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(71) Applicant (for all designated States except US): **VOLVO LASTVAGNAR AB** [SE/SE]; S-405 08 Göteborg (SE).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **STERVIK, Hans** [SE/SE]; Snäckliden 44, S-442 71 Kärna (SE). **ALM, Ivar** [SE/SE]; Backevägen 10, S-430 90 Öckerö (SE).

(74) Agent: **FRÖHLING, Werner**; Volvo Technology Corporation, Corporate Patents, 06820, M1.7, S-405 08 Göteborg (SE).

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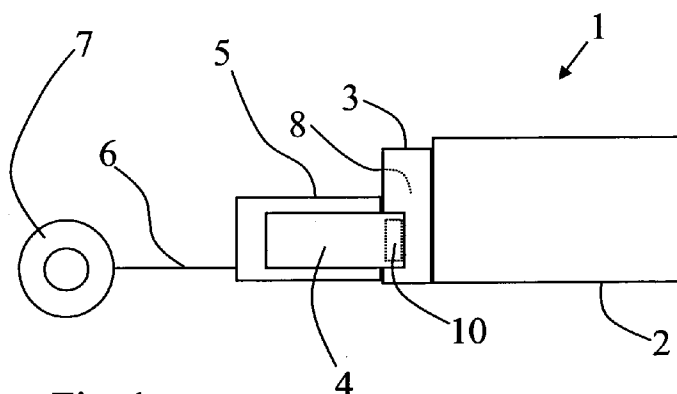


Fig. 1a

(57) Abstract: Arrangement for a power electronics unit in a HEV (1, 16, 24, 42, 43), said HEV comprising a combustion engine (2, 17, 25), an electric motor/generator (3, 21, 28, 26, 41), a transmission (5, 18, 27), said power electronics unit is shaped substantially as a plate, where a first biggest cross-sectional area of said plate is extended along and within a first transmission side of a transmission housing, said power electronics unit is fixed to said hybrid vehicle power train with a first attachment point (10, 23, 33, 34, 39). All attachment points (10, 11, 13, 14, 15, 23, 33, 34, 35, 36, 39, 42, 54, 55, 59) has a total thermal conductivity corresponding to less than 10 degrees temperature increase on a Kelvin-scale for 5kW of heat originating from one side of said attachment point. Embodiments also comprising sound damping capabilities are disclosed. Advantage is less parts and increased functionality.

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Arrangement for a power electronics unit in a hybrid vehicle

5 TECHNICAL FIELD OF THE INVENTION:

The present invention relates to an arrangement in a hybrid electric vehicle (HEV) equipped with a combustion engine, a transmission and at least one electric motor/generator, and where a power electronics
10 unit of the electric motor/generator is mounted on a gearbox of said transmission.

BACKGROUND OF THE INVENTION:

The need to reduce fossil fuel consumption and
15 emissions in vehicles powered by an internal combustion engine (ICE) is well known. Vehicles powered by electric motors attempt to address these needs. However, electric vehicles have limited range and limited power capabilities and need substantial time to
20 recharge their batteries. An alternative solution is to combine both an ICE and electric traction motor into one vehicle. Such vehicles are typically called Hybrid Electric Vehicles (HEVs). See for example, US5343970.

25 The HEV is described in a variety of configurations. Many HEV patents disclose systems in which an operator is required to select between electric and internal combustion operation. In other configurations, the electric motor drives one set of wheels and the ICE
30 drives a different set.

Other, more useful, configurations have developed. For example, a Series Hybrid Electric Vehicle (SHEV) configuration is a vehicle with an engine (most
35 typically an ICE) connected to an electric motor called a generator. The generator, in turn, provides electricity to a battery and another motor, called a traction motor. In the SHEV, the traction motor is the

sole source of wheel torque. There is no mechanical connection between the engine and the drive wheels.

A Parallel Hybrid Electrical Vehicle (PHEV)

5 configuration has an engine (most typically an ICE) and an electric motor that together provide the necessary wheel torque to drive the vehicle. Additionally, in the PHEV configuration, the motor can be used as a generator to charge the battery from the power produced
10 by the ICE. The PHEV has usually a transmission between the ICE and drive wheels of the vehicle in order to be able to alter gear ratio between the ICE and the drive wheels and also in many cases between the electric motor and the drive wheels.

