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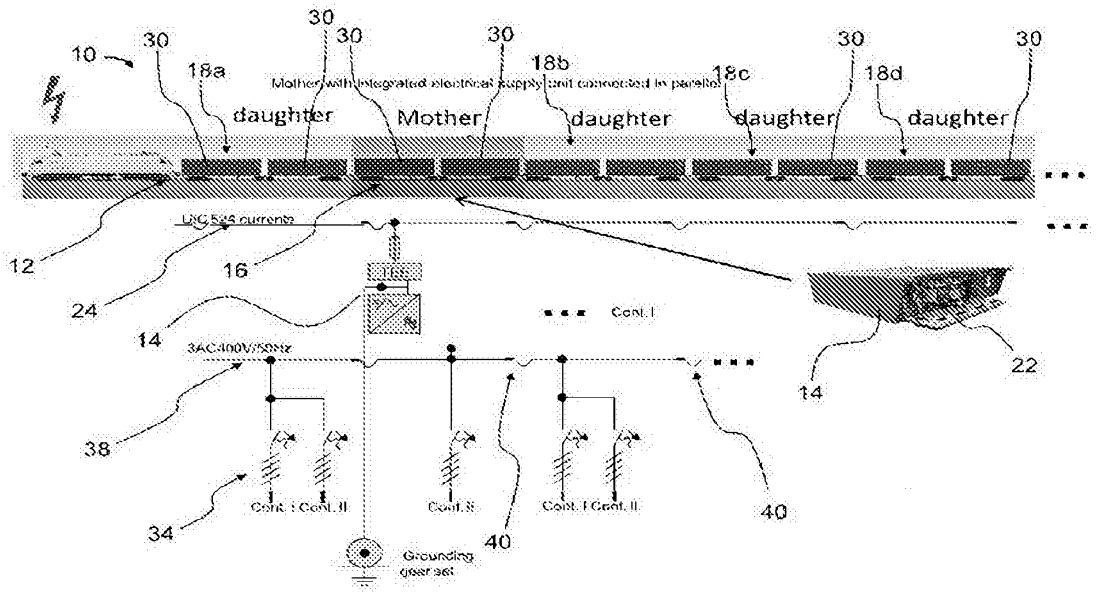
(54) **POWER SYSTEM AND ASSOCIATED METHODS**

(57) A freight rail train electrical power system for a goods-related auxiliary electrical system. The electrical power system has at least one electrical power supply unit for providing goods-related auxiliary electrical power. The electrical power supply unit provides an auxiliary electrical power output to a plurality of wagons. The electrical power supply is supplied with an input of electricity from a train-line ("Zugsammelschiene") of the train.



POWER SYSTEM AND ASSOCIATED METHODS

TECHNICAL FIELD

This disclosure concerns a power system. For example, the disclosure concerns a power system for powering a railway-associated system, particularly, but not exclusively, for powered freight transport via railway or railroad, such as refrigerated rail transport.

BACKGROUND

Containers are commonly used for freight transportation on various forms of transport. Standardisation of containers has facilitated easier transfer of containers between different vehicles, such as from ship to lorry, leading to such containers being known as intermodal freight containers. Standardised containers, such as with predetermined dimensions and anchor points, can be customised for different applications. For example, transportation of some freight or goods may require controlled conditions or powered systems during transit. In particular, refrigerated containers, or "reefers", may be used for transporting cooled goods, such as perishable foodstuffs, medicines, or the like.

Such containers are typically well-insulated, providing passive refrigeration. In addition, active refrigeration systems are often used to actively cool the containers, such as by circulating a refrigerant or a cooling agent. The containers are typically transported by ship, air, rail or road; and often complete journeys involving more than one mode of transport. Sometimes the powered systems, such as the active refrigeration, can be powered by bespoke power supplies, such as diesel generators associated with the containers. Goods requiring powered freight transportation often have an associated power supply, such as can be loaded onto a lorry, ship or rail wagon as appropriate with the container. Accordingly, each lorry or rail wagon can have a power supply for the container or containers on that lorry or wagon. Particularly where the containers are intermodal and can be transferred between different modes of transport or different vehicles, then it can be useful to ensure that each container always has a dedicated power supply available.

SUMMARY

According to a first aspect there is provided an electrical power system for a railway or railroad vehicle, such as for powering a rail train's auxiliary electrical system. The train may comprise a freight train. The auxiliary electrical system may comprise a goods-related electrical system. The electrical power system may comprise at least one electrical power supply unit for providing electrical power to a wagon or traincar, or multiple wagons or traincars. The electrical power supply unit may provide electrical power to a plurality of wagons. The electrical power supply unit may provide an electrical power output. The electrical power output may be for providing auxiliary electrical power to a plurality of wagons or traincars. A single electrical power output may provide electrical power for the plurality of wagons or traincars. The auxiliary electrical power output from the electrical power supply unit may be a non-train-line electrical power. The power output may comprise a non-train-line output. The auxiliary electrical system may comprise a power supply unit that is powered by electricity that is drawn from a rail power line, such as drawn from an overhead line. The auxiliary electrical system's power supply unit may comprise a convertor. For example, the auxiliary electrical system may comprise a convertor for converting electricity from a train's train-line ("Zugsammelschiene"). The train-line may be for providing train operational power, such as for the locomotion of the train. The train-line may provide traction and/or braking power/s for the train. The train-line may comprise a standard electrical train-line for supplying power along the train, such as with connections between wagons of the train. The train-line may comprise a train-line such as conforming to UIC (Union Internationale des Chemins de Fer) 552, 10th edition, June 2005 (UIC 552); or similar. The power supply unit may receive an input from the train line. For example, the power supply unit's input may be configured for connection to the train line, such as via a UIC 552 connection, or similar. The power output may provide an additional or alternative power output to a train's train line. For example, the power output may provide an additional power output, such as with a different power and/or voltage and/or current rating to the train's train line. In at least some examples, the auxiliary electrical power system may provide a lower voltage output than a train's standard train-line. The auxiliary electrical power may comprise a non-essential electrical power, such as non-essential to the running or operation of the train or of the wagon/s. The auxiliary electrical power system may comprise a non-critical electrical power system, such as non-critical to a safe operation of the train or of the wagon/s.

The present inventors have identified that always supplying each wagon with its own power supply for goods container/s on that wagon may not be the most efficient or economical method to power the goods container/s. By using a power output on one wagon to power further goods wagons, the total number of power supply units required may be reduced. Accordingly, energy, space, weight and/or cost efficiencies may be achieved.

The power system may comprise an entirely electrical power system. In contrast to a power system whereby electricity may be indirectly generated, such as via a generator (e.g. diesel or associated with locomotion, such as a dynamo), an entirely electrical power system may be advantageous. For example, the auxiliary electrical power system may power the plurality of wagons independently of movement of a railway vehicle, such as when the railway vehicle is, or has been, stationary. The auxiliary electrical power system may be operational provided that the train is connected to a railway powerline, such as an overhead line. The auxiliary electrical power system may be operational without generation; such as without a dynamo; and/or without a generator. For example, the auxiliary electrical power system may not require a diesel generator. The auxiliary electrical power system may be configured to provide the electrical power output without a battery, cell or other accumulator. The electrical power system may be configured to provide electrical power directly to the goods-related electrical system. Particularly compared to a generator-based system, the present auxiliary electrical power system may comprise a minimum of or no wearing parts. The auxiliary electrical power system may operate without a bespoke loco or a bespoke, specialised cable. For example, the auxiliary electrical power system may not require a specialist or bespoke wagon or car for supplying electrical power, the specialist or bespoke loco being unable or less able to transport goods than other non-specialist or non-bespoke goods cars or wagons. The auxiliary electrical power system may not provide or demand any extra resistance on wheels of the train. The auxiliary electrical power system may be generally insensitive to weather and/or train speed.

The wagon comprising the auxiliary electrical power supply unit may comprise a mother wagon. The mother wagon may be configured to supply auxiliary electrical power for a goods-related power sink/s associated with the mother wagon. The mother wagon may comprise an auxiliary electrical wagon connection/s for electrical connection to further wagon/s, such as the daughter wagon/s. Additionally, the mother wagon may comprise train-line connection/s for connection to further wagon/s, such as the daughter wagon/s and/or non-daughter wagons, such as non-goods wagons (e.g. locomotive wagons). Additionally, the mother wagon may be

configured to supply auxiliary electrical power for a goods-related power sink/s associated with the mother wagon.

The auxiliary electrical system may comprise one or more of: a refrigeration system; an air-conditioning system; a heating system; a circulation system, such as incorporating a fan and/or a vent. The auxiliary electrical system may be for supplying the output power to a plurality of power sinks. The auxiliary electrical system may be for supplying electricity to a variety of goods-related power sinks. The variety of goods-related power sinks may comprise a variety of similar types of goods-related power sinks. For example, the variety of goods-related may comprise various refrigeration systems, such as mixed cargo refrigeration systems. Additionally, or alternatively, the auxiliary electrical system may be suitable for and/or configured or configurable for various types of goods-related power sinks. For example, the variety of goods-related power sinks may comprise a mixture of one or more of: the refrigeration system; the air-conditioning system; the heating system; the circulation system. The power sink may comprise a computer, such as a programmable or programmed electronic device for monitoring and/or controlling one or more of the goods-related systems. For example, the power sinks may include a computer for monitoring container temperature, such as based upon data received from one or more sensors. The power sink may include a goods-related monitoring and/or management computer system. The power sink may include an auxiliary electrical power management system.

The auxiliary electrical power system may comprise a conductor/s for transmitting the auxiliary electrical power. The conductor/s may comprise a cable network/s or circuit/s discrete from a train line cable network/s or circuit/s; such as a train's UIC 552 train line cable network. The auxiliary electrical power system cable network may be discrete from a vehicle locomotion (e.g. propulsion and/or braking and/or control) cable network.

The auxiliary electrical power system may provide one or more auxiliary electrical power connection/s on each wagon in the system. The auxiliary electrical power connection/s on each wagon may be in addition to train line connections on each wagon, such as standard UIC 552 or similar on each wagon. Each wagon may comprise at least a pair of auxiliary electrical power goods connections for connection to at least a pair of containers on each wagon. Each wagon may comprise at least a pair of auxiliary electrical power wagon connections for connect to at least a pair of wagons, such as other wagons adjacent each end of the wagon. The each may wagon may include the mother and daughter/s wagons. The

auxiliary electrical power supply system may provide auxiliary electrical power in parallel to the train line.

The connector/s and/or conductor/s may be suitable for, such as rated for, train-line use (e.g. conforming to UIC 552 or the like).

The power output may comprise an AC voltage/s. The power output may provide an electrical power supply suitable for an electrical goods-related system, without requiring further or additional adaptation to be fed in or connected to the goods-related system. In at least some examples, the electrical power output may be configured for or suitable for direct connection to a goods container, such as an intermodal goods container conforming to ISO 1496-2, or similar. The electrical power output may comprise 3-phase AC. The electrical power output may comprise a voltage in a range of about 100V to about 600V. The electrical power output may supply a voltage in a range of about 300V to about 500V. In at least some examples, the convertor is configured to supply an electrical power output of about 360V to about 460V, 50HZ. In at least some examples, the convertor is configured to supply an electrical power output of about 400V to about 500V, 60HZ. In at least one example, the electrical power output is about 400V, 50Hz.

The convertor may conform to UIC 550 and/or UIC 626. The convertor may comprise a transformer. The convertor may convert an AC voltage into an AC voltage. Additionally or alternatively, the convertor may convert a DC voltage into an AC voltage. Additionally or alternatively, the convertor may convert an AC voltage into a DC voltage. Additionally, or alternatively, the convertor may convert a DC voltage into a DC voltage. The convertor may provide a voltage step-down. The convertor may comprise an Insulated Gate Bipolar Transistors (IGBT), such as a Siemens Sibest fourway power supply unit, similar to that used for Austrian Railways' Railjet passenger trains. Although specifically developed only for passenger trains, the present inventors have identified possible adaptation of such a power supply unit for particular goods railfreight as described herein. The power supply unit may be suitable for operation with a variety of inputs. For example, the power supply unit may operate with AC and/or DC inputs. Providing the power supply unit that can operates with the variety of inputs may allow the train to operate across different rail networks. For example, the convertor, and associated auxiliary electrical power system may operate continuously, or substantially continuously, across regional, international or intercontinental rail networks, accommodating transport of the rail freight on international or intercontinental journeys, such

as a silk route between Asia and Europe. The convertor may allow the auxiliary electrical power system to operate continuously irrespective of or independent from the electrical supply to the train, such as via a pantograph from an overhead line. The convertor may be configured or configurable to operate on an input selected from one or more of: AC 1000 V, 16 $^{2}/_{3}$ Hz; AC 1000V, 50 Hz; AC 1500 V, 50 Hz; DC 1500 V; and/or DC 3000 V. In at least some examples, the convertor may automatically adapt to changes in input; such as to provide a constant or consistent electrical power output irrespective of or independent from the electrical power input. The electrical input may conform to UIC 552. The electrical input may provide a maximum current of around: 600A; 800A or 1000A.

