contact element 60 is arranged at the ground surface 54. The second contact element 60 may have a shape of a flat plate or disc, which is arranged at a ground surface 54. The first contact element 52 may rest on the second contact element 60 when the first contact element 52 is connected to the second contact element 60.

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The first contact element 52 is adapted to rest on the second contact element 60. Therefore, the second contact element 60 is adapted to bear or at least partly bear the weight of the functional module 6. Thus the second contact element 60 may act as a combined platform and charging station for the first contact element 52. The second contact element 60 is connected to the external power source 56 by means of cables 59 and electric power is transmitted from the external power source 56 to the at least one energy storage unit 12 in the functional module 6 and/or in the drive module 1 via the first and second contact elements 52, 60 when the first and second contact elements 52, 60 are connected to each other.

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The second contact element 60 comprises an electrical conductive material. The second contact element 60, which is connected to the external power source 56 comprises an electrical conductive material. The electrical conductive material of the second contact element 60 may be adapted to transmit electric power.

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The first contact element comprises 52 an electrical conductive material. The first contact element 52 may be configured for transmitting electric power through electrical conductive material in the first contact element 52. Both the first contact element 52 and the second contact element 60 may comprise electrical conductive material. When the first contact element 52 is connected to the second contact element 60, electric power may be conductively transmitted from the external power source 56 to the at least one energy storage unit 12 in the functional module 6 and/or in the drive module 1. However, the first and second contact elements 52, 60 may be configured with inductive conductors (not shown), which are configured for transmitting electric power from the external power source 56 to the at least one energy storage unit 12.

Figures 9a and 9b schematically illustrate section views of a leg 47 provided with a charging device 50 according to an embodiment. The protective element 58, which at least partly surrounds the first contact element 52, is arranged to be movable between a first position 68 and a second position 69 in relation to the first contact element 52. The protective element 58 is movably arranged on the first contact element 52 and thus also of the leg 47.

In fig. 9a the leg 47 is in the retracted position. In fig. 9b the leg 47 is in the extended position, so that the leg 47 reaches the ground surface.

In the first position 68 of the protective element 58, the first contact element 52 is at least partly surrounded by the protective element 58 and the protective element 58 is arranged to isolate the terminal end 72 of the first contact element 52 from the external power source 56.

The protective element 58 is resilient and is at least partly movably arranged in relation to the first contact element 52 by compression of the protective element 58.

The resilient material in the protective element 58 allows the protective element 58 to move to the second position 69 when the protective element 58 is compressed, such as when the load of the functional module 6 is exerted on the protective element 58. The load will compress the protective element 58, so that the terminal end 72 of the

first contact element 52 may connect to the second contact element 60 and thus is enable to transmit electric power from the external power source 56 to the at least one energy storage unit 12. The protective element 58 may have a cylindrical shape provided with a longitudinal bore 74 in which the first contact element 52 is arranged.

5 In a situation when no load is exerted to the resilient protective element 58, the protective element 58 is in the first position 68 and is arranged to isolate the terminal end 72 of the first contact element 52 from the external power source 56.

10 The charging device 50 comprising at least one spring 78 connected to the first contact element 52. The spring 78 may have a protective function on the first contact element 52 and on the functional module 6. When a load acts on the protective element 58 and the protective element 58 reaches the second position 69, the load may also act on the first contact element 52. The spring 78 will act against this load and will have a dampening effect on the first contact element 52.

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In fig. 9b the protective element 58 is in the second position 69 and the terminal end is enabled to transmit electric power from the external power source 56 to the at least one energy storage unit 12. In the second position 69 of the protective element 58, the first contact element 52 is at least partly surrounded by the protective element 58 and the terminal end 72 of the first contact element 52 is exposed for and connected to the second contact element 60, so that electric power from the external power source 56 can be transmitted to the at least one energy storage unit 12.

25 When a load is exerted on the protective element 58, the length of the resilient protective element 58 will be reduced due to compression of the resilient protective element 58. Since the protective element 58 is resilient and is at least partly movably arranged in relation to the first contact element 52, the relative movement will enable the terminal end 72 of the first contact element 52 to contact and connect to the second contact element 60 for transmitting electric power from the external power source 56 to the at least one energy storage unit 12. The relative movement of the protective element 58 in relation to the first contact element 52 will bring the terminal end 72 of the first contact element 52 to an end of the longitudinal bore 74 of the cylindrical shaped protective element 58. This enables the terminal end 72 of the first contact element 52 to get close to the second contact element 60 and the external

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power source 56 and thus transmit electric power from the external power source 56 to the at least one energy storage unit 12. The protective element 58 is connected to the functional module 6 and may be compressed between the functional module 6 and the second contact element 60. In the embodiment shown in figures 9a and 9b
5 the protective element 58 may constitute the leg 47, which is provided with the first contact element 52. In the embodiment shown in figures 9a and 9b the protective element 58 is resilient. However, it is also possible to arrange a stiff protective element 58 which at least partly surrounds the first contact element 52, and which is displaceably arranged between the first and second positions.