15

A Parallel/Series Hybrid Electric Vehicle (PSHEV) has characteristics of both PHEV and SHEV configurations and is typically known as a "powersplit" configuration. In the PSHEV, the ICE is mechanically coupled to two
20 electric motors in a planetary gearset transaxle. A first electric motor, the generator, is connected to a sun gear. The ICE is connected to a carrier. A second electric motor, a traction motor, is connected to a ring gear (output) via additional gearing in a
25 transaxle. Engine torque powers the generator to charge the battery. The generator can also contribute to the necessary wheel (output shaft) torque. The traction motor is used to contribute wheel torque and to recover braking energy to charge the battery if a regenerative
30 braking system is used.

The desirability of combining an ICE with an electric motor is clear. The ICE's fuel consumption and emissions are reduced with no appreciable loss of
35 vehicle performance or range. Nevertheless, there remains a substantial opportunity to develop ways to optimize HEV operation.

One area of development is maintaining the desired

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operating temperature of the HEV components. A cooling system maintains optimal component operation and performance. Overheated components adversely affect efficiency and may eventually cause component failure.

5

A typical prior art cooling system for an ICE vehicle has a coolant fluid in an enclosed loop that passes through certain vehicle components and a heat exchanger (radiator). A heater core is also typically added to vent engine heat into the passenger compartment as desired. The engine and transmission components typically require cooling from a liquid cooling system. As the coolant circulates through these components in the closed loop, it absorbs heat that is released as the coolant passes through the radiator and heater core.

Coolant flow in the prior art cooling system is typically controlled by a pump driven front-end accessory drive (FEAD). As engine speed increases, the speed of the pump also increases allowing more coolant flow through the system. Additionally, a thermostat within the loop only allows coolant flow through the radiator after the coolant temperature reaches a level at which the engine temperature has stabilized and is considered "warmed up."

Though simple and reliable, the prior art coolant control system comprising a pump and a thermostat is inadequate for HEVs. For example, the HEV has additional components that require cooling, such as a power electronics unit. Further, the prior art coolant pump does not function when the engine is off. Thus, the typical vehicle accessories driven by the FEAD (including the coolant pump, air conditioning, and power steering) in a conventional vehicle must be powered by an alternate source in the HEV to maintain their functionality when the engine is not running.

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The cooling system of a prior art transmission usually comprises a predetermined amount of cooling oil contained in the transmission housing. Some of the gear wheels of the transmission are arranged to be in
5 contact with the cooling oil. When the gear wheels of the transmission rotate during operation, the cooling oil is splashed around in the transmission housing, making the oil coming into contact with basically all parts inside the transmission housing. The oil evens
10 the heat build up in the transmission and contributes to heat being conducted to the transmission housing. The transmission housing can be cooled by ambient air. There are also transmission cooling systems where the oil is circulated by a pump through cooling channels
15 inside the transmission housing and outside the transmission housing to a heat exchanger.

In a heavy HEV, such as a truck more than 5 tonnes it is common for an electric motor/generator to have a
20 performance capacity of more than 100 kW. A power electronics unit for such a relatively powerful electric motor/generator produces a lot of heat during operation that has to be cooled in order to secure the endurance of the electronic components in the power
25 electronics unit. Depending on the specification of the electronic components the maximum allowable temperature varies. Electronic components with less heat resistance are cheap and can have a maximum operative temperature of, for example, 60 degrees Celsius. If the electronic
30 components are specified to withstand temperatures of several hundred degrees Celsius then usually no cooling of the power electronics unit is needed. On the other hand such electronic components are expensive. In the future the power electronics unit is expected to shrink
35 in size due to technical development. The demand for cooling will probably increase since the electronic components will be more densely packed and the electric power handled by the power electronics unit will

increase concurrently with the use of more powerful electric motor/generators used in future HEV.