The goods-related auxiliary electrical system/s may comprise a container/s; such as an intermodal freight container. The container may conform to ISO 1496-2, or similar.

The goods-related auxiliary electrical system/s may comprise an active system. In at least some examples, the goods-related auxiliary electrical system/s comprises a powered refrigeration system. In at least some examples the goods-related auxiliary electrical system/s comprises a powered freezing system. The auxiliary electrical power system may be configured to improve efficiency, such as in cost, energy and/or time. For example, rather than require full or complete freezing of goods prior to transit, the goods may be at least partially actively frozen in transit. For example, the goods may become frozen or fully frozen in transit. Rather than merely maintaining goods at a frozen temperature whilst in transit, the goods' temperature may be at least partially reduced during transit, such as to reach a required or desired freezing temperature. For example, particularly for goods with a high value, quick perishability and/or high thermal capacity or goods in general that must undergo a particular cooling or freezing regime, such as at particular rates, the auxiliary electrical system may provide sufficient power to actively reduce the temperature of such goods in a container. Accordingly, the train may be able to commence a journey prior to full or complete freezing of the goods. For example, where a freezing time may be several hours, days or even weeks, such as to bring a container-load of meat to acceptable frozen temperature, the auxiliary electrical system may allow the train with the goods to depart before the acceptable frozen temperature has been reached. In at least some examples, the auxiliary electrical system may provide a similar power to a non-rail based electrical power supply, such as a warehouse-based electrical power supply. Accordingly, the auxiliary electrical power supply may allow the goods to be transported or begin transportation by rail at a different stage in a cooling or freezing regime. For example, the goods may be able to depart hours, days, or even weeks

earlier than may otherwise be possible if the goods must first be completely cooled or frozen before beginning transportation by rail.

The power sink may comprise a fan, such as a circulation fan for circulating a fluid. The fluid may comprise a gas, such as air. The fluid may comprise an inert fluid, such as nitrous oxide. The power sink may comprise a pump, such as for circulating a fluid. The fluid may comprise a coolant or a refrigerant. The power sink may comprise a heat exchanger and/or a condenser.

The/each mother and/or daughter wagon/s may comprise a fuse and/or a switch and/or an indicator. The fuse may be for preventing a supply of an inappropriate current to a container. The switch may be for selectively activating one or more auxiliary electrical circuits on the wagon, such as whether the wagon (or a circuit thereof) is ON or OFF. The indicator may be a light or the light, indicative of whether the wagon's auxiliary electrical circuit/s is/are connected to the auxiliary electrical power supply (i.e. whether the wagon is receiving and/or providing auxiliary electrical power).

According to a further aspect there is provided a mother wagon comprising the electrical power supply unit of any other aspect, example, embodiment or claim. In at least one example, the mother wagon comprises the convertor. The mother wagon may be configured to connect to other wagons in the auxiliary electrical power supply system. The mother wagon may be configured to supply electrical output for multiple wagons, such as by auxiliary electrical connection/s to one or more other wagons. The mother wagon with the convertor may comprise a master wagon for supplying auxiliary electrical power to one or more other wagons, such as one or more daughter or servant wagons. The mother wagon may comprise a freight or goods wagon. The wagon may comprise a Jacobs bogie. The mother wagon may be configured to supply auxiliary electrical power to the daughter wagon. The mother wagon may be configured to communicate with the daughter wagon. The mother wagon may be configured to communicate wirelessly. The mother wagon may be configured to receive a communication signal from the daughter wagon. The communication signal may comprise a signal indicative of the status of the daughter wagon or of a container/s thereon, such as whether the container/s are adequately powered. The signal may provide a confirmation that the container/s is/are connected and/are operating correctly, such as according to appropriate settings. The communication may provide an independent confirmation. At least one of the mother and/or at least one of the daughter wagon/s may be configured to communicate with a control centre; such as a remote control centre, (e.g. as operated or similar to a remote

Smith Holland container control centre). The communication may comprise data, such as status data and/or location data (e.g. GPS position or the like). The auxiliary electrical power supply system may be controlled from the control room. The communication between the daughter/s and mother wagons may be unidirectional, such as only from the daughter wagon/s to the mother wagon (e.g. to demand power). In at least some examples, the mother wagon may be configured to communicate bidirectionally with the daughter wagon (e.g. to request and receive daughter wagon status).

The mother wagon may be configured to receive goods. For example, the mother wagon may be configured to receive one or more containers. The mother wagon may comprise a chassis for receiving a pair of intermodal containers, the pair of intermodal containers being mountable and removable from the mother wagon as required, such as during intermodal transit. The mother wagon may be configured to supply electrical power to the goods. For example, the mother wagon may comprise a goods auxiliary electrical power connector/s. The mother wagon may be configured to receive train line electrical power. The mother wagon may comprise an interface between the train line and the convertor, for supplying electrical input to the convertor. The mother wagon's chassis may comprise the electrical connector/s and/or the interface. The mother wagon's chassis may comprise the convertor. The electrical power supply, including the convertor, may be housed in an undercarriage of the chassis of the mother wagon. Accordingly, the mother wagon may be configured for receiving goods, such as one or more container/s, on the chassis (e.g. above the electrical power supply unit). A single mother wagon may be configured to supply auxiliary electrical power to at least three daughter wagons. In at least some examples the mother wagon may be configured to supply auxiliary electrical power to at least three daughter wagons, the mother wagon and each daughter wagon housing two powered containers each. Accordingly, the mother wagon may be configured to supply auxiliary electrical power to at least eight powered containers. The powered containers may be high-powered containers, such as requiring maximum or near maximum power most or all of the time. For example, the high-powered containers may comprise reefers for fruit, flowers and/or vegetables or the like; or a combination thereof. Accordingly, the mother wagon may be configured to supply auxiliary electrical power for simultaneously powering up to eight high-powered goods containers. The mother wagon may be configured to provide continuous or substantially continuous power to the containers. Additionally, or alternatively, the mother wagon may be configured to provide intermittent, such as periodic or sequential, power to the container/s.

According to a further aspect there is provided a daughter wagon configured for electrical connection to the wagon with the electrical power supply unit of any other aspect, example, embodiment or claim, such as the mother wagon of the preceding aspect. In at least one example, the daughter wagon comprises the wagon with no or without the convertor. The daughter wagon may be configured to connect to other wagons in the auxiliary electrical power supply system. The daughter wagon may be configured to receive and/or transfer auxiliary electrical power, such as by auxiliary electrical connection/s to one or more other wagons. The daughter wagon may be configured to receive auxiliary electrical power from the mother wagon and/or from another daughter wagon. The daughter wagon may be configured to transfer the auxiliary electrical power from the mother wagon or the another daughter wagon to a yet further daughter wagon. The daughter wagon may comprise a freight or goods wagon. The wagon may comprise a Jacobs bogie. The daughter wagon may be configured to supply auxiliary electrical power to the yet further daughter wagon. The daughter wagon may be configured to communicate with the mother wagon. The daughter wagon may be configured to communicate wirelessly. The daughter wagon may be configured to communicate with the mother wagon unidirectionally, such as to send the signal to the mother wagon (e.g. to confirm the daughter wagon and/or the container/s thereon are electrically connected to the mother wagon). In at least some examples, the daughter wagon may be configured to receive a communication signal from the mother wagon. The daughter wagon may be configured to communicate bidirectionally with the mother wagon. The daughter wagon may be configured to receive goods. For example, the daughter wagon may be configured to receive one or more containers. The daughter wagon may comprise a chassis for receiving a pair of intermodal containers, the pair of intermodal containers being mountable and removable from the daughter wagon as required, such as during intermodal transit. The daughter wagon's chassis may comprise the electrical connector/s. The daughter wagon may comprise a communication means via the goods. For example, a container with a wireless communication means housed on the daughter chassis may provide communication.

According to a further aspect, there is provided a railway vehicle, such as a train, comprising at least one mother wagon of any other aspect, example, embodiment or claim and at least one daughter railway vehicle of any other aspect, example, embodiment or claim. The train may comprise a single mother wagon, the mother wagon providing the auxiliary electrical power supply to up to 5 daughter wagons. The single mother wagon may be configured to power up to one or more of: 10 daughter wagons; 15 daughter wagons; 20 daughter wagons; 25 daughter wagons. In at least some examples, the single mother wagon may be configured

to provide the auxiliary electrical power supply to more than 25 daughter wagons. The train may comprise a plurality of mother wagons, each mother wagon being configured to supply auxiliary electrical power to at least one respective daughter wagon. Accordingly, in at least some example trains, two or more mother wagons may provide auxiliary electrical power to 50 or more daughter wagons. Accordingly, such a train may comprise more than 100 powered containers, such as more than 100 reefers.

According to a further aspect there is provided a method of powering a railway-based auxiliary electrical system, such as powering a rail train's auxiliary electrical system. The train may comprise a freight train. The method may comprise supplying auxiliary electrical power to a goods-related electrical system. The method may comprise supplying auxiliary electrical power from a mother wagon, the mother wagon comprising an auxiliary electrical power supply unit, to one or more daughter wagon/s, the daughter wagon/s being bereft of an auxiliary electrical power supply unit.

The method may comprise monitoring a status. The status may comprise an electrical status of a wagon and/or a container housed thereon or therein. For example, the method may comprise checking electrical supply connection. The method may comprise sending a signal when or whenever an electrical connection to a wagon or a container is completed. The signal may be communicated between the daughter and mother wagons. For example, the power supply unit may be controlled or managed by a controller that identifies containers connected to the power supply unit of the mother wagon. For example, the container may comprise a reefer with a universal remote monitor, such as an Identec Q350 monitor. The method may comprise sending a signal as soon as a container is connected, allowing the container to be powered upon connection and optionally providing tracking capabilities to verify the status of goods in the container in transit. The method may comprise sending a signal when or whenever a container is electrically disconnected.

The method may comprise performing one or more actions in response to electrical connecting, such as one or more of: sending a signal, venting, circulating, queuing the container in a power management system. The action/s may be predetermined. The action/s may be automated. Additionally, or alternatively the actions may be selectable and/or manual. Sending the signal may comprise sending the signal within the train. Additionally, or alternatively, sending the signal may comprise sending the signal remotely from the train, such as remotely to a control or logging centre (e.g. at a fixed location, such as via satellite or

telecommunication link). The method may comprise communication and/or logging via a RFID system, such as an Identec Q350 reefer monitor.

The method may comprise locally buffering or storing electrical power, such on or at the container as such. For example, between a wagon's auxiliary electrical connector/s and the container, there may be provided a battery or for a discontinuity/ies in electrical supply. For example, the local buffer may enable a wagon to perform one or more actions such when disconnected or upon disconnection, such as to send signal indicative of disconnection or prolonged disconnection.

The method may comprise selectively providing power to one or more container/s and/or wagons simultaneously and/or sequentially. The method may comprise supplying power to the containers upon a demand-based power management system. For example, when a container is trying to draw auxiliary electrical power, the container (or associated wagon) may be queued to sequentially receive power after another container. Particularly where containers may not require 100% power all of the time, a power management system may allow a single mother wagon to power a greater total of wagons. The power management system may prioritise a container (or associated wagon) depending upon one or more factor/s, such as selected from: a type of container (e.g. type of good and/or type of power system); time since last power supply to said container; demand from one or more other container/s; the type of other container/s in the system; status of said container; status of said other container/s; time since last power supply to said other container/s; availability of power.

Another aspect of the present disclosure provides a computer program comprising instructions arranged, when executed, to implement a method in accordance with any other aspect, example or embodiment. A further aspect provides machine-readable storage storing such a program.

The invention includes one or more corresponding aspects, embodiments or features in isolation or in various combinations whether or not specifically stated (including claimed) in that combination or in isolation. For example, it will readily be appreciated that features recited as optional with respect to the first aspect may be additionally applicable with respect to the other aspects without the need to explicitly and unnecessarily list those various combinations and permutations here (e.g. the device of one aspect may comprise features of any other

aspect). Optional features as recited in respect of a method may be additionally applicable to an apparatus or device; and vice versa.

In addition, corresponding means for performing one or more of the discussed functions are also within the present disclosure.

It will be appreciated that one or more embodiments/aspects may be useful in at least partially powering a railway-associated system.

The above summary is intended to be merely exemplary and non-limiting.

Various respective aspects and features of the present disclosure are defined in the appended claims.

