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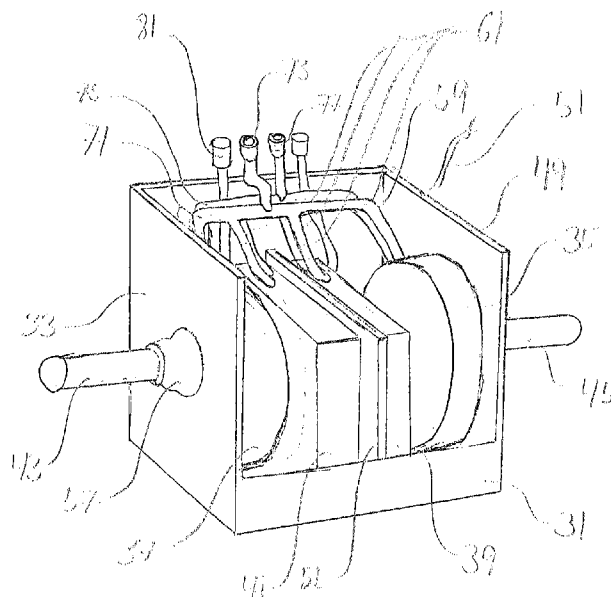


Fig. 2

(57) Abstract: The present invention relates to an electric motor assembly comprising a mounting box for an electric vehicle. The invention also relates to such a mounting box, to an electric vehicle comprising an electric motor assembly, a method of providing a motor assembly, and a method of installing a motor assembly.

WO 2012/064276 A1

MOTOR ASSEMBLY AND MOUNTING BOX FOR ELECTRICAL VEHICLE

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10 TECHNICAL FIELD

The present invention relates to an electric motor assembly comprising a mounting box for an electric vehicle. The invention also relates to such a mounting box, to an electric vehicle comprising an electric motor assembly, a method of providing a motor assembly, and a method of installing a motor assembly.

PRIOR ART

20 Electric vehicles comprising electric engines for propulsion of the vehicles are known in the art since late 19th century. Electric vehicles experienced a peak in the beginning of the 20th century, after which they were outcompeted by the combustion engine, mostly due to the increased range provided by the higher energy density of fossil fuels. Recent developments in battery technology have alleviated these problems, however, and electric drive is now considered a viable technology for vehicles, in particular in view of the decreased environmental impact expected with electric drive relative to combustion engines.

30 An electric vehicle is normally provided with an electric motor assembly for providing propulsion, and which comprises at least one electric motor comprising a stator, normally comprising a winding, and a force generating movable part, such as a rotor normally comprising a magnetic element, for generating a force or torque and for providing the force or torque to a drive

shaft. The electric motor assembly further comprises at least one electronic motor controller arranged to feed voltages and currents to the stator for controlling the operation of the movable part or rotor.

5 Several problems are identified with electric drive, which are not found with combustion engine drive. One of these problems is that electric drive requires electrical cables carrying large electric currents, posing problems both in view of electrical disturbances and in view of the high costs and space requirements needed for the cables. Another problem relates to the
10 manufacturing of the electric vehicles, requiring different techniques and methods not yet developed into their full potential relative to the more common manufacturing technologies devised relative to combustion engine vehicles. Another problem is that it is more expensive to design electric motors to be resistant against dirt, moisture and/or other environmental
15 conditions than combustion engines.

SUMMARY OF THE INVENTION

One objective of the present invention is to indicate an improved electric
20 motor assembly which improves upon an electric vehicle into which the electric motor assembly is installed.

According to one aspect of the invention this objective is achieved with the electric motor assembly according to claim 1.

25

According to another aspect of the invention this objective is also achieved with the mounting box according to claim 10.

According to another aspect of the invention this objective is also achieved
30 with the electric vehicle according to claim 15.

According to a preferred embodiment the electric motor assembly comprises a mounting box arranged to enclose both the electric motor and the additional motor and/or the motor controller inside the mounting box, and which

mounting box is provided with at least one opening for admitting passage of the shaft. Preferably the opening is provided in the form of a through-hole. The mounting box thus provides a basis or support onto which the electric motor and the additional motor and/or the electronic motor controller may easily be mounted inside the electric vehicle. Furthermore, the mounting box may offer protection for the electric motor and the additional motor and/or the electronic motor controller. Yet a further advantage is that the mounting box may bring mechanical stability to the vehicle, and may be used for carrying part of the loads affecting the vehicle during its use. The mounting box may also easily be designed to give wanted characteristics in terms of crash safety.

Preferably, the electric motor assembly comprising the mounting box, the electric motor and the additional motor and/or the electronic motor controller are adapted to be mounted as one unit inside the vehicle, preferably inside the motor compartment of said vehicle. The electric motor assembly, and thus the mounting box, is preferably also detachable as one unit from said vehicle, in particular detachable from the motor compartment of said vehicle, in order to allow for easy maintenance. Preferably, the mounting box comprises an openable lid to allow access to the motor and the additional motor and/or motor controller inside the mounting box. The lid is preferably provided with a lock requiring either proper tools or a key or key code to be opened. Since the motor and the additional motor and/or motor controller are enclosed by the mounting box the electric motor assembly is thus protected from being tampered with by unskilled persons who may attempt to do work on the assembly and thus putting themselves in danger of electric shocks or of damaging the motor assembly.