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The foregoing description of the embodiments has been furnished for illustrative and descriptive purposes. It is not intended to be exhaustive, or to limit the embodiments to the variants described. Many modifications and variations will obviously be apparent to one skilled in the art. The embodiments have been chosen and described in order
15 to best explicate principles and practical applications, and to thereby enable one skilled in the art to understand the embodiments in terms of its various embodiments and with the various modifications that are applicable to its intended use. The components and features specified above may, within the framework of the embodiments, be combined between different embodiments specified.

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CLAIMS

1. A functional module (6), adapted to be connected to a drive module (1) for forming an assembled vehicle (2), the drive module (1) comprising at least a pair of wheels (8) and being configured to be autonomously operated and drive the assembled vehicle (2), the functional module (6) comprising:
- 5 at least one leg (47) for supporting the functional module (6) on a ground surface (54); and
- 10 a control device (16, 70) configured to control the at least one leg (47) between an extended position in which it supports the functional module (6), and a retracted position.
2. The functional module (6) according to claim 1, wherein the at least one leg (47) is configured as a rod, which is movably arranged in its longitudinal direction.
- 15 3. The functional module (6) according to any one of the preceding claims, wherein the at least one leg (47) is configured as a telescopic device.
- 20 4. The functional module (6) according to claim 1, wherein the at least one leg (47) is foldably configured.
- 25 5. The functional module (6) according to any of the preceding claims, further comprising an actuator (48) for moving the at least one leg (47) between the extended position and the retracted position.
- 30 6. The functional module (6) according to claim 5, wherein the actuator (48) is hydraulically, pneumatically and/or electrically controlled.
7. The functional module (6) according to any one of the preceding claims, wherein the at least one leg (47) is adapted to carry or at least partly carry the load of the functional module (6).

8. The functional module (6) according to any one of the preceding claims, further comprising a charging device (50), the charging device comprising:
a first contact element (52) adapted to be arranged at the at least one leg (47) and configured for transmitting electric power from an external power source (56) to
5 at least one energy storage unit (12) in the functional module (6) and/or in the drive module (1).
9. The functional module (6) according to claim 8, further comprising a protective element (58), which at least partly surrounds the first contact element (52);
10 wherein the protective element (58) is arranged to be movable between a first and a second position in relation to the first contact element (52).
10. The functional module (6) according to any one of the claims 8 - 9, wherein the first contact element (52) is adapted to be connected to a second contact element
15 (60) connected to the external power source (56) and which second contact element (60) is arranged at the ground surface (54).
11. The functional module (6) according to any one of the preceding claims 1, comprising four legs (47), adapted to be arranged one in each corner of the functional
20 module (6).
12. The functional module (6) according to any one of claim 1-10, wherein the leg 47 is adapted to be arranged centrally of the functional module (6).
- 25 13. A vehicle (2) assembled from a set of modules (1, 6), the vehicle (2) comprising:
at least one drive module (1);
the vehicle (2) further comprising a functional module (6) according to any one of the preceding claims.
- 30 14. The vehicle according to claim 13, wherein the drive module (1) comprises at least a pair of wheels (8) and is configured to be autonomously operated and drive the assembled vehicle (2).

15. The vehicle (2) according to any one of claims 13 - 14, wherein the vehicle (2) comprises two drive modules (1).

5 16. The vehicle (2) according to any one of claims 13 - 15, wherein one of the drive modules (1) is configured to operate as a master and the other drive module and the functional module (6) is configured to operate as a slave.