It may be an aim of certain embodiments of the present disclosure to solve, mitigate or obviate, at least partly, at least one of the problems and/or disadvantages associated with the prior art. Certain embodiments or examples may aim to provide at least one of the advantages described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a view of an electrical power system according to a first example, including a schematic overview circuit diagram;

Figure 2 is an overhead plan view of an auxiliary electrical power system layout of a mother wagon according to the first example;

Figure 3 is an overhead plan view of an auxiliary electrical power system layout of a daughter wagon according to the first example;

Figure 4 is an overhead plan view of the wagon of Figure 2 or 3, showing a possible arrangement of containers on the wagon;

Figure 5 is an overhead plan view of the wagon of Figure 3, showing a possible positioning of connectors on the wagon;

Figure 6 is an overhead plan view of the wagon of Figure 2, showing a possible positioning of connectors on the wagon;

Figure 7 is a schematic view of an electrical power system according to a second example;

Figure 8 shows a schematic view of a train according to a third example;

Figure 9 shows a schematic view of a train according to a fourth example;

Figure 10 shows a table with an example of power supplies;

Figure 11 shows a schematic view of a train according to a fifth example; and

Figure 12 shows a schematic view of a train according to a sixth example.

DETAILED DESCRIPTION

Referring initially to Figure 1, there is shown an electrical power system 10, generally referenced by numeral 10, according to a first example. According to a first aspect there is provided an electrical power system 10 for a railway or railroad vehicle, such as for powering a rail train's auxiliary electrical system. Here, the train 12 comprises a freight train. The auxiliary electrical system comprises a goods-related electrical system. The electrical power system 10 comprises at least one electrical power supply unit 14 for providing electrical power to multiple wagons 16, 18a, 18b, 18c, 18d. The electrical power supply unit 14 provides an electrical power output for providing auxiliary electrical power to the plurality of wagons 16, 18a, 18b, 18c, 18d. Here, a single electrical power output from a single electrical power supply unit 14 on a mother wagon 16 provides electrical power for the plurality of wagons 16, 18a, 18b, 18c, 18d. It will be appreciated that the schematic view of Figure 1 includes a detail view of the single electrical power supply unit 14 with an arrow indicating where the unit is located, housed under the chassis of the mother wagon 16. As can be seen from the example circuit diagram of Figure 1, the auxiliary electrical power output from the electrical power supply unit 14 is a non-train-line electrical power. The auxiliary electrical system comprises a power supply unit 14 that is powered by electricity that is drawn from a rail power line (not shown), such as drawn from an overhead line. The auxiliary electrical system's power supply unit 14 comprises a convertor 22 for converting electricity from a train's train-line ("Zugsammelschiene") 24. It will be appreciated that the train-line 24 can be for providing train operational power, such as for the locomotion of the train; and optionally for other auxiliary power requirements. The train-line 24 comprises a standard electrical train-line for supplying power along the train 12, such as with connections between wagons 16, 18a, 18b, 18c, 18d of the train, here conforming to UIC (Union Internationale des Chemins de Fer) 552, 10th edition, June 2005 (UIC 552). As shown in the circuit diagram, the power supply unit 14 receives its input 26 from the train line 24, the power supply unit's input 26 being configured for connection to the train line 26, via a UIC 552 connection, or similar. The power output provides an additional or alternative power output to the train's train line 24, shown in the

circuit diagram as a parallel supply. Here, the power output provides an additional power output, with a different voltage and current rating to the train's train line 24. The auxiliary electrical power system 10 provides a lower voltage output than the train's standard train-line 24. The auxiliary electrical power comprises a non-essential electrical power, which is non-essential to the running or operation of the train 12, also being non-critical to a safe operation of the train 12.

The present inventors have identified that always supplying each wagon 16, 18a, 18b, 18c, 18d with its own power supply for goods container/s 30 on that wagon 16, 18a, 18b, 18c, 18d may not be the most efficient or economical method to power the goods container/s 30. By using a power output on one wagon 16 to power further goods wagons 18a, 18b, 18c, 18d, the total number of power supply units 14 required is reduced. Accordingly, energy, space, weight and/or cost efficiencies is achieved.

The power system 10 comprises an entirely electrical power system 10. In contrast to a power system 10 whereby electricity is indirectly generated, such as via a generator (e.g. diesel or associated with locomotion, such as a dynamo), an entirely electrical power system 10 is advantageous. For example, the auxiliary electrical power system 10 shown here can power the plurality of wagons 16, 18a, 18b, 18c, 18d independently of movement of the train, such as when the train is, or has been, stationary; or is moving slowly. The auxiliary electrical power system 10 is operational provided that the train 12 is connected to a railway powerline, such as an overhead line. The auxiliary electrical power system 10 is operational without generation: without a dynamo and without a generator. For example, the auxiliary electrical power system 10 here does not require a diesel generator. The auxiliary electrical power system 10 is configured to provide the electrical power output without a battery, cell or other accumulator, providing electrical power directly to the goods-related electrical system. Particularly compared to a generator-based system, the present auxiliary electrical power system 10 comprises a minimum of or no wearing parts. The auxiliary electrical power system 10 operates without a bespoke loco or a bespoke, specialised cable. As can be seen from Figure 1, the auxiliary electrical power system 10 does not require a specialist or bespoke wagon or car for supplying electrical power, noting that a specialist or bespoke loco might be unable or less able to transport goods than other non-specialist or non-bespoke goods wagons, such as the wagons 16, 18a, 18b, 18c, 18d shown in Figure 1. The auxiliary electrical power system 10 here does not provide or demand any extra resistance on wheels of the train 12; and is generally insensitive to weather and train speed.

Referring now also to Figures 2 to 6, the mother wagon 16 comprising the auxiliary electrical power supply unit 14 is configured to supply auxiliary electrical power for a goods-related power sink/s associated with the mother wagon 16. As can be seen from Figures 2 and 6 in particular, the mother wagon 16 comprises auxiliary electrical wagon connections 40 for electrical connection to further wagons 18a, 18b, 18c, 18d, such as the daughter wagons 18a, 18b, 18c, 18d as shown in Figure 1; or another mother wagon (not shown) or the traction loco 13 shown in Figure 1 - in an alternative train configuration to that shown in Figure 1. Additionally, the mother wagon16 comprises train-line connections 32 (Zugsammelschiene) for connection to further wagons, such as the daughter wagons 18a, 18b, 18c, 18d and/or non-daughter wagons, such as another mother wagon (not shown) or non-goods wagons (e.g. the locomotive wagon 13). The train-line connections 32 are standard UIC 552. Additionally, the mother wagon 16 here is configured to supply auxiliary electrical power for a goods-related power sink/s associated with the mother wagon 16, in the form of a pair of containers 30, as schematically shown in Figure 4, via auxiliary electrical power goods connections 34 on each wagon in the system. The auxiliary electrical power goods connections 34 on each wagon 16, 18a, 18b, 18c, 18d is in addition to train line connections 32 on each wagon 16, 18a, 18b, 18c, 18d. Each wagon comprises at least a pair of auxiliary electrical power goods connections 34 for connection to at least a pair of containers 30 on each wagon 16, 18a, 18b, 18c, 18d. Each wagon comprises at least a pair of auxiliary electrical power goods connections 34 for connection to at least a pair of wagons 16, 18a, 18b, 18c, 18d, adjacent each end of the wagon 16, 18a, 18b, 18c, 18d, including the mother and daughters wagons 16, 18a, 18b, 18c, 18d. As can clearly be seen from the circuit diagram of Figure 1, the auxiliary electrical power supply system 10 provides auxiliary electrical power in parallel to the train line 12.

As shown here, the auxiliary electrical power system 10 is suitable for each and all of: a refrigeration system; an air-conditioning system; a heating system; a circulation system, such as incorporating a fan and/or a vent; and various combinations hereof. The auxiliary electrical power system 10 can supply electricity to a variety of goods-related power sinks. As will be appreciated from the figures, the provision of the auxiliary electrical power goods connections at or on each chassis of each wagon 16, 18a, 18b, 18c, 18d allows each wagon to be used for a different power sink/s as required. In at least some examples, the power sink comprises a computer, with a programmable or programmed electronic device for monitoring and/or controlling one or more of the goods-related systems. The computer monitors container temperature, based upon data received from one or more sensors. The computer is effectively

a goods-related monitoring and management computer system for an auxiliary electrical power management system.

The auxiliary electrical power system 10 comprises conductors 38 for transmitting the auxiliary electrical power. The conductors 38 comprises a cable network or circuit discrete from the train's UIC 552 train line cable network or circuits; and is discrete from a train locomotion (e.g. propulsion and/or braking and/or control) cable network. Although forming a parallel circuit to the train line 24, the connectors 34 and conductors 38 of the auxiliary electrical power system 10 are rated to conform to UIC 552.

Each mother and daughter wagon 16, 18a, 18b, 18c, 18d comprises fuses and a switch and an indicator light, located in or on a column 56. The fuse is for preventing a supply of an inappropriate current to a container 30. The switch is for selectively activating one or more auxiliary electrical circuits on the wagon 16, 18a, 18b, 18c, 18d, such as whether the wagon 16, 18a, 18b, 18c, 18d (or a circuit thereof) is ON or OFF. The indicator light here is a light, indicative of whether the wagon's auxiliary electrical circuit/s is/are connected to the auxiliary electrical power supply 10 (i.e. whether the wagon 16, 18a, 18b, 18c, 18d is receiving and/or providing auxiliary electrical power).

Referring now to Figure 7, there is shown a schematic view of an auxiliary electrical power system 110 according to a second example. The electrical power system 110 is generally similar to that 10 shown in Figures 1 to 6, with similar features referenced by similar reference numerals, incremented by 100. Accordingly, the electrical power system 110 of Figure 7 comprises a mother wagon 116 with a power supply unit 114.

The power output comprises an AC voltage/s, providing an electrical power supply suitable for an electrical goods-related system, without requiring further or additional adaptation to be fed in or connected to the goods-related system. As shown here, the electrical power output is configured for and suitable for direct connection to intermodal goods containers 130 conforming to ISO 1496-2. The electrical power output comprises 3-phase AC. The electrical power output comprises a voltage in a range of about 100V to about 600V. The electrical power output supplies a voltage in a range of about 300V to about 500V. More specifically, the convertor 122 is configured to supply an electrical power output of about 360V to about 460V, 50HZ, being about 400V, 50Hz here. It will be appreciated that the train 212 is shown

here schematically, in a quasi partial exploded assembly, whereas in practice the mother wagon 116 and daughter wagon 118a are connected end to end.

The convertor 122 here conforms to UIC 550 and UIC 626. In particular, the convertor 122 converts an AC voltage into an AC voltage; and also a DC voltage into an AC voltage. Here, the convertor 122 provides a voltage step-down via Insulated Gate Bipolar Transistors (IGBT), provided in a Siemens Sibest fourway power supply unit 114, similar to that used for Austrian Railways' Railjet passenger trains. Although specifically developed only for passenger trains, the present inventors have managed to adapt the power supply unit 114 for particular goods railfreight as described herein. The power supply unit 114 is suitable for operation with a variety of inputs. For example, the power supply unit 114 operates with AC or DC inputs. Providing the power supply unit 114 that can operate with the variety of inputs allows the train 112 to operate across different rail networks. For example, the convertor 122, and associated auxiliary electrical power system 110 can operate continuously, or substantially continuously, across regional, international or intercontinental rail networks, accommodating transport of the rail freight on international or intercontinental journeys, such as a silk route between Asia and Europe. The convertor 122 allows the auxiliary electrical power system 110 to operate continuously irrespective of or independent from the electrical supply to the train 112, such as is supplied to the train 112 via a pantograph from an overhead line. The convertor 122 is configured to operate on at least any of the following inputs: AC 1000 V, 16 $^{2}/_{3}$ Hz; AC 1000V, 50 Hz; AC 1500 V, 50 Hz; DC 1500 V; and/or DC 3000 V. Here, the convertor 122 automatically adapts to changes in input; such as to provide a constant or consistent electrical power output to the auxiliary electrical power system 110 irrespective of and independent from the electrical power input. Here, the electrical input conforms to UIC 552, providing a maximum current of around: 600A; 800A or 1000A.

The mother wagon 116 is configured to connect to other wagons 118a in the auxiliary electrical power supply system. The mother wagon 116 is configured to supply auxiliary electrical output for multiple wagons 116, 118a, by the auxiliary electrical connections 134. Here, each wagon 116, 118a comprises a Jacobs bogie. Here, the mother wagon 116 is configured to communicate with the daughter wagon 118a.

It will be appreciated that the daughter wagon 118a is configured to supply auxiliary electrical power to the yet further daughter wagons (not shown). The daughter wagon 118a is configured to communicate with the mother wagon 116. Here, the mother and daughter wagons comprise

For example, the container comprises a reefer with a universal remote monitor, such as an Identec Q350 monitors 160 for communicating wirelessly. It will be appreciated that the monitors 160 may be mounted or connected to the containers (not shown mounted), such that each wagon 116, 118a may comprise two monitors 160.