US2004/0134695 discloses a vehicle power train with a
5 combustion engine, a gearbox and an Integrated Starter/Generator (ISG) arranged between the combustion engine and the gearbox. Thus, this document does not disclose a HEV, still, in one embodiment disclosed the power electronics unit of the ISG is arranged on the
10 gearbox. The power demand of an ISG is usually between 1 to 5 kW. The power electronics unit of the ISG is, thus, relatively small and handles a relatively low power. The need for cooling is relatively small. Further, this document discloses an embodiment where a
15 cooling system of the engine also is used for cooling the power electronics unit, when the power electronics unit is arranged on the engine. Only two standard mounting points for a conventional ring gear starter are used when the power electronics unit is mounted on
20 the engine. There is also disclosed a plug in connection between the power electronics unit and the ISG.

Noise from a vehicle power train is always an issue.
25 The transmission components of a vehicle transmission contributes to the increase of noise when in operation. A step geared transmission, especially when gear changing frequently, can cause slamming and rattling, which can be disturbing for the environment.
30 A known noise damping solution is to arrange a relatively thin plate on the outside of the transmission housing. The fixing point of the plate extends around the whole periphery of one side of the plate. Said transmission outside, said plate side and
35 said fixing point enclose a compartment comprising a medium, such as air, with high noise damping capabilities. The fixing point as such can be of a noise damping material such as rubber or the like.

The object of the present invention is to make an arrangement for a power electronics unit in a HEV more space effective with a minimal amount of components. A further object of the present invention is to
5 contribute to a simple and effective installation of a cooling arrangement of said power electronics unit and to contribute to noise reduction of said vehicle.

SUMMARY OF THE INVENTION

10 The arrangement according to the invention is an arrangement for a power electronics unit in a hybrid vehicle power train. Said hybrid vehicle power train comprising a combustion engine arranged for propulsion, and an electric motor/generator arranged for
15 propulsion, a transmission with a transmission housing, said transmission is arranged to adapt gear ratio between at least one of said propulsion units and driven vehicle wheels, said motor/generator is arranged to exchange electric power with a power electronics
20 unit, a cooling arrangement comprising cooling channels for cooling at least said power electronics unit, said power electronics unit is shaped substantially as a plate, where a first biggest cross-sectional area of said plate is extended substantially along and
25 substantially within a first transmission side of said transmission housing and covering at least a part of said first transmission side, said power electronics unit is fixed to said hybrid vehicle power train with at least one first attachment point. The invention is
30 characterized in that all attachment points has a total thermal conductivity corresponding to less than 10 degrees temperature increase on a Kelvin-scale for 5kW of heat originating from one side of said attachment point.

35

The advantage with the arrangement according to the invention is increased space efficiency of the power electronics unit installation at the same time as the thermal conductivity of the attachment point/-s

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has/have been decreased, which increases the performance of the cooling arrangement of the power electronics unit.

5 According to one embodiment of the arrangement according to the invention said electric motor/generator and said power electronics unit are connected and fixed to each other to form a first unit, and where said connection is said first attachment
10 point formed by a plug in connection. This embodiment decreases the number of components.

According to one embodiment of the arrangement according to the invention said power electronics unit
15 is also attached to said first transmission side via at least a second attachment point made of a material with low thermal conductivity. The advantage is that the carrying performance of the power electronics unit is increased still with low total thermal conductivity at
20 the attachment points.

According to one embodiment of the arrangement according to the invention, said plug in connection is arranged to transmit at least one of or both of a
25 cooling media for said cooling arrangement and electric power between said motor/generator and said power electronics unit. This decreases the number of components.

30 According to one embodiment of the arrangement according to the invention, said power electronics unit plate is arranged to cover said first transmission side in such a way as to damp noise originating from said transmission.

35 According to one embodiment of the arrangement according to the invention, said second attachment point is extended around the periphery of a side of said power electronics unit facing the transmission,

and where said first transmission side, said power electronics unit side and said second attachment point enclose a compartment comprising a medium with low thermal conductivity and high noise damping capabilities. This decreases the number of components at the same time as the functionalities of the installation increases.

According to one embodiment of the arrangement according to the invention, said first and second attachment points are of materials with high noise damping capabilities.

According to one embodiment of the arrangement according to the invention, said power electronics unit plate comprises said power electronics unit with noise damping material and in an extended part only of a noise damping material, said extended part being arranged in order to better cover said first transmission side. The extended part increases especially the noise reduction capabilities of the installation.