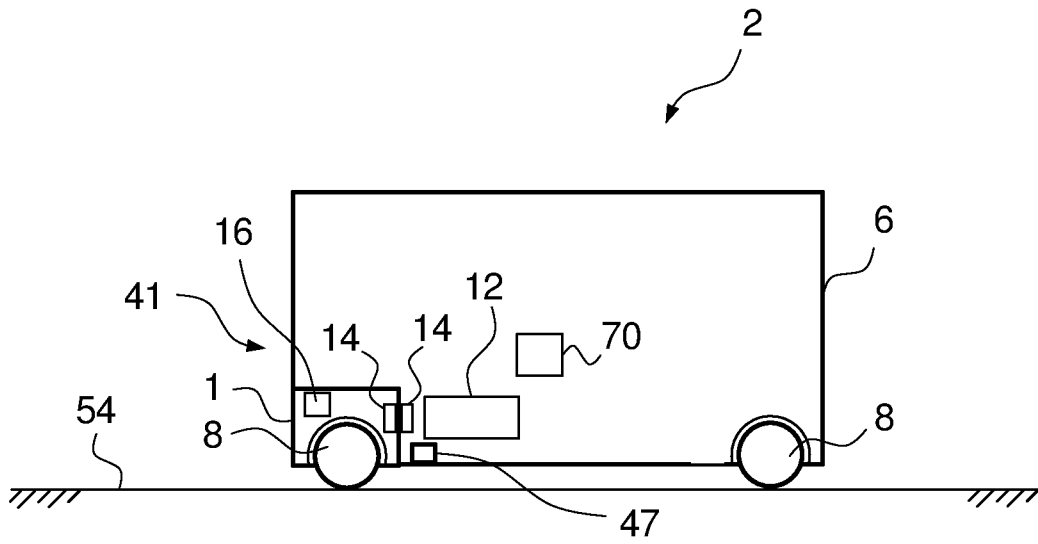


Fig. 1a

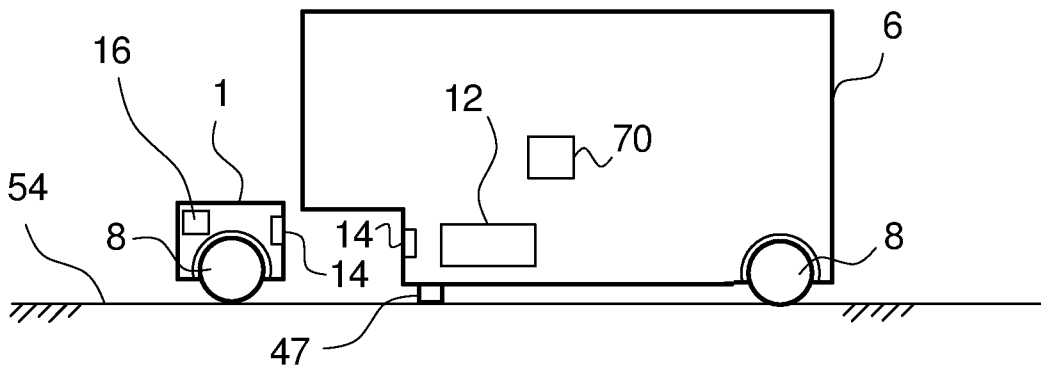


Fig. 1b

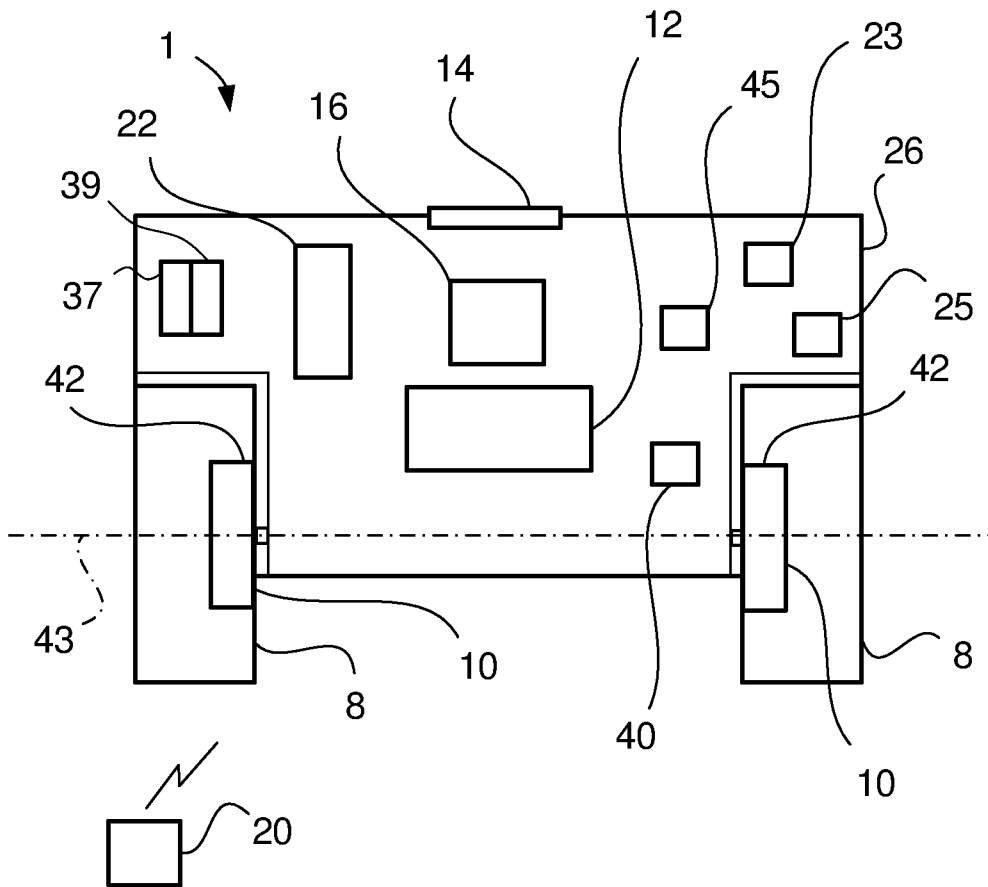


Fig. 2