Referring now to Figure 8, there is shown a schematic view of a train 212 according to a third example. The electrical power system 210 is generally similar to that 110 shown in Figure 7, with similar features referenced by similar reference numerals, incremented by 100. Accordingly, the electrical power system 210 of Figure 8 comprises a mother wagon 216 with a power supply unit 214.

The goods-related auxiliary electrical system 210 here comprises an active system, being a powered refrigeration system. In the particular train configuration shown in Figure 8, the mother wagon 216 is configured to supply auxiliary electrical power to at least three daughter wagons 218a, 218b, 218c, the mother wagon 216 and each daughter wagon 218a, 218b, 218c housing two powered containers 230 each. Accordingly, the mother wagon 216 is configured to supply auxiliary electrical power to at least eight powered containers 230. Here, the powered containers 230 are all high-powered containers 230, such as requiring maximum or near maximum power most or all of the time. For example, the high-powered containers 230 here comprise reefers for a combination of fruit, flowers and vegetables or the like. Accordingly, the mother wagon 216 is configured to supply auxiliary electrical power for simultaneously powering up to eight high-powered goods containers 230, providing continuous or substantially continuous power to the containers 230. As shown here, it will be appreciated that the daughter wagons 218a, 218b, 218c are each configured to receive and also transfer auxiliary electrical power, via the auxiliary electrical connections 234 to other wagons 218a, 218b, 218c. Each daughter wagon 218a, 218b, 218c is configured to receive auxiliary electrical power from the mother wagon 216 directly or from another daughter wagon 218a, 218b, 218c (here the rearwards two daughter wagons 218b, 218c receive auxiliary electrical power supply from a respective adjacent daughter wagon 218a, 218b respectively. It will be appreciated that each container 230 constitutes a power sink comprising a fan, for circulating air; and a pump, for circulating a refrigerant; and a heat exchanger and/or a condenser.

In use, the example shown allows a method of powering the freight train's auxiliary electrical system 210. The method comprises supplying auxiliary electrical power to the goods-related

electrical system, being the refrigerated containers 230. The method comprises supplying auxiliary electrical power from the mother wagon 216, the mother wagon 216 comprising the auxiliary electrical power supply unit 214, to the daughter wagons 218a, 218b, 218c, the daughter wagons 218a, 218b, 218c being bereft of an auxiliary electrical power supply unit 214.In use, an electrical status of each wagon 216, 218a, 218b, 218c or each container 230 housed thereon or therein is monitored. When or whenever an electrical connection to a wagon 216, 218a, 218b, 218c or a container 230 is completed a signal is sent. The signal is communicated between the daughter and mother wagons 216, 218a, 218b, 218c. The power supply unit 214 is controlled or managed by a controller that identifies containers 230 connected to the power supply unit 214 of the mother wagon 216. As soon as a container 230 is connected the signal is sent, allowing the container 230 to be powered upon connection and optionally providing tracking capabilities to verify the status of goods in the container 230 in transit. Similarly, when or when a container 230 is disconnected the signal is sent, allowing actions to be taken to safeguard the goods in the container 230.

One or more actions is performed in response to electrical connecting, such as one or more of: sending a signal, venting, circulating, queuing the container 230 in a power management system. In general, the action/s is predetermined and automated. Additionally, or alternatively the actions is selectable or manual, such as via an override system. Sending the signal comprises sending the signal within the train 212. Additionally, or alternatively, sending the signal comprises sending the signal remotely from the train 212, such as remotely to a control or logging centre (e.g. at a fixed location, such as via satellite or telecommunication link). Here, the method comprises communication and/or logging via a RFID system, using Identec Q350 reefer monitors.

Referring now to Figure 9, there is shown a schematic view of a train 312 according to a fourth example. The electrical power system 310 is generally similar to that 210 shown in Figure 8, with similar features referenced by similar reference numerals, incremented by 100. Accordingly, the electrical power system 310 of Figure 9 comprises a mother wagon 316 with a power supply unit 314.

Here, the mother wagon 316 is configured to provide intermittent, such as periodic or sequential, power to the each of the containers 330. In this particular example, the goods-related auxiliary electrical system 310 includes a powered freezing system. Here, the auxiliary electrical power system 310 is configured to improve efficiency, such as in cost, energy and/or

time. For example, rather than require full or complete freezing of goods prior to transit, the goods are at least partially actively frozen in transit. For example, the goods in the containers 330 become frozen or fully frozen in transit. Rather than merely maintaining goods at a frozen temperature whilst in transit, the goods' temperature is at least partially reduced during transit, such as to reach a required or desired freezing temperature. For example, particularly for goods with a high value, quick perishability and/or high thermal capacity or goods in general that must undergo a particular cooling or freezing regime, such as at particular rates, the auxiliary electrical system 310 provides sufficient power to actively reduce the temperature of such goods in the containers 330. Accordingly, the train 312 is able to commence a journey prior to full or complete freezing of the goods. For example, where a freezing time is several hours, days or even weeks, such as to bring a container-load of meat to acceptable frozen temperature, the auxiliary electrical system 310 allows the train 312 with the goods to depart before the acceptable frozen temperature has been reached. In at least some examples, the auxiliary electrical system 310 provides a similar power to a non-rail based electrical power supply, such as a warehouse-based electrical power supply (not shown). Accordingly, the auxiliary electrical power supply 310 allows the goods to be transported or begin transportation by rail at a different stage in a cooling or freezing regime than was otherwise or previously possible. For example, the goods are able to depart hours, days, or even weeks earlier than may otherwise be possible if the goods must first be completely cooled or frozen before beginning transportation by rail.

The goods here are relatively low power goods containers 330. For example, the containers 330 may contain frozen beef at a temperature of around -30°C. Such containers 330 do not require maximum power supply 100% of the time. Noting also that the containers 330 are passively insulated, such an internal temperature of such containers 330 may rise by as little or less than about 1°C when exposed to sunny conditions for as much as 24 hours. Accordingly, here, the method comprises selectively providing power to one or more containers 330 or wagons 316, 318a, 318b, 318c, 318d, 318e, 318f, 318g, 318h, 318i, 318j simultaneously and sequentially. The method comprises supplying power to the containers 330 upon a demand-based power management system. For example, when a container 330 is trying to draw auxiliary electrical power, the container 330 (or associated wagon 316, 318a, 318b, 318c, 318d, 318e, 318f, 318g, 318h, 318i, 318j) is queued to sequentially receive power after another container 330. Particularly where containers 330 do not require 100% power all of the time, the power management system allows the single mother wagon 316 to power a greater total of wagons 316, 318a, 318b, 318c, 318d, 318e, 318f, 318g, 318h, 318i, 318j. The

power management system prioritises each container 330 (or associated wagon 318a, 318b, 318c, 318d, 318e, 318f, 318g, 318h, 318i, 318j) depending upon one or more factors, selected from: a type of container 330 (e.g. type of good and/or type of power system); time since last power supply to said container; demand from one or more other container/s 330; the type of other containers 330 in the system; status of said container 330; status of said other containers 330; time since last power supply to said other containers 330; availability of power. Here, the lower power requirements of the containers allow a total of 10 daughter wagons 318a, 318b, 318c, 318d, 318e, 318f, 318g, 318h, 318i, 318j and one mother wagon 316 to be supplied from the single mother wagon 316; still providing available power for each container around 90-100% of the time as required, based upon a typical input via a train line.

Referring now to Figure 10, there is shown a table showing examples of typical power requirements for various goods on various journeys, noting that not all journeys shown or not all entire journeys shown may be rail journeys. The table data describes a University of Wageningen study and provides an indication of actual needed availability of power, using different controls (QII and nQ), whereby it can be seen that some journeys may only actually need power available for the container for as little as 12-27% of the time, dependent upon control regime. Accordingly, such control regimes can allow even greater numbers of containers (and associated wagons) to be supplied from a single mother wagon, as can be seen by comparing Figures 11 and 12 with Figures 8 and 9 respectively. Figure 11 shows a schematic view of a train 412 according to a fifth example. The electrical power system 410 is generally similar to that 210 shown in Figure 8, with similar features referenced by similar reference numerals, incremented by 200. Accordingly, the electrical power system 410 of Figure 11 comprises a mother wagon 416 with a power supply unit 414. The containers 430 and goods are generally similar to those 430 shown in Figure 8; however an improved control regime such as indicated in Figure 10 allows more containers 430 to be supplied from the single mother wagon 416, here doubling the number of daughter wagons 418a, 418b, 418c, 418d, 418e, 418f that can be powered. Likewise, Figure 12 shows a schematic view of a train 512 according to a sixth example. The electrical power system 510 is generally similar to that 510 shown in Figure 9, with similar features referenced by similar reference numerals, incremented by 200. Accordingly, the electrical power system 510 of Figure 21 comprises a mother wagon 516 with a power supply unit 514. The containers 530 and goods are generally similar to those 530 shown in Figure 9; however an improved control regime such as indicated in Figure 10 allows more containers 530 to be supplied from the single mother wagon 516, here doubling the number of daughter wagons 518a, 518b, 518c, 518d, 518e, 518f, 518g,

518h, 518i, 518j, 518k, 518l, 518m, 518n, 518o, 518p, 518q, 518r, 518s, 518t that can be powered.

It will be appreciated that any of the aforementioned apparatus may have other functions in addition to the mentioned functions, and that these functions is performed by the same apparatus.

The applicant hereby discloses in isolation each individual feature described herein and any combination of two or more such features, to the extent that such features or combinations are capable of being carried out based on the present specification as a whole in the light of the common general knowledge of a person skilled in the art, irrespective of whether such features or combinations of features solve any problems disclosed herein, and without limitation to the scope of the claims.

The applicant indicates that aspects of the present invention may consist of any such individual feature or combination of features. It should be understood that the embodiments described herein are merely exemplary and that various modifications is made thereto without departing from the scope or spirit of the invention. For example, it will be appreciated that although shown here as a single-mother arrangement, other systems may have multiple mothers (e.g. multiple mothers, within/along a single train, each mother supplying one or more daughter wagons).

Similarly, although shown here with similar types of goods-related power sinks, such as reefers, other examples may comprise other mixtures, such as combinations of freezing, heating, etc. Where examples of foodstuffs have been provided here, other goods such as pharmaceuticals or chemicals may be transported in such or similar powered wagons.

CONCLUSIES

1. Elektrisch voedingssysteem voor een vrachtspoortrein, voor een aan goederen gerelateerd elektrisch hulpsysteem, waarbij het elektrische voedingssysteem ten minste één elektrische voedingsbroneenheid omvat om te voorzien in aan goederen gerelateerd elektrisch hulpvermogen, waarbij de elektrische voedingsbroneenheid geconfigureerd is om te voorzien in een elektrische hulpvermogenuitvoer naar een veelheid aan wagons, en waarbij de elektrische voedingsbron geconfigureerd is om gevoed te worden met een invoer van elektriciteit van een treinlijn van de trein.

2. Elektrisch voedingssysteem volgens conclusie 1, waarbij de treinlijn een UIC 552 treinlijn omvat.

3. Elektrisch voedingssysteem volgens één der voorgaande conclusies, waarbij het aan goederen gerelateerde elektrische hulpvermogen bedoeld is voor een intermodale vrachtcontainer.

4. Elektrisch voedingssysteem volgens conclusie 3, waarbij de intermodale vrachtcontainer een koelcontainer is.

5. Elektrisch voedingssysteem volgens één der voorgaande conclusies, waarbij de elektrische voedingsbroneenheid is voorzien in een frame van een enkele moederwagon om te voorzien in elektrisch hulpvermogen voor de veelheid aan wagons, waarbij de veelheid aan wagons de moederwagon en meerdere dochterwagons omvat.

6. Elektrisch voedingssysteem volgens conclusie 5, waarbij de moederwagon geconfigureerd is om één of meerdere intermodale vrachtcontainers op het frame op te kunnen nemen.

7. Elektrisch voedingssysteem volgens conclusie 5 of conclusie 6, waarbij de voedingsbroneenheid van het elektrische hulpvermogensysteem een omzetter omvat om

een spanning van de invoer van de treinlijn om te zetten om te voorzien in een spanning die verschillend is van deze van de treinlijn van de trein.

8. Elektrisch voedingssysteem volgens conclusie 7, waarbij de omzetter de spanning van de invoer van de treinlijn omlaag brengt naar een uitgangspanning van het elektrische hulpvermogen in een bereik van ongeveer 100 volt tot ongeveer 600 volt.

9. Elektrisch voedingssysteem volgens conclusie 8, waarbij de spanning van de uitvoer van het elektrische hulpvermogen ongeveer 400 volt bedraagt.

10. Elektrisch voedingssysteem volgens conclusie 9, waarbij de spanning van de uitvoer van het elektrische hulpvermogen een driefasige AC is bij 50 Hz.