According to one embodiment of the arrangement according to the invention, a second electric motor/generator with a second power electronics unit are arranged in connection to said transmission and which together form a second unit via a second plug in connection, and where said second power electronics unit is arranged along a second transmission side of said transmission housing. The advantage is that the number of components can be decreased even further and the noise reduction capabilities can be kept on a high level without any additional noise reducing components.

According to one embodiment of the arrangement according to the invention a hose for transmitting cooling media is connected to said power electronics unit on substantially an opposite side of where said

plug in connection is arranged. This embodiment is characterized in that said second attachment point is formed of a part of said hose and a cooling hose holder for holding said hose, and where said hose holder is
5 attached to said transmission housing. The advantage is that performance of carrying the power electronics unit can be increased without increase of the number of components and still with low total thermal conductivity at the attachment points.

10

According to one embodiment of the arrangement according to the invention said power electronics unit is only fixed to said first transmission side with at least one of said first attachment point. Said first
15 attachment point can be of a screw-nut type, with a relatively small cross-sectional area. This embodiment can also be combined with a hose for transmitting cooling medium that is connected to said power electronics unit on substantially an opposite side of
20 where said screw-nut type attachment point is arranged, and where said hose and a cooling hose holder for holding said hose forms a further attachment point, and where said hose holder is attached to said transmission housing.

25

In a further embodiment of said invention a second attachment point can be combined with said screw-nut type attachment point, and where said second attachment point is extended around the periphery of a side of
30 said power electronics unit facing the transmission, and where said first transmission side, said power electronics unit side and said second attachment point enclose a compartment comprising a medium with low thermal conductivity and high noise damping
35 capabilities. This embodiment can also be combined with a hose for transmitting cooling medium that is connected to said power electronics unit on substantially an opposite side of where said screw-nut type attachment point is arranged, and where said hose

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and a cooling hose holder for holding said hose forms a further attachment point, and where said hose holder is attached to said transmission housing.

- 5 Further advantageous embodiments of the invention emerge from the dependent patent claims following patent claim 1.

BRIEF DESCRIPTION OF THE DRAWING

- 10 The present invention will be described in greater detail below with reference to the accompanying drawings which, for the purpose of exemplification, shows further preferred embodiments of the invention and also the technical background, and in which:
- 15 Figures 1a and 1b diagrammatically shows a PHEV power train in two different views of an embodiment of the invention.
- Figures 2a and 2b diagrammatically shows a PHEV power train in two different views of an embodiment of the invention.
- 20 Figures 8a and 8b diagrammatically shows a PHEV power train in two different views of an embodiment of the invention.
- Figures 3 to 7 and 10 diagrammatically show a top view of further five different PHEV power trains and
- 25 embodiments of the invention.
- Figure 9 diagrammatically shows a side view of another PHEV power train and embodiments of the invention.

30 DESCRIPTION OF THE INVENTION

- Figure 1a and 1b show a PHEV power train 1 comprising a first embodiment of the invention. The HEV power train comprises a combustion engine 2, an electric
- 35 motor/generator 3 with a power electronics unit 4, a transmission 5, a propeller shaft 6 and drive wheels 7. Arranged mainly coaxially inside of said electric motor/generator 3 is a clutch 8 (not disclosed), which is arranged to transmit torque between the engine 2 and the transmission 5 and which can be engaged or

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disengaged depending of vehicle condition. The transmission can be a step geared transmission with several gear ratios.

5 According to the invention the power electronics unit 4 is formed as a relatively thick space efficient plate arranged along one side of the transmission 5. The outer of the transmission housing can have a cubic form or a cylinder form or something in between. When the
10 power electronics unit is said to be arranged along a side of said transmission housing, this side is defined as the projection of the outer contour of the transmission housing. Thus, said projection can be a cross sectional plane of the transmission housing along
15 which said power electronics unit is arranged. In the in figure 1a and 1b showed embodiment only one attachment point is used for fixing the power electronics unit to the side of the transmission. This attachment point is formed by a plug in connection 10
20 arranged to fix the power electronics unit to the electric motor/generator 3. The plug in connection is arranged to have a thermal conductivity corresponding to less than 10 degrees temperature increase on a Kelvin-scale for 5kW of heat originating from one side
25 of said attachment point. Thus, if there for example is a 5kW power loss in the electric motor/generator converted to heat at the surface of the electric motor/generator within the plug in connection area 10, this heat will only create a temperature increase of
30 less than 10 degrees on the corresponding surface of the power electronics unit. The plug in connection is designed in such a way as to have a relatively low thermal conductivity. This can be achieved for example by choosing materials for the plug in connection having
35 low thermal conductivity. Examples of materials with low thermal conductivity are ceramics, plastics or rubber.