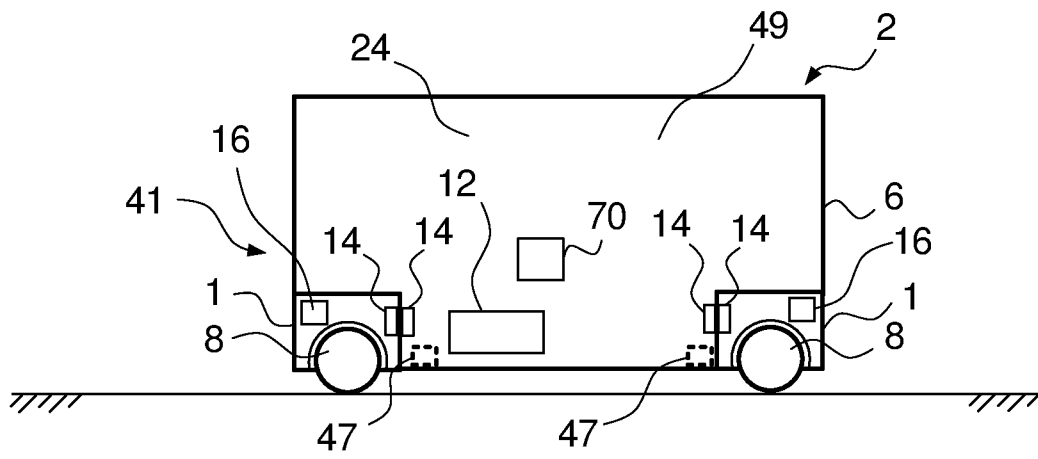


Fig. 3a

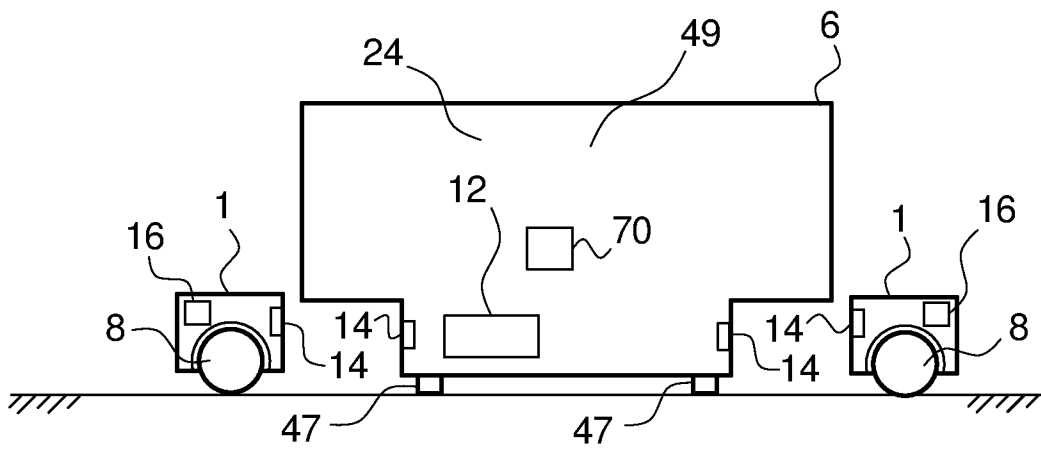


Fig. 3b

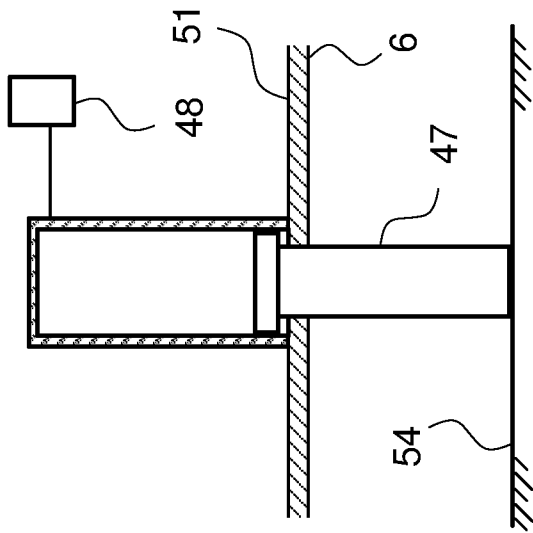


Fig. 4a