11. Elektrisch voedingssysteem volgens één der conclusies 7 tot en met 10, waarbij de omzetter een Insulated Gate Bipolar Transistor (IGBT) inrichting omvat.

12. Elektrisch voedingssysteem volgens één der voorgaande conclusies, waarbij een energieketen van een elektrische voedingsleiding van een spoorweg, zoals een bovenleiding, naar het elektrische hulpvermogensysteem een volledig elektrische vermogenvoedingsketen omvat.

13. Elektrisch voedingssysteem volgens één der voorgaande conclusies, waarbij het systeem een kabelnetwerk omvat voor het overbrengen van elektriciteit van de omzetter, waarbij het kabelnetwerk een discreet kabelnetwerk omvat dat gescheiden is van de treinlijn.

14. Elektrisch voedingssysteem volgens één der voorgaande conclusies, waarbij het systeem een op vraag gebaseerd voedingbeheerssysteem omvat om een levering van het afgegeven elektrische hulpvermogen naar de veelheid aan wagons te controleren.

15. Elektrisch voedingssysteem volgens één der voorgaande conclusies, waarbij het systeem geconfigureerd is om te voorzien in het afgegeven elektrische hulpvermogen voor de veelheid aan wagons, onafhankelijk van een beweging van de trein, op voorwaarde dat de treinlijn gevoed is, zoals wanneer de trein verbonden is met een bovenleiding.

16. Moederwagon, een elektrische voedingsbroneenheid volgens één der voorgaande conclusies omvattende.

17. Moederwagon volgens conclusie 16, waarbij de moederwagon geconfigureerd is om verbonden te worden met andere wagons in een elektrisch hulpvermogenvoedingsysteem volgens één der voorgaande conclusies, waarbij de moederwagon geconfigureerd is om elektrisch vermogen te leveren voor meerdere wagons, door middel van een elektrische hulpverbinding of door middel van elektrische hulpverbindingen naar één of meerdere andere wagons.

18. Moederwagon volgens conclusie 16 of conclusie 17, waarbij de moederwagon geconfigureerd is om één of meerdere containers op te kunnen nemen.

19. Moederwagon volgens één der conclusies 16 tot en met 18, waarbij de moederwagon een interface omvat tussen de treinlijn en de omzetter, om een elektrische invoer te leveren aan de omzetter vanuit de treinlijn.

20. Moederwagon volgens één der conclusies 16 tot en met 19, waarbij de moederwagon en de dochterwagon elk geconfigureerd zijn om twee van vermogen voorziene containers op te nemen, zodat de moederwagon geconfigureerd kan zijn om elektrisch hulpvermogen te leveren aan ten minste vier van vermogen voorziene containers.

21. Dochterwagon, geconfigureerd voor een elektrische verbinding met een moederwagon volgens één der conclusies 16 tot en met 20.

22. Trein, ten minste één moederwagon volgens één der conclusies 16 tot en met 20 omvattende, alsook ten minste één dochterwagon volgens conclusie 21.

23. Werkwijze voor het van vermogen voorzien van een spoorweggebaseerd elektrisch hulpsysteem voor een vrachttrein, waarbij de werkwijze omvat:

het voorzien van een elektrische invoer van een treinlijn van de trein naar een elektrische hulpvoedingsbroneenheid in een moederwagon;

het omzetten van de elektrische invoer in de elektrische voedingsbroneenheid in een uitvoer van de elektrische voedingsbroneenheid, om te voorzien in elektrisch hulpvermogen voor een aan goederen gerelateerd elektrisch systeem;

het leveren van de uitvoer van de moederwagon aan de één of meerdere dochterwagons, waarbij de dochterwagon(s) niet voorzien is of zijn van een dergelijke elektrische hulpvoedingsbroneenheid.

24. Werkwijze volgens conclusie 23, waarbij de werkwijze het monitoren omvat van een status, waarbij de status een elektrische status van een wagon en/of van een container die daarop of daarin is geplaatst, omvat.

25. Werkwijze volgens conclusie 23 of conclusie 24, waarbij de werkwijze het verzenden omvat van een signaal wanneer een wagon of een container elektrisch verbonden en/of losgekoppeld is of wordt.

26. Werkwijze volgens conclusie 25, waarbij de werkwijze het uitvoeren omvat van één of meerdere acties in respons op een elektrische verbinding en/of loskoppeling, waarbij de actie(s) geselecteerd is of zijn uit één of meerdere van: het versturen van een signaal, het ontluchten, het circuleren, het in een wachtrij plaatsen van de containers in een vermogensbeheersysteem.

27. Werkwijze volgens één der conclusies 23 tot en met 26, waarbij het leveren van elektrisch hulpvermogen aan het aan goederen gerelateerde elektrische systeem het leveren omvat van elektrisch hulpvermogen aan een koelcontainer.

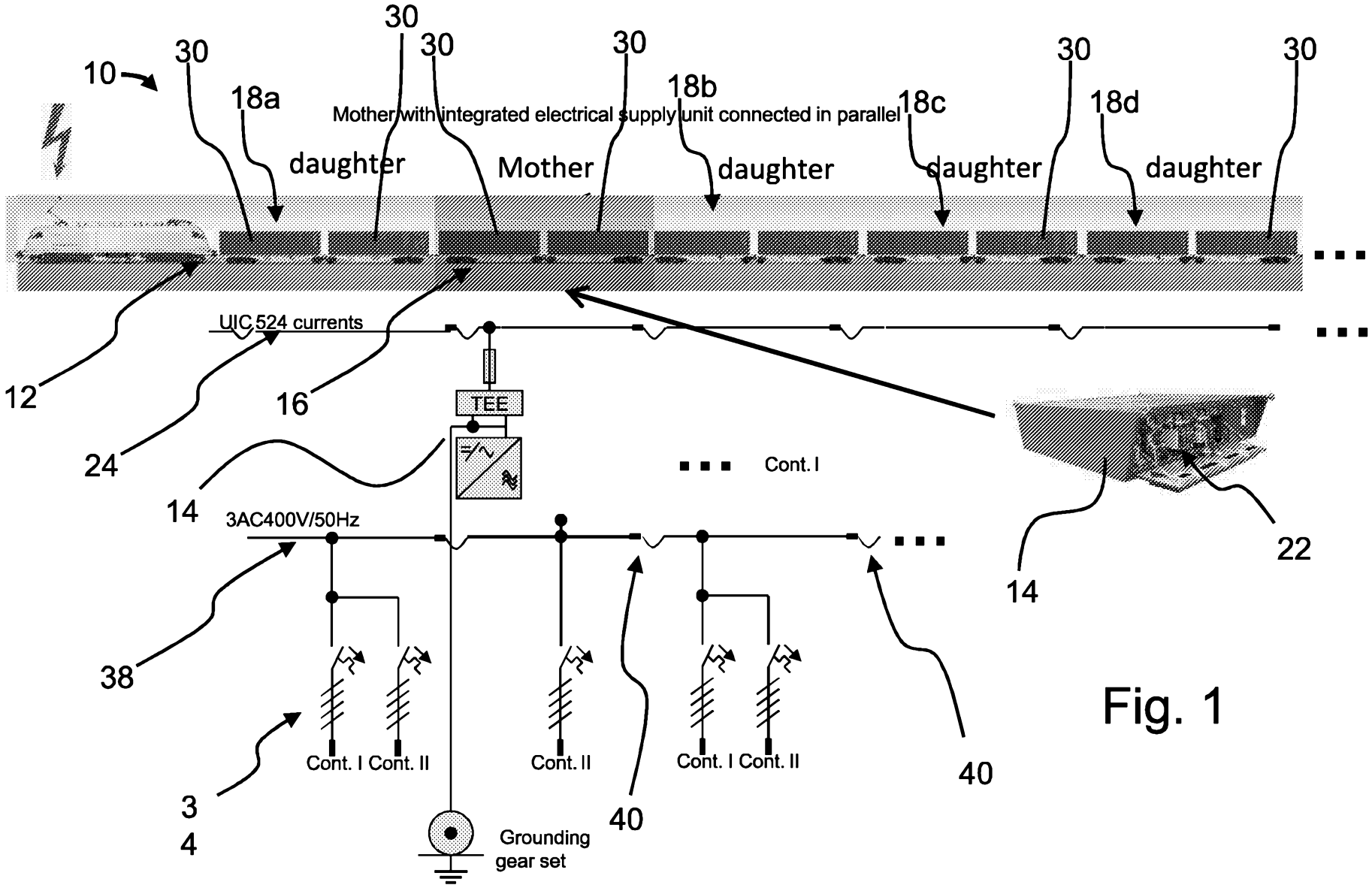

10
30
18a
daughter
30
30
Mother with integrated electrical supply unit connected in parallel
Mother
30
18b
daughter
18c
daughter
30
18d
daughter
30
UIC 524 currents
12
24
16
TEE
14
Cont. I
3AC400V/50Hz
14
22
38
Cont. I Cont. II
Cont. II
Cont. I Cont. II
40
40
3
4
Grounding
gear set

Fig. 1

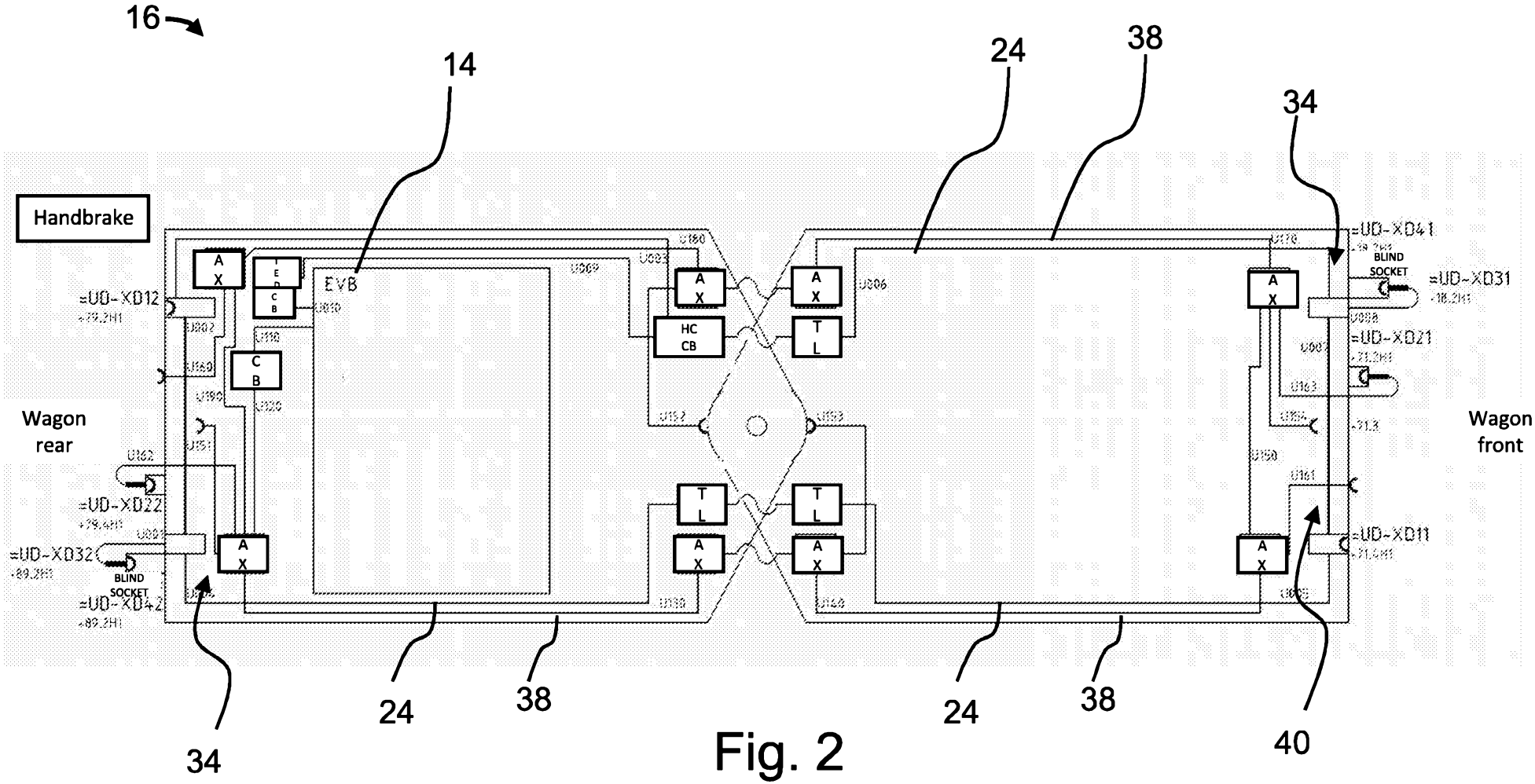

16
14
24
38
34
Handbrake
EVB
=UD-XD12
=UD-XD22
=UD-XD32
=UD-XD42
=UD-XD41
=UD-XD31
=UD-XD21
=UD-XD11
BLIND SOCKET
BLIND SOCKET
A X
C B
HC CB
T L
Wagon rear
Wagon front
34
24
38
24
38
40