The mounting box is preferably adapted to be positioned inside, and be surrounded by the motor compartment of the vehicle, vessel or craft. The mounting box may share one or more of its walls, roof or floor with one or more of the walls, roof or floor of the motor compartment, but preferably, the mounting box only makes up at the most a small portion, and preferably no portion, of the chassis or bodywork forming the motor compartment. Hence,

the mounting box should in no terms be confused with the motor compartment per se, which encloses many more additional components than the mounting box, which encloses the motor and the additional motor and/or the controller. The electric motor or motors and/or electronic motor controller
5 are furthermore provided with their own housings, or possibly a joint housing, enclosing the motor and the motor controller, respectively. The housing or housings is/are then in turn enclosed by and contained inside the mounting box. Hence, the mounting box should in no terms be confused with said housings. The housings are separate from the mounting box, and
10 preferably, the mounting box is shaped so that a space is at least partly provided between the mounting box and the housing or housings, apart from the points in which the motor or motors and/or controller are fastened to the mounting box.

15 Preferably the mounting box is adapted to be installed in an electric vehicle, preferably a land-based, motor-driven vehicle, preferably a wheeled vehicle intended for public roads. The vehicle thus comprises at least one drive wheel connected to said drive shaft for propulsion of the vehicle. In one preferred embodiment the vehicle may be an automobile. In another embodiment the
20 vehicle may be a truck, lorry, buss, or any other heavy vehicle. The at least one electric motor of the electric motor assembly is preferably a synchronous electric motor. The motion and force generated by the force generating part, normally a rotor, is controlled by the currents and voltages fed to the electric motor, and in particular of the phase, frequency, and magnitude of the
25 current.

According to one embodiment the mounting box comprises electrically conducting wall portions and an electrical connection for connecting the conducting wall portions to a ground potential of the vehicle, in order to
30 electromagnetically shield the electric motor assembly from electromagnetic disturbances. Thus the electric motor assembly is EMC-protected. The electric motor and the electronic motor controller carry huge currents, which may induce disturbances in any nearby electrical equipment. By providing the electric motor assembly inside an EMC-protective mounting box the

electric motor assembly is shielded in an efficient and inexpensive manner. Thus other circuits in the vehicle, vessel or craft may be designed with less regard to electromagnetic disturbances, so that the circuits may be designed to be less expensive, more efficient, and/or smaller in size. Furthermore, the other circuits may be positioned closer to the motor assembly. This, in turn, alleviates, or may even negate, the extra space requirement added by inclusion of the mounting box.

According to one embodiment the mounting box comprises at least one protective wall intended to face outwardly, and designed to protect the motor assembly against attacks and other forms of hostile elements in the environment. Preferably, the protective wall is also intended or arranged to face the external environment outside the vehicle. The mounting box may thus form a protection both in relation to the environment outside of the mounting box, and also in relation to the external environment outside of the vehicle. In one embodiment the mounting box comprises a hard protective wall protecting against damage from knocks, blows or flying objects. This is particularly useful for automobiles and personal cars, which normally comprises motor compartments that have open undersides. Thus the mounting box provides a protected environment inside the mounting box for the sensitive electric motor and electronic motor controller. The motor and the controller thus may be designed with less self protection and may therefore be less expensive. Also, there is less need to redesign the electric motor, the electronic motor controller and/or the vehicle in order to protect the electric motor or controller. Preferably, the mounting box is adapted to enclose the entire electric motor assembly in order to better protect the motor assembly.

According to one embodiment the mounting box comprises a protective wall designed to protect the motor assembly against liquid attacks. Preferably, the mounting box comprises at least one protective wall intended to face an external environment and adapted to protect the motor assembly against being splashed by liquids. Hence the mounting box may protect the electric motor and/or electronic motor controller against water and/or oil. Preferably,

the mounting box is also water sealed. Thus there is a decreased risk of short circuits and deterioration due to corrosion.

According to one embodiment the electric motor assembly comprises a mounting box adapted for enclosing at least one electronic motor controller
5 inside the mounting box. Preferably the motor controller is adapted to control the motor, and is preferably positioned close to, most preferably bearing against, the electric motor. By positioning the electronic motor controller and the electric motor close to each other inside a common mounting box the
10 amount and length of heavy electric cables may also be reduced, which is important since the controller normally feeds large currents to the electric motor.

According to one embodiment the electric motor assembly comprises at least
15 two electric motors enclosed inside the mounting box. Hence it is possible to install an electric motor assembly comprising more than one electric motor inside the same mounting box. Since the motors are normally not as sensitive to EMC-problems, and in any case are normally driven with nearly similar currents, it does not pose great problems with installing two or more motors
20 inside the same mounting box. Further, this may make it possible to install an electric motor assembly comprising more than one electric motor in one, single installation operation. Hence the installation becomes faster, easier and less costly. By installing two motors in the same mounting box less connection and fastening operations are needed.

25

In one embodiment the electric motor assembly and the at least two electric motors may be connectible with and arranged to drive the rotation of two oppositely arranged drive shafts, wherein one motor is connected to and drives each shaft. Hence the motor assembly is suitable for being installed in
30 a wheeled vehicle, having at least two drive wheels, one on each side of the vehicle. One type of such vehicles may be land-based, wheeled vehicles intended for the public road network. Preferably the motor assembly then comprises at least two motor controllers, which are both contained inside the mounting box, and which motor controllers are arranged to control the

operation of one electric motor, and thus the rotation of one shaft, each. Hence different functions such as a differential, differential lock, ABS-brakes, and others may more easily be achieved.

5 According to one embodiment the mounting box comprises at least one internal wall dividing the mounting box into at least two separate compartments. The internal wall hence separates at least two of the at least one electric motor and/or the at least one electronic motor controller from each other. The internal wall also gives an opportunity for stable mounting of
10 the components inside the mounting box by providing an additional wall for attaching or fastening the components to inside the mounting box. Preferably, the internal wall is also at least partly conducting and connected with a ground potential of the vehicle, wherein the internal wall gives an internal EMC protection. This is an advantage in particular if more than one motor
15 controller is provided inside the same mounting box.