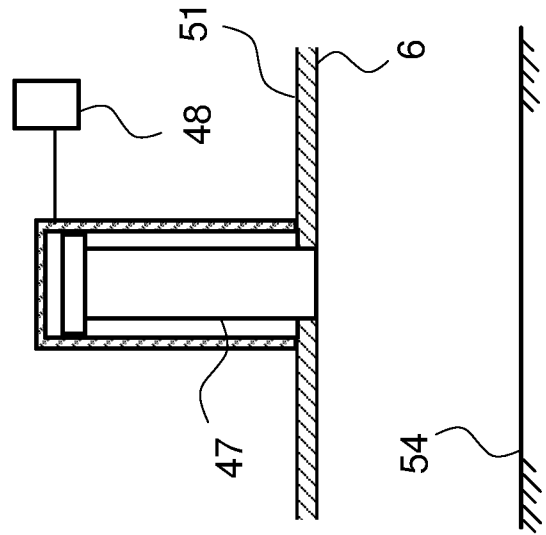


Fig. 4b

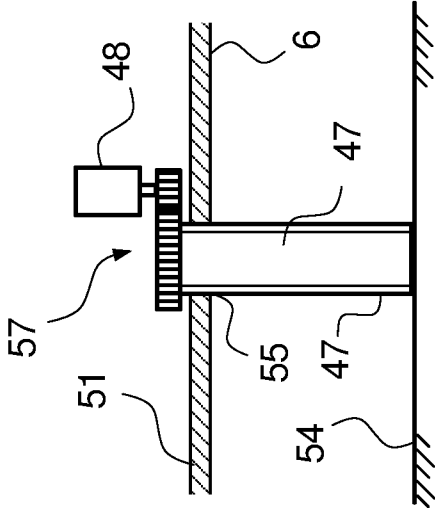


Fig. 5a

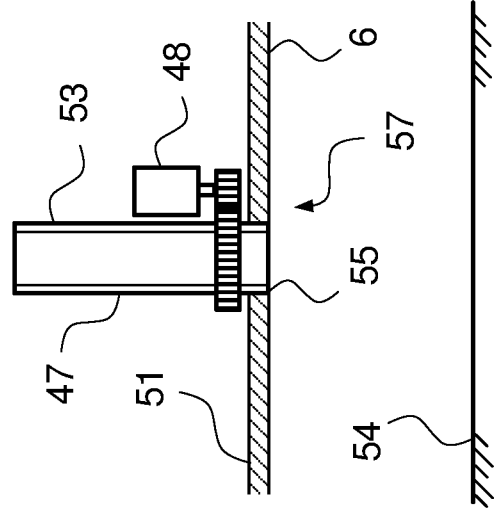