Fig. 2

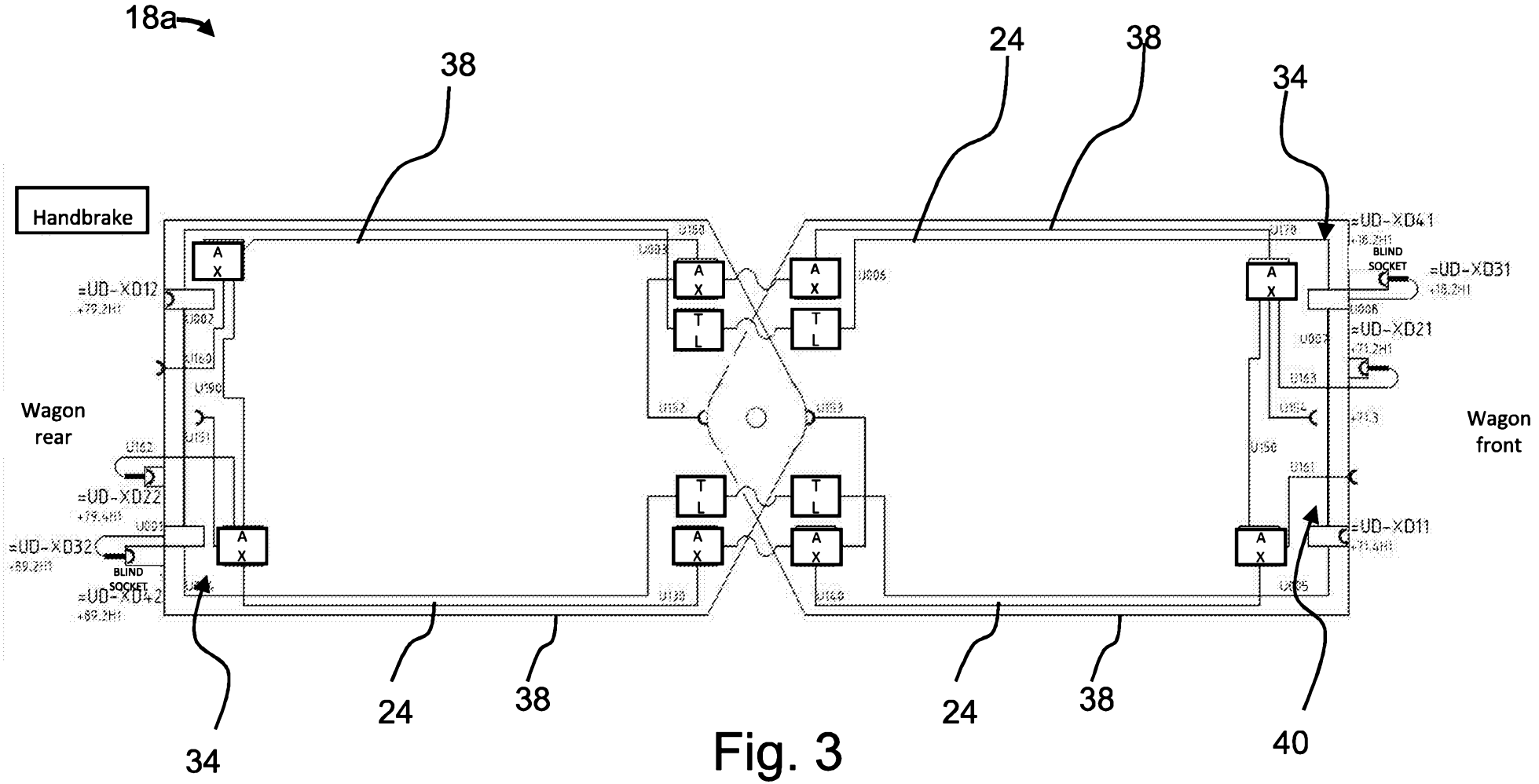

18a
38
24
38
34
Handbrake
Wagon rear
Wagon front
=UD-XD12
=UD-XD22
=UD-XD32
=UD-XD42
=UD-XD41
=UD-XD31
=UD-XD21
=UD-XD11
BLIND SOCKET
A X
T L
34
24
38
24
38
40

Fig. 3

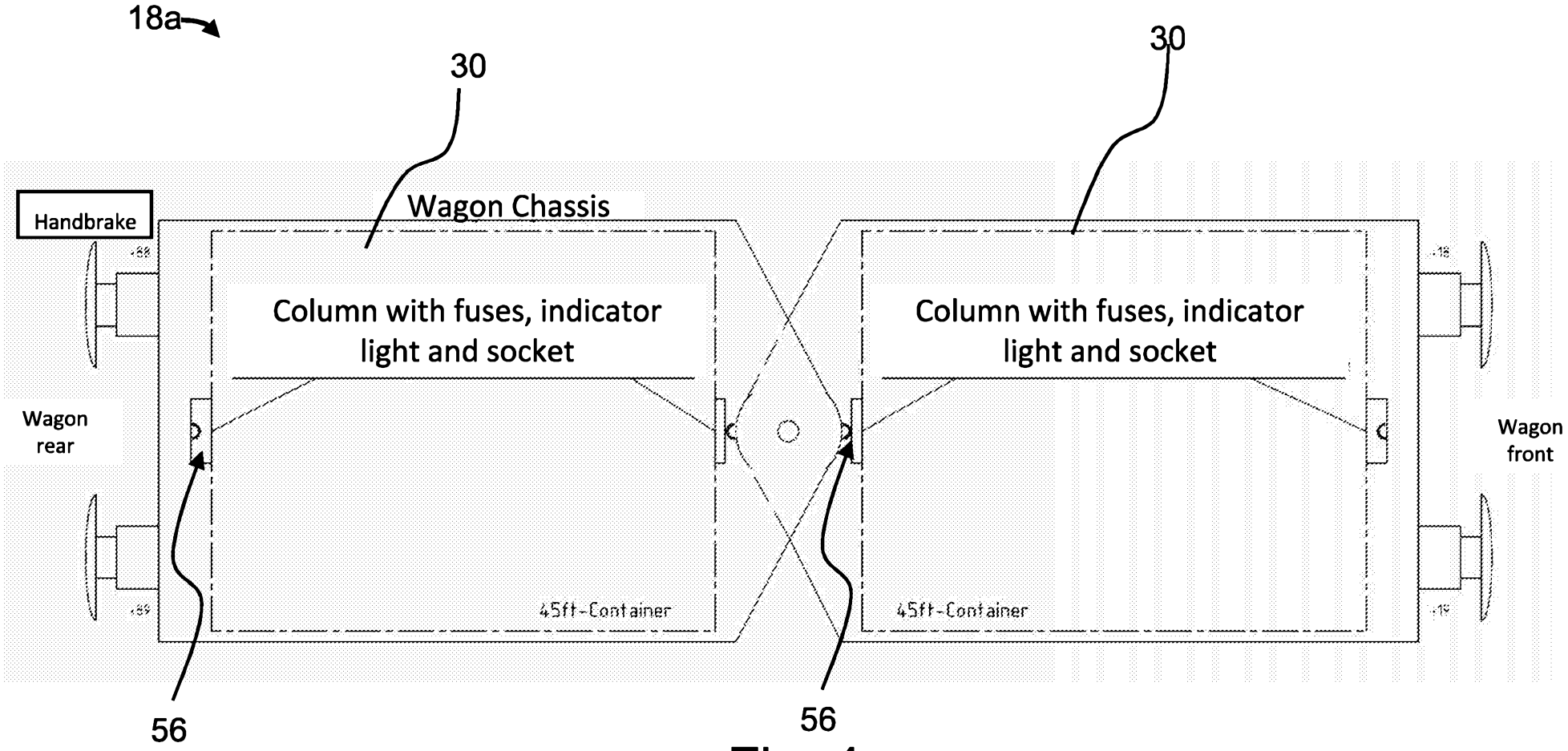

18a
30
30
Wagon Chassis
Handbrake
Column with fuses, indicator light and socket
Column with fuses, indicator light and socket
Wagon rear
Wagon front
45ft-Container
45ft-Container
56
56

Fig. 4

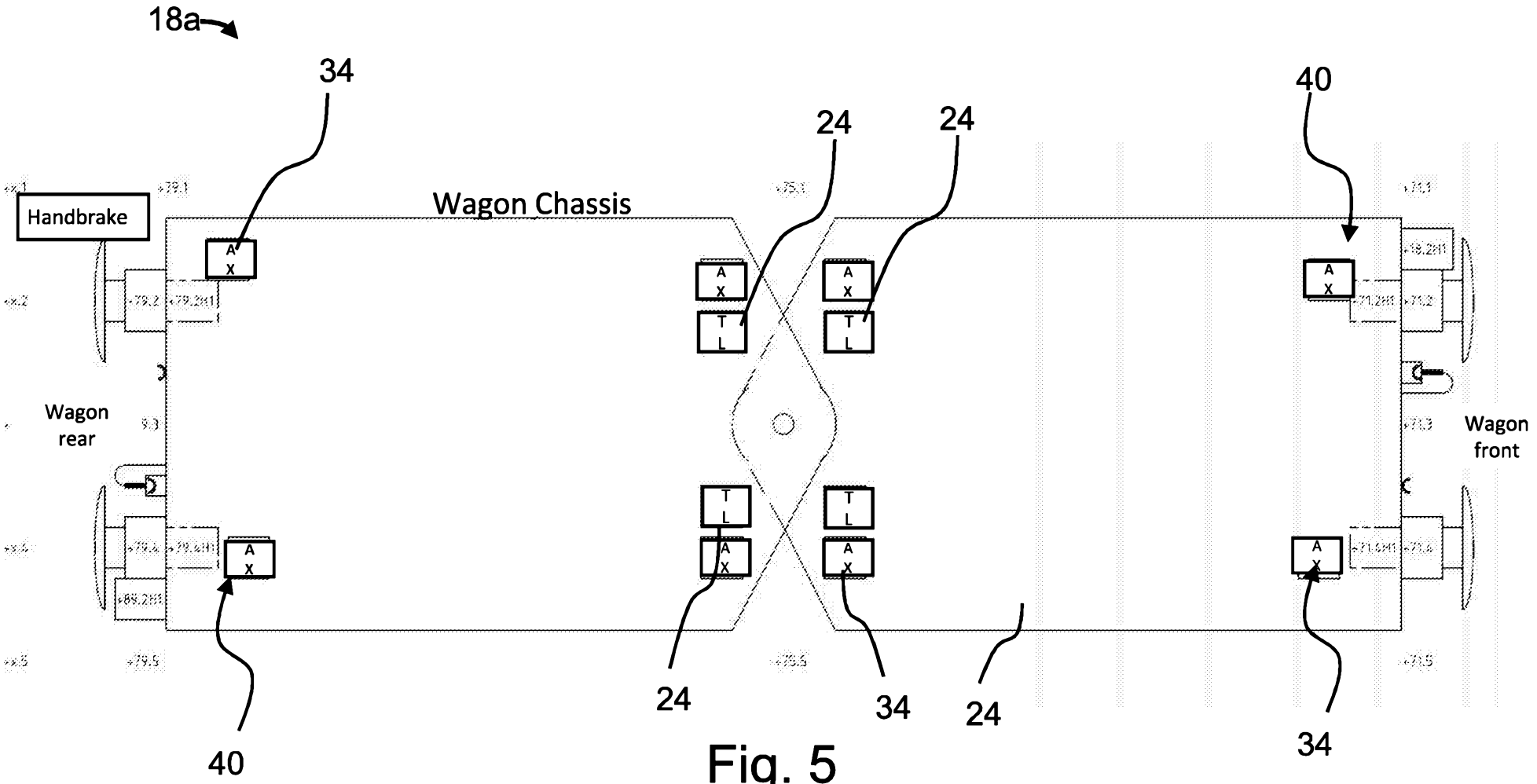

18a
34
24
24
40
Handbrake
Wagon Chassis
Wagon rear
Wagon front
A X
T L
40
24
34
24
34