According to one embodiment the motor assembly comprises an internal liquid cooling system inside the mounting box for cooling the motor assembly. Hence heat may be removed from the electric motor assembly. By forming the
20 cooling system inside the mounting box it may be designed more efficiently and to a lower cost. Preferably the cooling system is designed to cool both the electric motor or motors and/or the electronic motor controller with a cooling liquid, preferably the same type of liquid, and most preferably the same liquid. Preferably the cooling system is designed to cool at least a major part,
25 preferably all, components inside the mounting box with the same type of, and preferably the same, cooling liquid. In one preferred embodiment the cooling liquid is cooling oil. In another embodiment the cooling liquid may be cooling water. The cooling liquid may comprise an anti-freeze agent or other functional substances as needed.

30

According to one embodiment the internal cooling system comprises at least one first type of cooling circuit connected with and cooling the at least one electric motor, and at least one second type of cooling circuit connected with and cooling the at least one electronic motor controller, wherein the first and

second cooling circuits are connected in parallel. Hence the cooling liquid delivered to each drive component has not been pre-heated by another of the drive components, assuring an efficient cooling.

5 According to one embodiment the cooling system comprises a first inflow connector and a second outflow connector for the cooling liquid, wherein the first and second cooling circuits are connected to the same inflow and outflow connectors. The connectors are preferably designed to allow connection of a hose, pipe or other conductor for cooling liquid from a part of a cooling
10 system located externally of the mounting box, to the part of the cooling system provided inside the mounting box. Hence the number of connection operations needed to be performed during installation of the motor assembly into the vehicle in order to install and connect the cooling system is reduced. According to a preferred embodiment both the first inflow connector and the
15 second outflow connector are accessible from outside the mounting box. Hence during installation there is no need to open a lid of the mounting box in order to connect the cooling system with the external cooling system and in particular with an external heat sink. Preferably the mounting box comprises a first and a second forking element connected with the inflow and outflow
20 connectors, respectively, and forking the cooling liquid to the respective cooling circuits.

According to one embodiment the motor assembly is designed so that at least a majority of the electrical conductors requiring a connection external of the
25 mounting box are grouped together to form at the most two or less bundles of conductors. Hence the conductors are more ordered, easier to connect externally, and also, less space is required than if the separate conductors were projecting in a large variety of different directions from the mounting box. Preferably at least a majority of the conductors in each bundle are
30 arranged to be connected externally through one and the same plug socket. Hence the time needed for connecting the conductors is also reduced. Most preferably the motor assembly is designed so that all electrical conductors of the assembly which are to be connected externally are provided in one, single bundle in a single plug socket connection point. Hence the operation time of

connecting electrical contacts to the assembly in a production line is greatly reduced. In particular, in case of an electric assembly comprising two motors and two motor controllers operating with three-phase current, the number of connection operations at the assembly stage in the production line are
5 reduced from fourteen (corresponding to three current connections between each controller and motor, three current connections between each controller and an external power unit connected with the battery pack, and one signal connection between each controller and an external control device) to only one connection (six current-phase contacts and two control signal contacts
10 provided in one and the same plug socket).

According to one embodiment the electric motor assembly comprises a protective sleeve surrounding the shaft at its exit from the mounting box and covering said opening or through-hole. The protective sleeve may be formed of
15 a polymer, a rubber, or a similar material, and is arranged to protect against entrance of dirt, water, mud, grime and such, via the through hole. Thus the only large opening (or openings) into the mounting box is(are) more or less closed off and sealed by the sleeve(s). Preferably, the opening for the shaft is roughly circular in shape, in order to reduce electromagnetic emissions, noise
20 and disturbances.

According to another aspect of the invention the objective is also achieved with the method of providing an electric motor assembly according to claim 11. According to yet another aspect of the invention the objective is also
25 achieved with the method of installing an electric motor assembly into an electric vehicle according to claim 13.

By providing and/or installing at least one electric motor, at least one electronic motor controller, and at least one mounting box enclosing both the
30 electric motor and the electronic motor controller many of the features, purposes and advantages of the embodiments already described above are achieved.

According to one embodiment of the invention the motor assembly is shaped so that the mounting box, and thus the motor assembly, is mountable as one unit inside the vehicle. Hence the motor assembly is provided by pre-installing the at least one electric motor or motors and/or the at least one electronic motor controller inside the mounting box so that the mounting box
5 encloses both the at least one electric motor or motors and/or the at least one electronic motor controller inside the mounting box, and then providing the mounting box, and thus the motor assembly, as one unit, in order to allow subsequent installation inside a vehicle. The method of installing the motor
10 assembly similarly comprises installing a mounting box having the at least one electric motor or motors and/or the at least one electronic motor controller pre-mounted and installed inside the mounting box. Hence the mounting box is shaped so that it, and thus the motor assembly, is mountable as one unit inside a vehicle. The drive shaft is then also preferably
15 arranged to pass through an opening in the form of a hole in the mounting box and is connected with the movable part, or rotor, of the electric motor.

Hence the entire motor assembly may be mounted inside the vehicle in one single step, instead of requiring at least two steps, one for each motor(s)
20 and/or controller(s). Furthermore, the number of fastening and connection operations for attaching the motor assembly as one unit into the vehicle is far less than the number of fastening and connection operations needed for attaching a motor assembly comprising two or more separate units. In particular, according to a rough estimate, at least eight fasteners are needed
25 for firmly attaching both a motor and its separate controller, while only four fasteners are needed for firmly attaching the mounting box. The operation of connecting power cables between the electric motor and the motor controller may also be carried out outside of the main manufacturing line, which further streamlines the production process. The time needed for lifting and
30 inserting the assembly into the vehicle may also be reduced, since the shape of the mounting box may be adapted for speedy installation, in difference to the motor and motor controller, whose shapes are more or less determined by their internal workings. Thus, the cycle time for the installation operation may be reduced, giving opportunities to better fit the installation operation

into a manufacturing process. The design with the electric motor and the motor controller comprised in only one package also allows for an easier delivery.