Further, the power electronics unit comprises electronics that has to be cooled in order to secure functionality. A cooling arrangement (not showed) in the power electronics unit is connected to a second
5 cooling arrangement (not showed) of said electric motor/generator via the plug in connection 10, thus integrating the power electronics unit and the electric motor/generator to form a unit. The plug in connection can also comprise necessary electric connections
10 between the power electronics unit 4 and the electric motor/generator 3 or only one of said electric connections and said cooling arrangement connection. Said cooling arrangements form together with other necessary, not shown components, a cooling system of
15 the power electronics unit and the motor/generator.

Figures 2a and 2b disclose a similar HEV power train as in figures 1a and 1b. In the embodiment of figures 2a and 2b a second attachment point, besides the plug in
20 connection, has been added and is arranged to connect the transmission housing and the power electronics unit. Besides low thermal conductivity this second attachment point together with the power electronics unit plate 12 is designed to damp noise originating
25 from said transmission. This is achieved by the second attachment point extending around the periphery of the side of the power electronics unit facing the side of the transmission (see dashed line in figure 2a). Thus, the transmission side, the side of the power
30 electronics unit and the second attachment point are enclosing a compartment comprising a medium with low thermal conductivity and high noise damping capabilities. This medium can for example be air. The second attachment point as such can be made of for
35 example rubber. According to one embodiment of the invention this second attachment point is not design for fixing the power electronics unit to the transmission, thus the second attachment point has a very low carrying functionality. The main carrying

functionality of the power electronics unit lies in this embodiment on the plug in connection. In a further embodiment this second attachment point as disclosed in figures 2a and 2b can have a carrying functionality. In
5 such an embodiment the second attachment point is made stiffer, for example with stiffer material or a composite, comprising metal parts and parts made of a material with low thermal conductivity and high noise reduction. In order to allow carrying performance to
10 the second attachment point, said attachment point can be fixed to the transmission side and to the power electronics unit in a known manner, with for example different screw/nut solutions, vulcanization etc.

15 Figure 3 discloses a similar PHEV power train as in figures 1a and 1b. The only difference is that another variant of a second attachment point 13 has been added that has a power electronics unit carrying
functionality with low thermal conductivity. This
20 variant of the second attachment point 13 can for example comprise of a bushing made of a material with low thermal conductivity. The transmission housing and the power electronics unit can each of them be equipped with corresponding flanges (not shown) to which the
25 bushing can be attached by vulcanization and/or screw/nut arrangement (not shown). In one embodiment there can be more than one of this variant of the second attachment point 13. Preferably such an attachment point is arranged substantially on the
30 opposite side of the plug in connection side of the power electronics unit in order to better balance the carrying performance between the plug in connection 10 and this variant of the second attachment point 13. This second attachment point can also be made of a
35 composite (for example metal and a material with low thermal conductivity) with a thermal conductivity corresponding to less than 10 degrees temperature increase on a Kelvin-scale for 5kW of heat originating from one side of said attachment point.

Figure 4 discloses a similar PHEV power train as in figure 3, i. e. figure 4 discloses a third variant of a second attachment point that has power electronics unit
5 carrying functionality and low thermal conductivity. This third variant of a second attachment point comprises basically of a part of a hose 15 and a hose holder 14. Said hose can be a cooling hose for transmitting cooling media from a pump and a cooler to
10 the power electronics unit cooling arrangement. The hose holder is fixed to the transmission housing and holding the hose in a fixed position. Thus, this hose holder and hose configuration if made sufficiently strong and stiff can have power electronics unit
15 carrying functionality. Further, at least one of the hose holder or the hose is made of a material with low thermal conductivity. In a further embodiment of the invention there can be more than one hose with a hose holder attached to the side of the power electronics
20 unit and attached to the transmission housing. Thus, there can be more than one of this third variant of a second attachment point. As can be seen in figure 4 the hose 15 is connected to said power electronics unit 4 on substantially an opposite side of where said plug in
25 connection 10 is arranged. This will better balance the carrying performance between the plug in connection 10 and this third variant of the second attachment point formed of hose 15 and hose holder 14.