Fig. 5

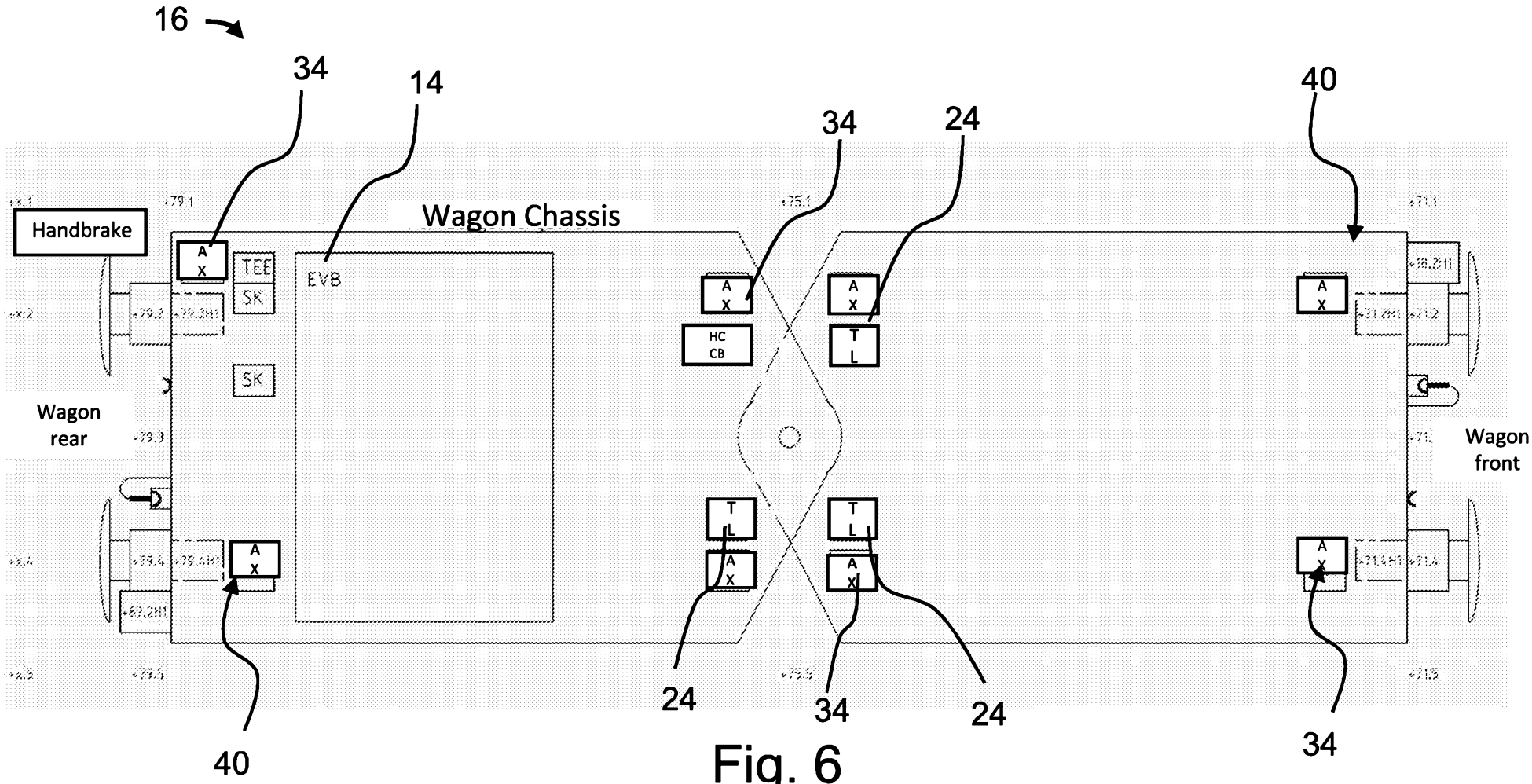

16
34
14
34
24
40
Handbrake
Wagon Chassis
A X
TEE
SK
EVB
HC CB
T L
Wagon rear
Wagon front
40
24
34
24
34

Fig. 6

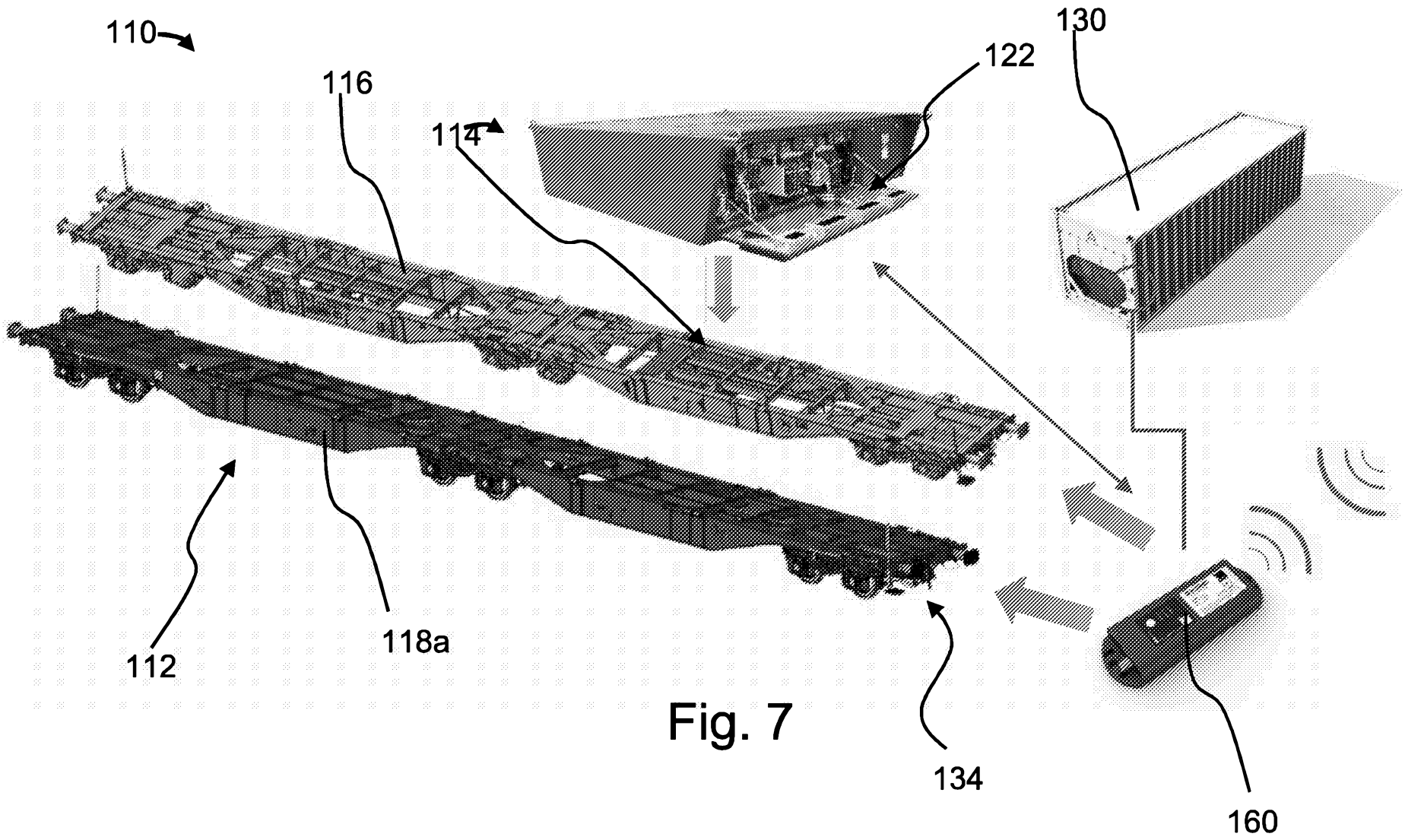
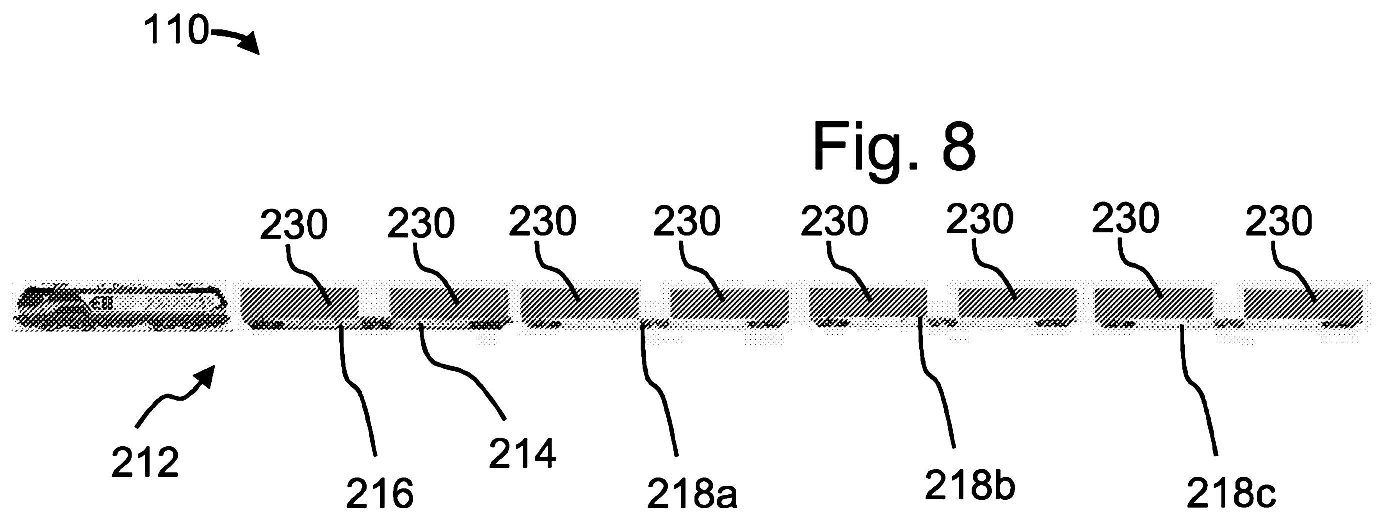


Fig. 7

Fig. 8


110
230
230
230
230
230
230
230
230
212
216
214
218a
218b
218c

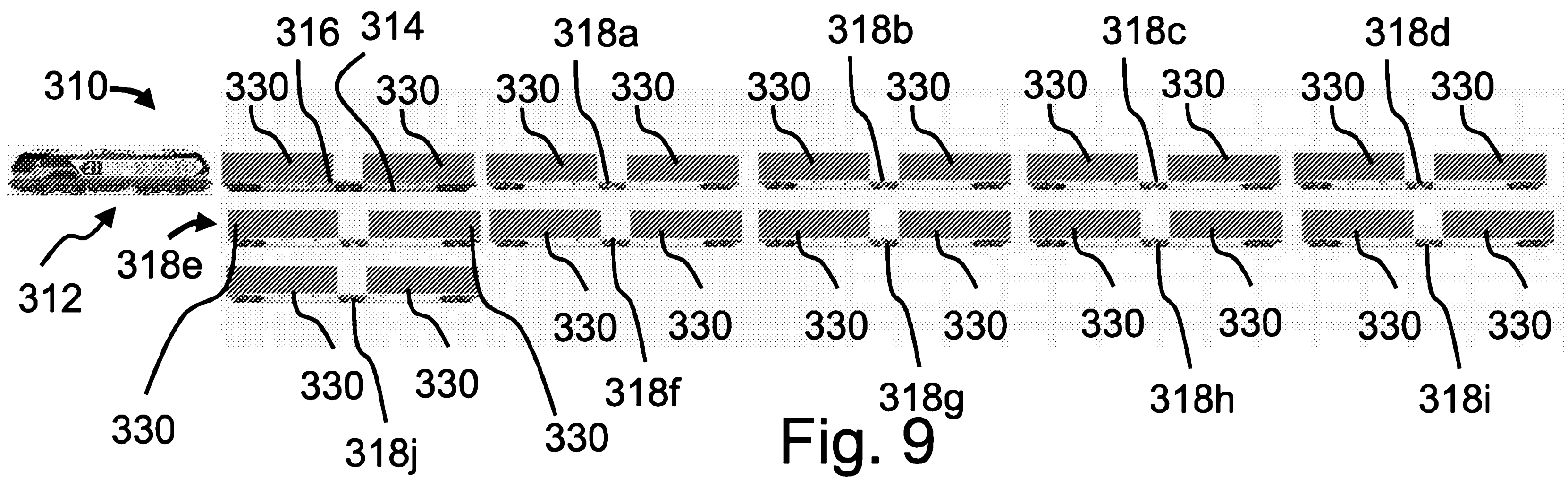

310
316
314
318a
318b
318c
318d
330
312
318e
318f
318g
318h
318i
318j

Fig. 9

Compressor on

Evaporator on

Unit	control	origin	destination	Duration [days]	product	T_{set} [°C]	Avg. el. power [kW]	tC [%]	tMS [%]	Energy savings [%]	Needed availability of power:
PL	QII	Australia	Japan	15	Beef	-1.0	1.6	18%	38%	47%	18-38 %
PL	nQ	Australia	Japan	15	Beef	-1.0	3.0				
TL	QII	SA	UK	17	Apples	-1.0	2.3	23%	26%	56%	23-26 %
TL	nQ	SA	UK	17	Apples	-1.0	5.2				
TL	QII	SA	Portugal	15	Citrus	+4.0	0.6	14%	27%	74%	14-27 %
TL	nQ	SA	Portugal	15	Citrus	+4.0	2.2				
PL	QII	Ecuador	NL	18	Banana	13.3	1.1	12%	27%	63%	12-27 %
PL	nQ	Ecuador	NL	18	Banana	13.3	3.0				
EL	QII	Ecuador	NL	19	Banana	13.3	2.0	21%	27%	63%	21-27 %
EL	nQ	Ecuador	NL	19	Banana	13.3	5.5				