5 BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

The invention is now to be described as a number of non-limiting examples of the invention with reference to the attached drawings.

10 Fig. 1a-b shows one example of a vehicle in the form of an automobile comprising a mounting box according to the invention.

Fig. 2 shows one example of a mounting box comprising two electric motors and two electronic motor controllers.

15

Fig. 3a shows one example of a method for producing a motor assembly according to the invention.

20 Fig. 3a shows one example of a method for installing a motor assembly into a vehicle, vessel or craft according to the invention.

DETAILED DESCRIPTION

In fig. 1 an electric vehicle 1 comprising an electric motor assembly 3 according to a first example of the invention is shown. The vehicle comprises 25 an electric motor 5 (shown in fig. 1b) connected to a drive wheel 7 via a drive shaft 9 for providing propulsion for the vehicle, and at least one battery cell for providing electric power to the electric motor. In this example the vehicle is thus an electric motor-driven, land-based, wheeled vehicle intended for public roads. In this example the vehicle is an electric automobile. 30

The at least one electric motor 5 comprises a stator 11 comprising electrical conductors forming a winding for the production of a variable magnetic and/or electric field, and a force generating movable part 13 adapted to

interact with the magnetic field for generating a torque or a force, and for providing the torque or force to the drive shaft. In this example the force generating movable part 13 comprises a rotor rotatable around a rotational axis for generation of a torque. The motor assembly 3 further comprises at least one electronic motor controller 15 arranged to feed voltages and currents to the stator 11 for controlling the operation of the rotor. The vehicle also comprises one or more control devices operable by the driver for controlling the motion of the vehicle, such as a steering wheel, gas pedals, brakes etc. The vehicle further comprises one or more electronic control devices arranged to receive driver input from the operation of the control devices, and to feed processed control signals to the electronic motor controller in response to the driver input.

The electric motor assembly further comprises a mounting box 17 arranged to enclose both the electric motor 5 and the motor controller 15 inside the mounting box. The mounting box 17 thus protects the electric motor and electronic motor controller from the environment, and, in some respects, also protects the environment from the electric motor and the electronic motor controller. The mounting box further allows easy manufacturing of the vehicle. The mounting box 17 is adapted to allow easy and safe mounting of the motor and controller inside the mounting box. The mounting box is further provided with at least one opening 19, in this example in the form of a through hole, for admitting passage of the shaft. Thus the shaft may easily be connected with the force generating part 13, in this example with the rotor, inside the mounting box, while it is connected with the drive wheel in a position outside the mounting box.

The vehicle comprises a chassis, forming the supporting framework of the vehicle, and a bodywork, forming the outer shape and the passenger and driver compartment of the vehicle. The chassis and/or the bodywork are further shaped to form a motor compartment 21 adapted for positioning of the electric motor assembly inside the compartment, which motor compartment in this example is positioned at the front end of the vehicle, just before and below the wind-screen. The mounting box 17 is in this example

provided attached to the vehicle inside the motor compartment of the vehicle. In another example the mounting box could also constitute a part of the chassis, and may thus carry a part of the loads affecting the vehicle. The mounting box may thus function as a supportive element within the vehicle.

5 The mounting box could also be mounted in the rear of the vehicle for rear-wheel or four-wheel driven vehicles.

The mounting box 17 comprises electrically conducting wall portions 23 and an electrical connection 25 for connecting the conducting wall portions to a
10 ground potential of the vehicle, in order to electromagnetically shield the electric motor assembly from electromagnetic disturbances. In this example at least a major part, in this example the entire, mounting box 17 is made of electrically conducting material. The mounting box is further shaped to completely enclose the electric motor and controller inside the box, apart from
15 openings for the shafts and connectors. The openings are further circular in shape in order to reduce passage of electromagnetic waves and pulses.

In figure 2 a second example of an electric motor assembly 31 according to the invention is shown. It should be appreciated that the assemblies of fig. 1
20 and fig. 2, respectively, could easily substitute each other. Further, in order to avoid unnecessary repetition in this application, features described in relation to one of the assemblies 3, 31 are also considered to be included in the other assembly 3, 31.

25 The electric motor assembly 31 in fig. 2 comprises a mounting box 33, a first 35 and a second 37 electric motor, and a first 39 and a second 41 electronic motor controller, which are mounted inside the mounting box of the electric motor assembly. In this example the electric motors are synchronous electric
30 motors, and the electronic motor controllers are adapted to drive the rotation of the rotors of the synchronous electric motors by feeding three phases of alternating current to three separate windings comprised in the stator of each motor, and to control the torque and speed of the motors by controlling the phase, frequency and magnitude of the currents. Each electric motor comprises a rotor, in this example a hollow rotor, connected to a respective

drive shaft 43, 45. The mounting box is further provided with openings 47, in this example in the form of through holes, for allowing passage of the drive shafts.

5 The outer walls 49 of the mounting box provides protection in the same manner as described for the mounting box of fig. 1, such as damage protection, EMC-protection etc. In particular, the mounting box comprises protective walls enclosing the electric motor and the electronic motor controller. In this example the walls 49 are made of metal sheets. However
10 the walls could also be made by a metal net in order to reduce weight, and if so, preferably with circular openings for EMC purposes. The walls are designed to protect the motor assembly against one or more of debris, stones, road water, mud, grime, oil, water, snow, and/or road salt. In this example the underside wall of the mounting box is facing downwardly in order to
15 better protect the motor assembly against dangers originating from the road. The metal walls provide EMC-protection as described for the mounting box in relation to fig. 1, and for this purpose the mounting box 33 also comprises a grounding connection 51.