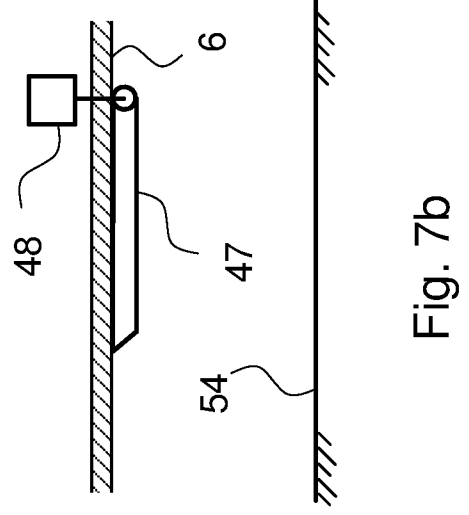
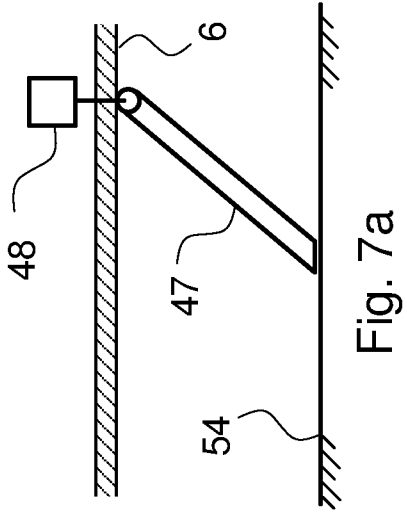
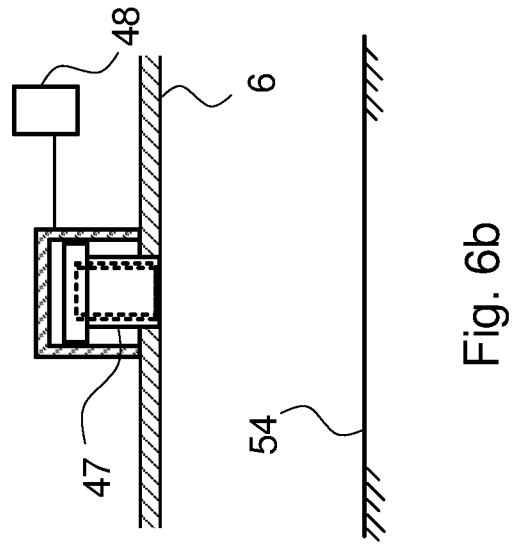
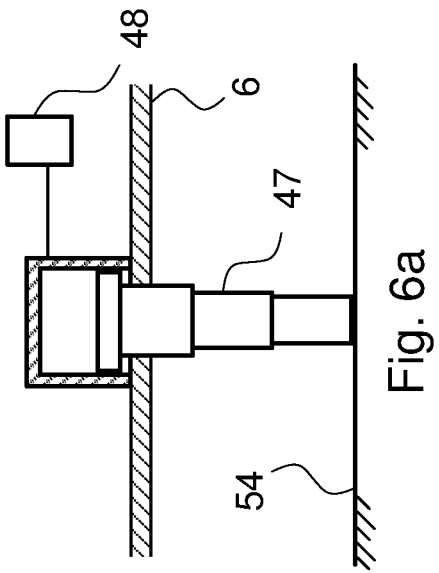