Fig. 10

Fig. 11

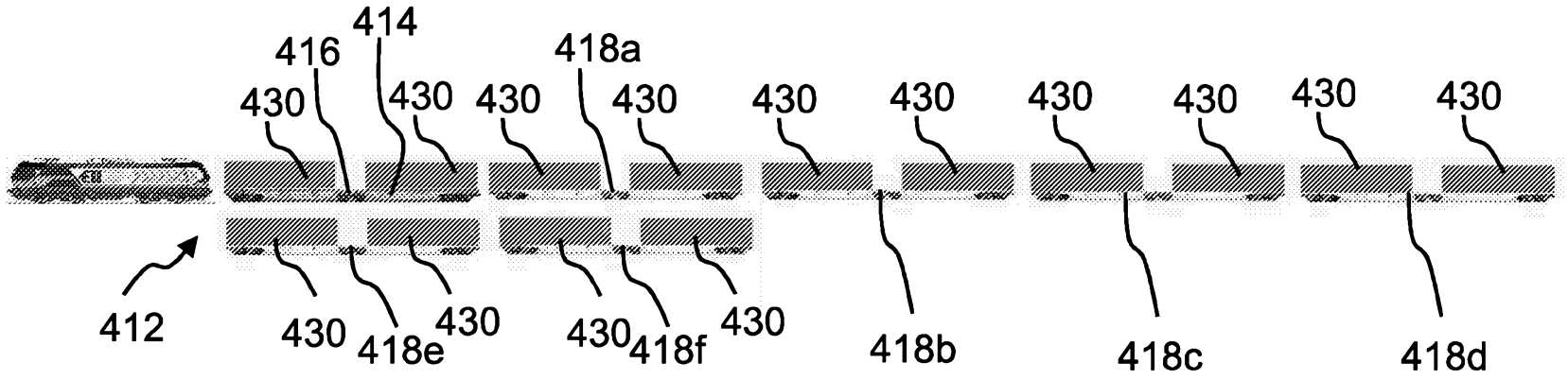
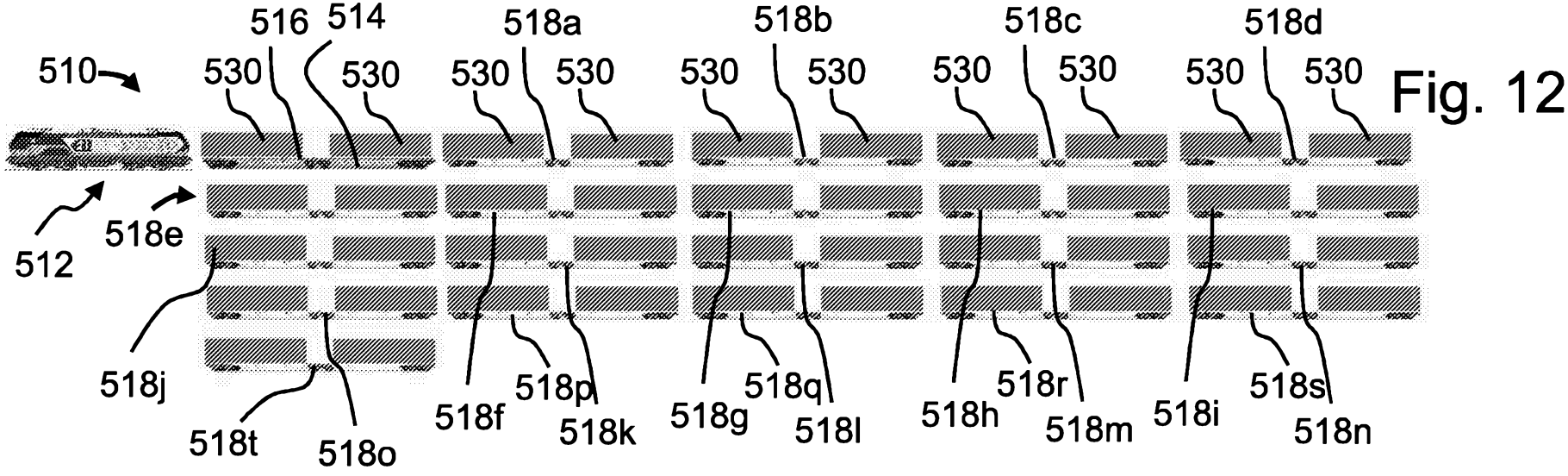

410
414
416
418a
430
412
418e
418f
418b
418c
418d

Fig. 12


510
516
514
518a
518b
518c
518d
530
512
518e
518j
518t
518o
518f
518p
518k
518g
518q
518l
518h
518r
518m
518i
518s
518n

ABSTRACT

A freight rail train electrical power system for a goods-related auxiliary electrical system. The electrical power system has at least one electrical power supply unit for providing goods-related auxiliary electrical power. The electrical power supply unit provides an auxiliary electrical power output to a plurality of wagons. The electrical power supply is supplied with an input of electricity from a train-line ("Zugsammelschiene") of the train.

Fig. 1

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	P241004NL/AK
Nederlands aanvraag nr. **2018714**	Indieningsdatum **13-04-2017**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Rail Innovators Holding B.V.**	
Datum van het verzoek voor een onderzoek van internationaal type **24-06-2017**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN69175**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

B61D27/00;B60L1/00;B61D3/20;B60L9/00;B60L11/02;B61L15/00;B61L25/04

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**B61D;B60L;B61L**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III.	☐	**GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	☐	**GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2018714

A. CLASSIFICATIE VAN HET ONDERWERP
INV. B61D27/00 B60L1/00 B61D3/20 B60L9/00 B60L11/02
B61L15/00 B61L25/04
ADD.
Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimum documentatie (classificatie gevolgd door classificatiesymbolen)
B61D B60L B61L

Onderzochte andere documentatie dan de minimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	US 6 087 739 A (JALLIFFIER FRANCOIS [FR] ET AL) 11 juli 2000 (2000-07-11) * kolom 4; figuren 1-3 * * kolom 5, regel 47 - regel 59 *	1-27
A	DE 10 2012 205215 A1 (SIEMENS AG [DE]) 2 oktober 2013 (2013-10-02) * samenvatting *	14
A	US 2014/263860 A1 (IDEN MICHAEL E [US] ET AL) 18 september 2014 (2014-09-18) * figuur all *	18,20
A	US 2013/325247 A1 (KANNER ABE [CA] ET AL) 5 december 2013 (2013-12-05) * samenvatting *	24-26

☐ Verdere documenten worden vermeld in het vervolg van vak C.

☒ Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

* Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
5 december 2017	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Wansing, Ansgar

1

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek: NL 2018714

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
US 6087739	A 11-07-2000	CA 2240477 A1	03-01-1999
		EP 0888944 A1	07-01-1999
		FR 2765540 A1	08-01-1999
		PL 326966 A1	04-01-1999
		RU 2150395 C1	10-06-2000
		US 6087739 A	11-07-2000
DE 102012205215	A1 02-10-2013	CN 104203637 A	10-12-2014
		DE 102012205215 A1	02-10-2013
		EP 2802478 A2	19-11-2014
		WO 2013144272 A2	03-10-2013
US 2014263860	A1 18-09-2014	US 2014263860 A1	18-09-2014
		WO 2014153119 A2	25-09-2014
US 2013325247	A1 05-12-2013	CA 2863807 A1	05-12-2013
		CN 104349964 A	11-02-2015
		EP 2855232 A2	08-04-2015
		HK 1203464 A1	30-10-2015
		JP 6101795 B2	22-03-2017
		JP 2015519866 A	09-07-2015
		KR 20150024810 A	09-03-2015
		US 2013325247 A1	05-12-2013
		WO 2013179121 A2	05-12-2013

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN69175	13.04.2017		NL2018714

International Patent Classification (IPC)
INV. B61D27/00 B60L1/00 B61D3/20 B60L9/00 B60L11/02 B61L15/00 B61L25/04

Applicant
Rail Innovators Holding B.V.

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☒ Box No. VIII Certain observations on the application

	Examiner
	Wansing, Ansgar

Application number

WRITTEN OPINION

NL2018714

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	2, 14, 18, 20, 24-26
	No:	Claims	1, 3-13, 15-17, 19, 21-23, 27
Inventive step	Yes:	Claims	
	No:	Claims	1-27
Industrial applicability	Yes:	Claims	1-27
	No:	Claims	

2. Citations and explanations

see separate sheet

WRITTEN OPINION

Box No. VIII Certain observations on the application

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

D1 US 6 087 739 A (JALLIFFIER FRANCOIS [FR] ET AL) 11 juli 2000 (2000-07-11)

D2 DE 10 2012 205215 A1 (SIEMENS AG [DE]) 2 oktober 2013 (2013-10-02)

D3 US 2014/263860 A1 (IDEN MICHAEL E [US] ET AL) 18 september 2014 (2014-09-18)

D4 US 2013/325247 A1 (KANNER ABE [CA] ET AL) 5 december 2013 (2013-12-05)

Lack of novelty

2 The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

3 D1 discloses (references in brackets refer to D1)

Elektrisch voedingssysteem voor een vrachtspoortrein (2, 2a, 46), voor een aan goederen gerelateerd elektrisch hulpsysteem (12), waarbij het elektrische voedingssysteem ten minste één elektrische voedingsbroneenheid (30) omvat om te voorzien in aan goederen gerelateerd elektrisch hulpvermogen (40), waarbij de elektrische voedingsbroneenheid geconfigureerd is om te voorzien in een elektrische hulpvermogenuitvoer naar een veelheid aan wagons (4), en waarbij de elektrische voedingsbron (30) geconfigureerd is om gevoed te worden met een invoer van elektriciteit van een treinlijn (18,22,26) van de trein.

Other independent claims

4 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claims 23, which therefore is also considered not new.

Dependent claims, negative assessment

5 Dependent claims do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/or inventive step.

5.1 In particular:

5.2 Claim 2: UIC552 is the international standard for electrical connection. The adherence to this standard per se can not be inventive.

5.3 Claims 3, 4 and 27: Reference 12, of D1 indicates a refrigeration unit, 10 a movable storage unit.

5.4 Claims 5, 6, 16, 17,19 and 21, 22: See D1, figures 1 and 2.

5.5 Claims 7 to 10: See D1, step down means (30) converting 1500V into 380V, three-phase.

5.6 Claim 11: The use of IGBT in converters is standard.

5.7 Claims 12 and 13: D1 shows a complete power supply system including overhead wire (48), catenary (50), source, possibly including voltage step down means (51), train line (18, 22, 26), converter (30) and a discreet low voltage distribution net (40, 44) that is apart from the train line.

5.8 Claim 14: D1 shows an on-board power and data processing unit (30). Power management for trains with auxilliary loads on different cars is also known from D2.

5.9 Claim 15: The train in D1 is configured to provide low voltage to the wagons from the overhead wire if connected to this wire independent from its movement.

5.10 Claims 18 and 20: It is known to have more than one container on a rail-car, see e.g. D3.

5.11 Claims 24 to 26: Automatic connection of coupled rail cars and acting on this detection is known, see D4.

6 **Re Item VIII**

Certain observations on the application

6.1 Claim 5 is not clear.

6.1.1 Claim 5 attempts to define a first entity "voedingssystem" in terms of the features of a second entity "moederwagon", which is not part of the first entity. This gives rise to an ambiguity. The claim should be redrafted so as to make clear whether it is directed to the "voedingssystem" alone or to a system

comprising the "voedingssystem" and the "moederwagon". It is noted however that in the former case, any "voedingssystem" having the features mentioned in the claim would be suitable for the use with a "moederwagon", and would therefore anticipate the subject-matter of the claim, regardless of whether or not it is actually used in combination with such "moederwagon".

6.1.2 The same applies to "moederwagon" of claim 20 that is defined by features of a "dochterwagon" not part of the first entity.

6.2 The term "volledig elektrische vermogenssketten" used in claim 12 is vague and unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers, thereby rendering the definition of the subject-matter of said claim unclear.

6.3 Also the relative term "volledig" used in the same claim 12 has no well-recognized meaning and leaves the reader in doubt as to the meaning of the technical feature to which it refers, thereby rendering the definition of the subject-matter of said claim unclear.