20 The mounting box further comprises a lid 53 for closing the mounting box during normal operation of the vehicle. The lid is in fig. 2 shown separate from the mounting box proper, for the sake of visibility. The lid 53 is in this example arranged to be attachable and detachable from the mounting box, for allowing or disallowing access to the interior of the mounting box, but it
25 may also be permanently attached and instead be adapted to be openable and closable. The lid 53 may further be held in place by fasteners such as screws or bolts, etc., may be permanently fastened by welding, or may comprise an opening mechanism, such as hinges, and which may or may not contain a lock. The lid 53 is made of an electrically conducting material, and
30 is electrically connected with the other, electrically conducting walls of the mounting box.

The mounting box 33 further comprises an internal wall 55 separating the mounting box into two compartments, wherein each compartment

accommodates one electric motor and its corresponding electronic motor controller. The internal wall 55 hence separates the two electric motors, and the two electronic motor controllers, from each other. The electronic motor controllers are attached to and mounted to bear against the internal wall for firm attachment. The internal wall 55 is made of an electrically conducting material and is electrically connected with the electrically conducting outer walls of the mounting assembly, and thus with the ground potential of the vehicle, in order to reduce any electromagnetic disturbances inside the mounting box.

10

In this example the electric motor assembly and the two electric motors 35,37 are connected with and arranged to drive the rotation of two oppositely arranged drive shafts 43,45, wherein one motor is connected to and drives each shaft. Hence the motor assembly is suitable for being installed in a wheeled vehicle, having at least two drive wheels, one on each side of the vehicle. The two motor controllers are arranged to control the operation of one electric motor, and thus the rotation of one shaft, each. Hence different functions such as a differential, differential lock, ABS-brakes, and others may more easily be achieved.

20

The electric motor assembly comprises a protective sleeve 57 covering the opening 47 for the shaft in the mounting box. The protective sleeve is arranged to surround the shaft at its exit from the mounting box in order to seal off the through hole. The protective sleeve is made of a polymer, a rubber, or a similar material, and is arranged to protect against entrance of dirt, water, mud, grime and such, via the opening or through hole.

25

The motor assembly comprises an internal liquid cooling system 59 inside the mounting box for cooling the motor assembly. The internal cooling system is arranged to allow circulation of a cooling liquid for transportation of heat away from the components and out from the mounting box. The internal cooling system comprises a plurality of cooling circuits 61, in this example one separate liquid cooling circuit for each major component to be cooled, inside the mounting box. The internal cooling system further comprise a first

30

forking element 71 for conducting cooling liquid from a single inflow connector 73 to the separate cooling circuits in parallel, and a second forking element 75 for conducting cooling liquid from the plurality of cooling circuits to a single outflow connector 77. The inflow and outflow connectors are
5 arranged to be accessible from the outside of the mounting box, in this example through openings 79 in the mounting box, through which the connectors extend.

The motor assembly further comprises two bundles 81 of electrical
10 conductors arranged to pass through two additional openings 83 in the mounting box, and which bundles of electrical conductors are connectable via one plug socket 85 each. Hence only two external electrical connections need to be made to electrically connect the entire motor assembly. The four
15 openings 79, 83 allowing external connections between the internal components of the assembly and the environment are in this example located on top of the mounting box in order to allow easy access. It is an advantage if the external connection openings are positioned close to each other, wherein the time for connecting the mounting box is shortened. The openings are
20 further shaped to fit tightly and preferably sealingly around the connectors or conductors, and are preferably also circular in shape.

The mounting box, and thus the motor assembly, is in this example shaped to be mountable as one unit inside the motor compartment of the vehicle, for manufacturing and installation in accordance with the methods as described
25 below in relation to figs 3a and 3b. However, in another example the mounting box could instead be installed by first attaching the body of the mounting box into the vehicle, then installing and connecting the electric motor and electronic motor controller inside the body of the mounting box, continuing with connecting the electric motor and electronic motor controller
30 to each other, and then connecting the drive shaft to the rotor and the drive wheel, and connecting the electrical and cooling connectors to their respective systems, and concluding by attaching the lid onto the mounting box. This method is however more time consuming and less adapted for slim production lines.

In fig. 3a one example of a method for manufacturing and providing the electric motor assembly according to the invention is described. Correspondingly, in fig. 3b one example of installing an electric motor assembly according to the invention is described. It should be appreciated that the two methods could be, and would benefit from, being combined with each other. For simplicity, the methods are described for a motor assembly such as the one described in fig. 2. However, the methods are equally applicable to any other form of motor assembly in accordance with the attached independent claims.

In a first step 91 of the method in fig. 3a the method comprises providing or manufacturing a mounting box adapted to be able to enclose both the electric motor and the motor controller inside the mounting box, and which mounting box is provided with at least one opening for admitting passage of a shaft. In this specific example the mounting box is adapted to enclose two motors and two motor controllers, and is provided with two openings for two shafts.

In a second step 92 the method comprises inserting shafts into the rotors of two electric motors, and securing the shafts to the motors.

In a third step 93 the method comprises installing and attaching the electric motors inside the mounting box. The motors are attached with an appropriate number of fasteners. The shafts are arranged to pass out of the openings in the walls of the mounting box.

In a fourth step 94 two protective sleeves are attached onto and arranged to surround the openings for the shafts.

In a fifth step 95 the method comprises installing and attaching electronic motor controllers inside the mounting box, and electrically connecting the controllers to the electric motors.