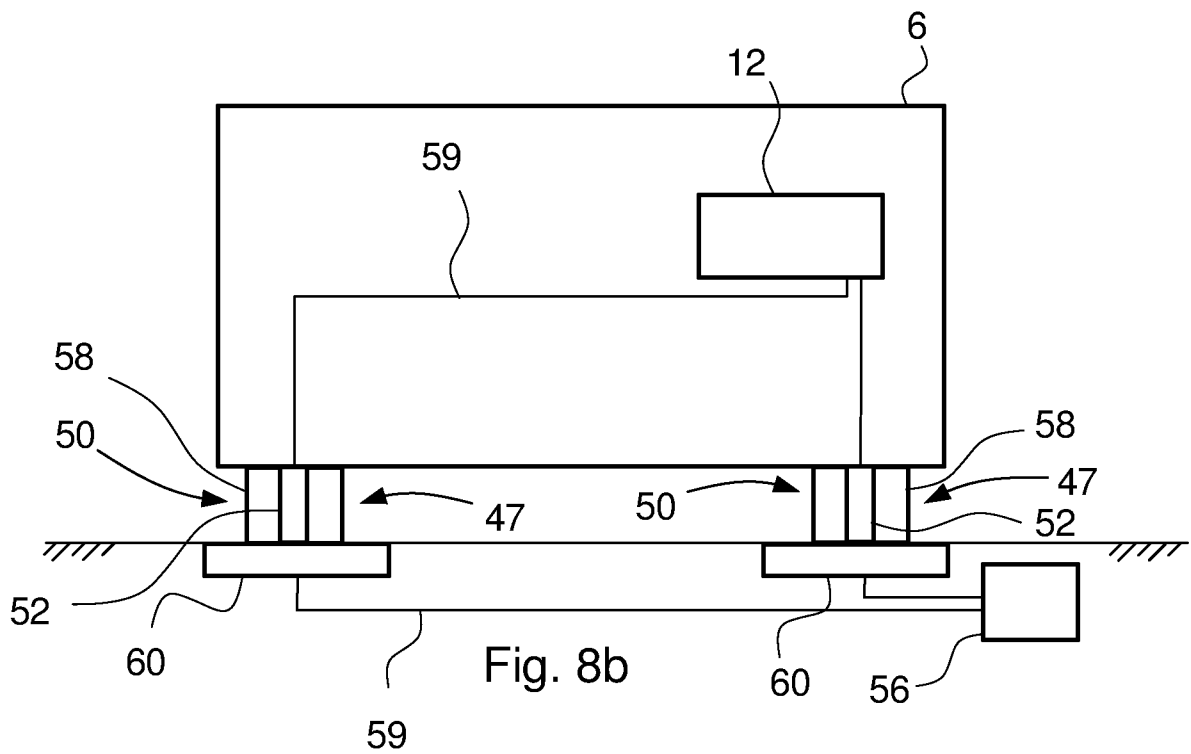
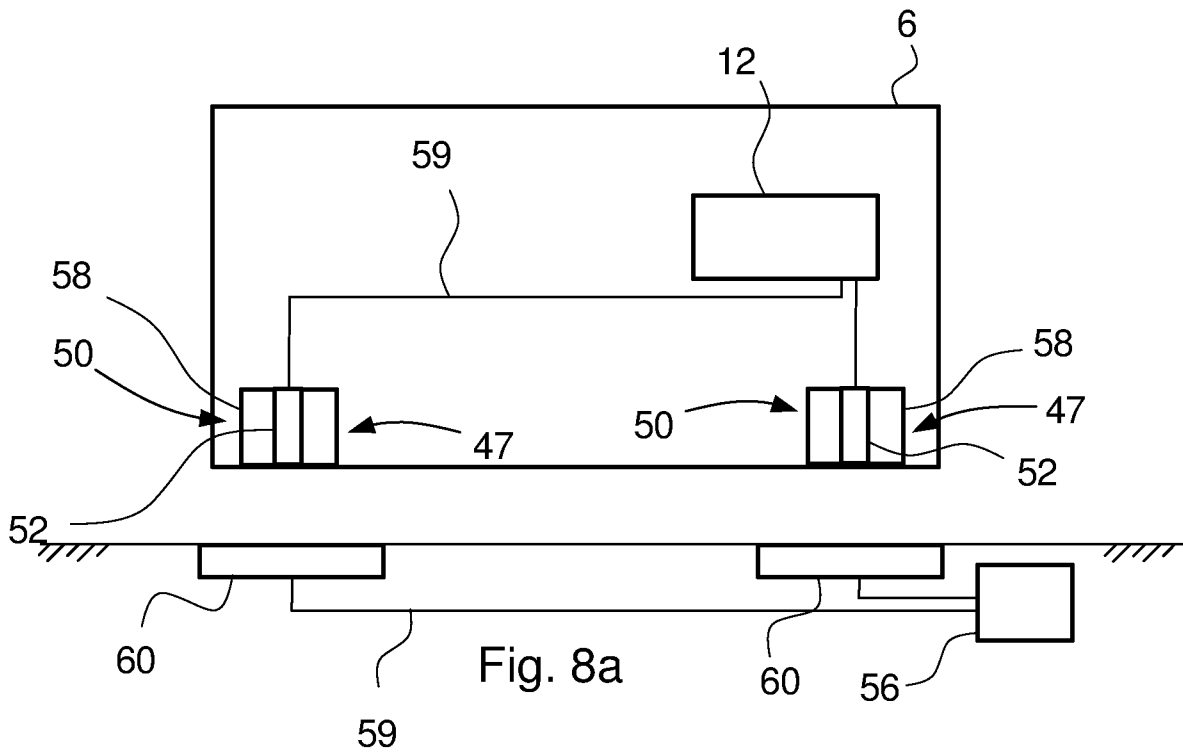
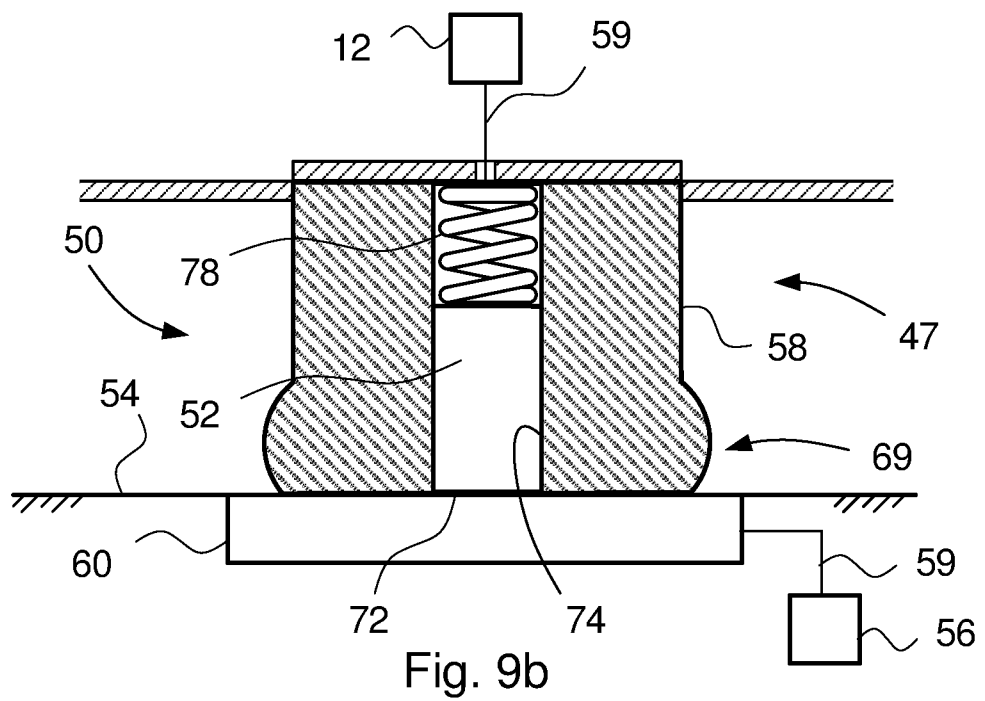
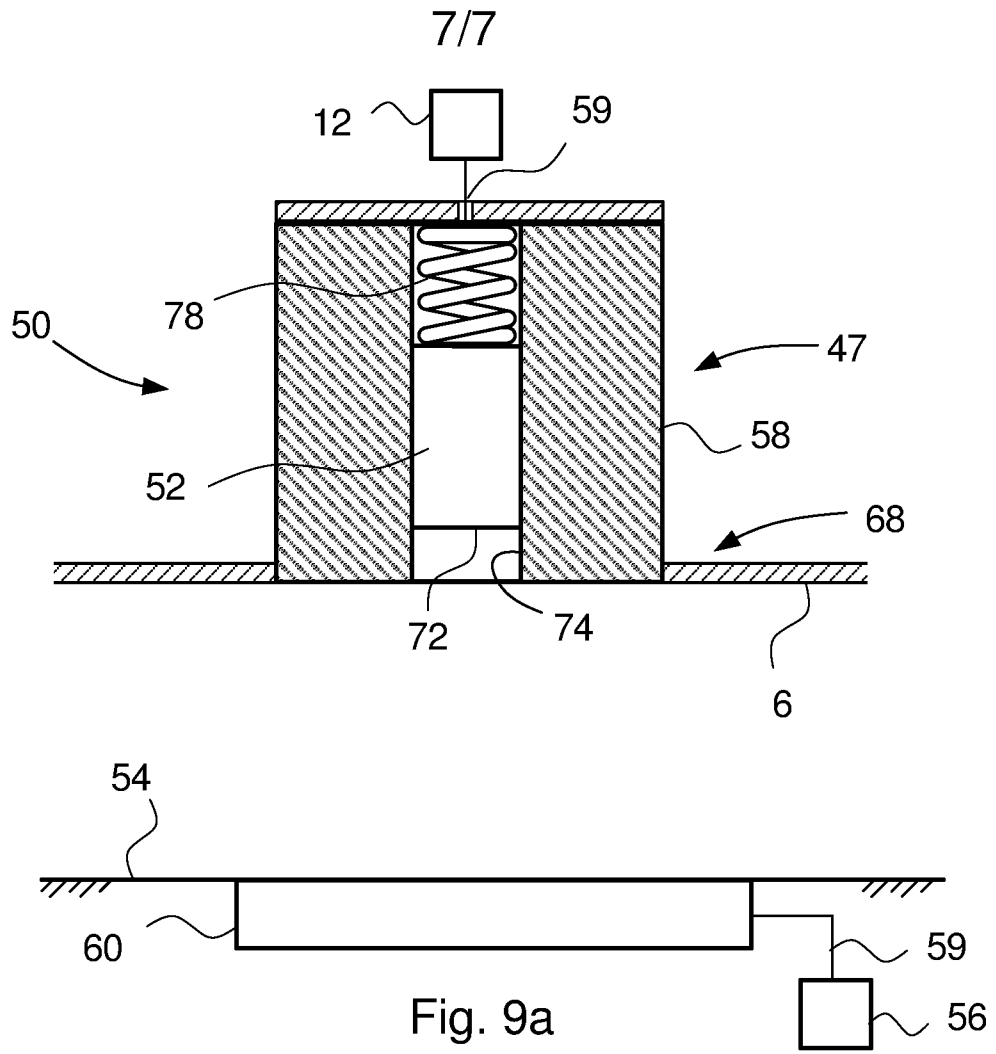