In a sixth step 96 the method comprises connecting forking elements to cooling circuits internally provided inside the electric motors and motor controllers.

5 In a seventh step 97 the method comprises attaching the lid on the mounting box, and inserting the electrical connectors, the inflow connector and the outflow connector to pass through their appropriate openings in the lid.

10 In an eight and concluding step 98 for the method of fig. 3a the method comprises providing the motor assembly for delivery, and/or directly to a production line for an electric vehicle.

In a first step 101 of the method of manufacturing a vehicle, vessel or craft and in relation to fig. 3b the method comprises receiving a motor assembly
15 comprising a mounting box containing and enclosing both at least one electric motor and at least one motor controller inside the mounting box, and comprising at least one shaft connected with a rotor of the motor, wherein the mounting box is provided with an opening for admitting passage of the shaft. In this example the method comprises receiving a motor assembly comprising
20 two electric motors and two electronic motor controllers, wherein the assembly comprises two shafts, one connected with each motor, and arranged to project in opposite directions from the mounting box.

25 In a second step 102 the method comprises lifting the mounting box into the motor compartment of a vehicle, vessel or craft, in this specific example into the motor compartment of an automobile.

30 In a third step 103 the method comprises fastening the output end of each shaft with a corresponding drive element in the vehicle, vessel or craft, in this example with a drive wheel of the vehicle.

In a fourth step 104 the method comprises fastening the mounting box with fasteners to the framework or chassis of the vehicle, vessel or craft. The

fastening operation can for example include any one or more of fastening with screws, bolts, rivets, nails, welding etc.

5 In a fifth step 105 the method comprises connecting the inflow and outflow connectors of the motor assembly to an external cooling system belonging to the vehicle, vessel or craft.

10 In a sixth step 106 the method comprises connecting the electrical contacts in the form of two plug sockets to corresponding external electrical contacts belonging to the vehicle, vessel or craft.

15 In a seventh step 107 the method comprises connecting an electrical conductor connected with the walls of the mounting box to a ground potential of the vehicle.

Thus the motor assembly may be installed very quickly and efficiently into the vehicle, vessel or craft, relative to the operations required to install two motors and their controllers separately into a vehicle.

20 It should be appreciated that the order of the steps in both methods described may be alternated depending on the configuration and shape of the different components. Indeed, dependent on accessibility and reach, some steps could even be carried out simultaneously.

25 The invention is not limited to the examples and embodiments shown but may be varied freely within the framework of the following claims. In particular, the individual features of one example may be freely transferred to another example, and one or more features may be deleted, added or substituted without departing from the scope of the invention, which is
30 defined in the attached claims.

CLAIMS

1. An electric motor assembly for an electric vehicle, vessel or craft, the motor assembly comprising at least one electric motor comprising a stator and a force generating movable part, such as a rotor, for generating a force or torque and for providing the force or torque to a drive shaft, and at least one additional electric motor and/or at least one electronic motor controller arranged to feed voltages and currents to the stator for controlling the operation of the movable part, characterized in that the electric motor assembly further comprises a mounting box arranged to enclose both the electric motor and the at least one additional motor and/or motor controller inside the mounting box, and which mounting box is provided with at least one opening for admitting passage of the drive shaft.
2. An electric motor assembly according to claim 1, characterized in that the mounting box comprises electrically conducting wall portions and an electrical connection for connecting the conducting wall portions to a ground potential of the vehicle, vessel or craft, in order to electromagnetically shield the electric motor assembly.
3. An electric motor assembly according to claim 1, characterized in that the mounting box comprises at least one protective wall intended to face an external environment and adapted to protect the motor assembly against being splashed by liquids.
4. An electric motor assembly according to claim 1, characterized in that the electric motor assembly comprises at least two electric motors, and that the mounting box is arranged to enclose both of the at least two electric motors inside the mounting box.
5. An electric motor assembly according to claim 4, characterized in that the at least two electric motors are connectible with and arranged to drive the rotation of two oppositely arranged drive shafts.

6. An electric motor assembly according to claim 4 or 5, characterized in that the mounting box comprises at least one internal wall separating at least two of the at least two electric motors from each other.

5 7. An electric motor assembly according to claim 4, characterized in that the motor assembly comprises at least two motors and at least two motor controllers for controlling the motors inside the mounting box.

8. An electric motor assembly according to claim 1, characterized in that the
10 motor assembly comprises an internal liquid cooling system inside the mounting box for cooling the motor assembly.

9. An electric motor assembly according to claim 8, characterized in that the cooling system comprises an inflow connector and an outflow connector for
15 the cooling liquid to both the at least one electric motor and to the at least one electronic motor controller, wherein both the inflow connector and the outflow connector are accessible from outside the mounting box.

10. A mounting box for being installed in a vehicle, vessel or craft,
20 characterized in that the mounting box is adapted to enclose at least one additional motor and/or at least one electronic motor controller to be mounted inside the mounting box, and which mounting box comprises at least one through hole for admitting passage of a drive shaft.

25 11. A method of providing an electric motor assembly according to claim 1 for installation into a vehicle, vessel or craft, the method comprising:

- providing the at least one electric motor,
- providing at least one additional motor and/or at least one electronic motor controller, and

30 - providing a mounting box, wherein the mounting box is adapted for enclosing both the electric motor and the motor controller inside the mounting box.

12. A method for providing an electric motor assembly for installation into a vehicle, vessel or craft according to claim 11, wherein the method comprises

- installing the at least one electric motor or motors and/or the at least one electronic motor controller inside the mounting box before installation into the vehicle, vessel or craft, so that the mounting box encloses both the at least one electric motor or motors and/or the at least one electronic motor controller inside the mounting box, and then
- providing the mounting box, and thus the motor assembly, as one unit, in order to allow subsequent installation inside the vehicle, vessel or craft.

13. A method for installing an electric motor assembly according to claim 1 into an electric vehicle, vessel or craft, the method comprising:

- installing the at least one electric motor, the at least one electronic motor controller, and the mounting box into the vehicle, vessel or craft so that the mounting box encloses both the at least one electric motor and an additional motor and/or at least one electronic motor controller inside the mounting box.

14. A method for installing an electric motor assembly into a vehicle, vessel or craft according to claim 13, wherein the method comprises

- installing a mounting box having the at least one electric motor or motors and/or the at least one electronic motor controller pre-mounted inside the mounting box.

15. An electric vehicle, vessel or craft comprising a motor compartment and an electric motor assembly mounted inside the motor compartment, which electric motor assembly comprises at least one electric motor comprising a stator and a force generating movable part, such as a rotor, for generating a force or torque and for providing the force or torque to a drive shaft, and at least one electronic motor controller arranged to feed voltages and currents to the stator for controlling the operation of the movable part, characterized in that the electric motor assembly further comprises a mounting box installed

inside the motor compartment of the vehicle, vessel or craft, wherein the mounting box is arranged to enclose at least one additional motor and/or at least one electronic motor controller mounted inside the mounting box, and which mounting box comprises at least one through hole for admitting
5 passage of the drive shaft.

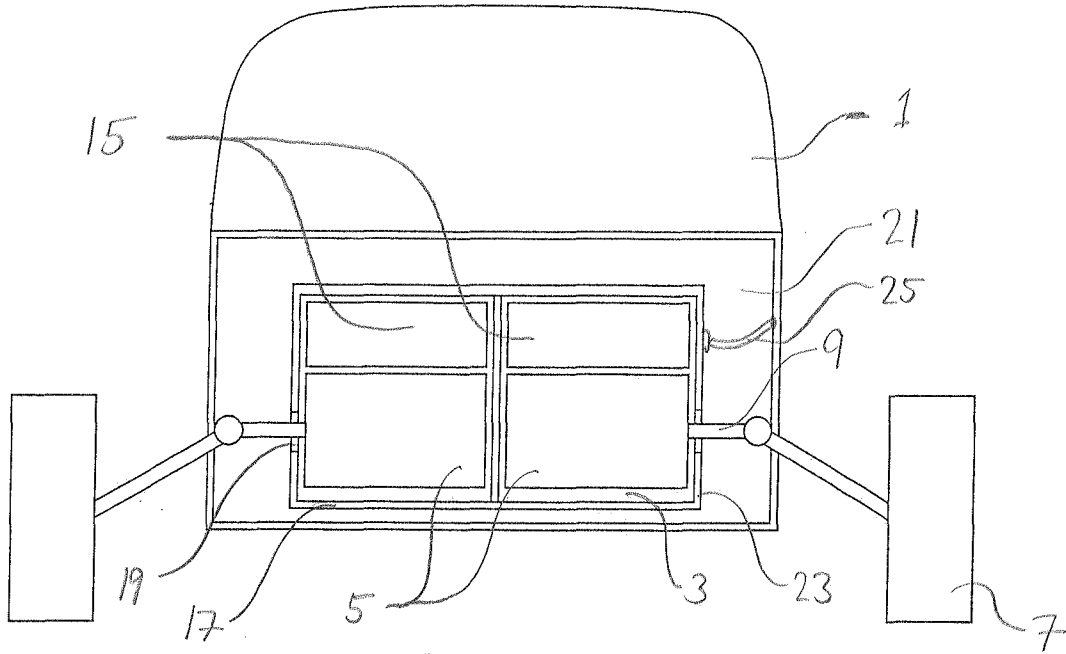


Fig. 1a

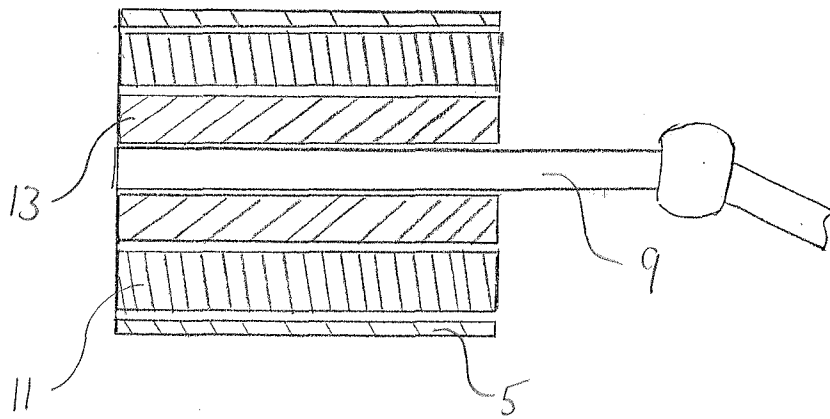


Fig. 1b

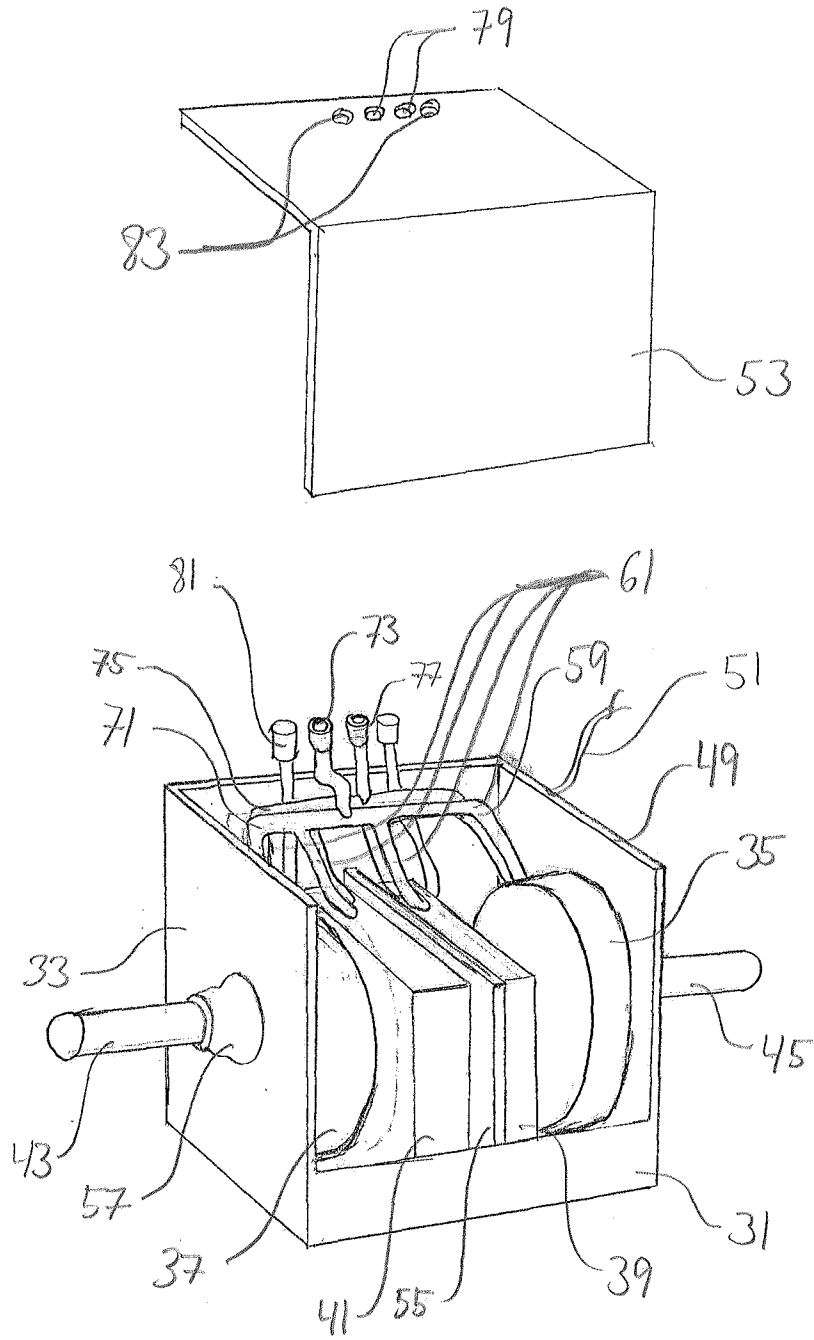


Fig. 2

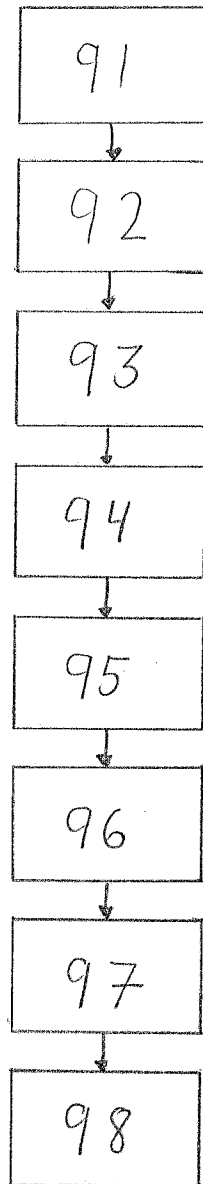


Fig 3a

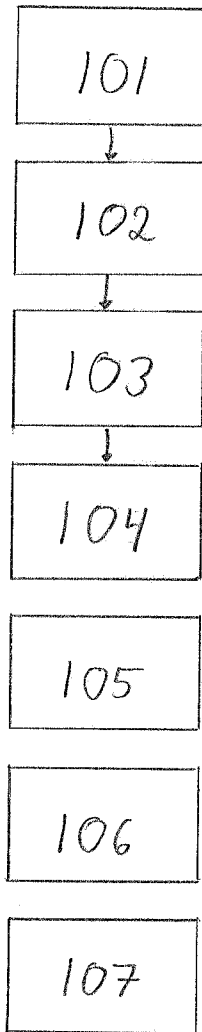


Fig 3b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2011/051357

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: B60K, B60L, H02K

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, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 20100025131 A1 (GLOCERI GARY J ET AL), 4 February 2010 (2010-02-04); paragraphs [0070]-[0071], [0133]; figure 1	1-5, 7-15
A	--	6
A	WO 2010071539 A1 (ELECTROENGINE IN SWEDEN AB ET AL), 24 June 2010 (2010-06-24); page 16, line 13 - line 24; page 19, line 23 - line 33	1-15
A	DE 102005026874 A1 (VOLKSWAGEN AG), 14 December 2006 (2006-12-14); abstract; figure 1	1-15
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 Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search

13-02-2012

Date of mailing of the international search report

28-02-2012

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Continuation of: second sheet

International Patent Classification (IPC)

B60K 7/00 (2006.01)

B60L 11/18 (2006.01)

H02K 5/00 (2006.01)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SE2011/051357

US	20100025131 A1	04/02/2010	AU	2007234883 A1	18/10/2007
			EP	2026988 A2	25/02/2009
			EP	2258569 A3	22/12/2010
			JP	2009532277 A	10/09/2009
			WO	2007118082 A3	21/02/2008
WO	2010071539 A1	24/06/2010	WO	2010071540 A1	24/06/2010
DE	102005026874 A1	14/12/2006	NONE		