Fig. 5b







INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2019/050422

A. CLASSIFICATION OF SUBJECT MATTER		
IPC: see extra sheet		
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: B60L, B60P, B60S, B62D		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE, DK, FI, NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
EPO-Internal, PAJ, WPI data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 20180050626 A1 (DELP MICHAEL J ET AL), 22 February 2018 (2018-02-22); paragraphs [0004], [0031], [0083], [0096], [0100]; figures 3, 4A-C, 11, 11A	1-7, 11-14
Y	--	1-7, 8-10, 11-16
Y	DE 102016209099 A1 (BAYERISCHE MOTOREN WERKE AG), 27 July 2017 (2017-07-27); paragraphs [0021], [0034]-[0035], [0039]-[0040]; figures 1, 2A, 3A	1-7, 11-16
Y	CN 106904153 A (GOERTEK TECH CO LTD), 30 June 2017 (2017-06-30); page 2, paragraph [0004] - page 2, paragraph [0004]; figures 1, 3	8-10
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<input checked="" type="checkbox"/>	Further documents are listed in the continuation of Box C.	<input checked="" type="checkbox"/> 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		"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
"D" document cited by the applicant in the international application		"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
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"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)		"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
"O" document referring to an oral disclosure, use, exhibition or other means		
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Date of the actual completion of the international search	Date of mailing of the international search report	
11-07-2019	12-07-2019	
Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer Lisa Assbring Telephone No. + 46 8 782 28 00	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2019/050422

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	DE 202012002846 U (DEUTSCHES FORSCHUNGSZENTRUM FUER KUENSTLICHE INTELLIGENZ GMBH), 20 July 2012 (2012-07-20); paragraphs [0042]-[0043]; figures 1, 5, 6 -- -----	1-16

Continuation of: second sheet

International Patent Classification (IPC)

B60P 3/42 (2006.01)

B60S 9/02 (2006.01)

B62D 63/02 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2019/050422

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DE	102016209099	A1	27/07/2017	NONE			
CN	106904153	A	30/06/2017	NONE			
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