30 Figure 5 discloses a PHEV power train 16, where a combustion engine 17 is connected to an input shaft (not shown) of a stage geared transmission 18 via a clutch 19. The transmission 18 is further connected to driven wheels 20 via an electric motor/generator 21
35 attached at an output shaft (not shown) of the transmission 18. The electric motor/generator 21 with its power electronics unit 22 is attached to one end of the transmission housing. Said power electronics unit is attached to the electronic motor/generator via a

plug in connection 23 with the same essential features according to the invention as mentioned in the preceding embodiments. In further embodiments of the embodiment shown in figure 5 the features of a second attachment point can be used in a similar way as in the embodiments shown in figures 2a, 2b, 3 and 4.

Figure 6 discloses an embodiment of the invention based on a combination of the embodiments mentioned in relation to figures 2a, 2b and 5. Thus, this power train 24 comprises besides a combustion engine 25, a clutch (not shown) coaxially arranged inside of a first electric motor/generator 26, a step geared transmission 27, a second electric motor/generator 28 connected to an output shaft (not shown) of the transmission and driven wheels 29 connected to the second electric motor/generator 28 via for example a propeller shaft 30. The two electric motor/generators have each of them a power electronics unit 31 and 32 arranged in the corresponding way as in the embodiments of figures 5, 2a and 2b, i. e. with plug in connections 33 and 34. Further, both plug in connections 33 and 34 have a second attachment point 35 and 36 corresponding to the second attachment point explained above in connection to the embodiment disclosed by the figures 2a and 2b, i. e. with noise reduction functionality and low heat conductivity. The power electronics units 31 and 32 are arranged on each side of the transmission 27.

Figure 7 discloses a similar HEV power train as in figures 2a and 2b. Here said power electronics unit plate comprises said power electronics unit 38 with noise damping material and in an extended part 37 only of a noise damping material. The extended part 37 is fixed to the power electronics unit 38 and arranged in order to better cover said first transmission side in order to increase noise reduction. This embodiment can also be applied to the embodiment shown in figure 6.

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Figure 8a and 8b disclose a HEV power train 42 similar to the one in figure 3. According to the invention also a power electronics unit 40, as in the above described embodiments, is formed as a relatively thick space efficient plate arranged along one side of the transmission 5. The main difference is that the embodiment of figure 8a and 8b does not have any plug in connection. Thus the motor/generator 41 is slightly modified compared to the one shown in figure 3. Instead of a power electronics unit being connected to the electric/motor via said plug in connection (as in figure 3), the power electronics unit 40 of the embodiment in figures 8a and 8b is somewhat shorter and is, for example, near the corners of the power electronics unit attached to the transmission housing of the transmission 5. In the shown example the attachment points 39 have a relatively small cross-sectional area, compared to the power electronics unit, and can be embodied for example by a screw-nut arrangement made of a material having a low thermal conductivity and/or corresponding to less than 10 degrees temperature increase on a Kelvin-scale for 5kW of heat originating from one side of said attachment point for all (four in the shown example, but can be more or less than four) the attachment points 39 together, which means that material with low thermal conductivity may not be necessary as long as the total heat transmission is low. The transmission of cooling medium and/or electric power to and from the power electronics unit 40 can be performed in a known manner through hoses and electric wires.

Figure 9 discloses a similar HEV power train as in figures 8a and 8b. In the embodiment of figure 9 a second attachment point 42, besides said above described "screw-nut" attachment points 39, has been added and is arranged to connect the transmission housing and the power electronics unit 40. Besides low thermal conductivity this second attachment point 42

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together with the power electronics unit plate 40 is designed to damp noise originating from said transmission 5. Said second attachment point 42 is similar to the second attachment point 11 shown in the embodiment of, for example, figure 2a and 2b. Thus, in this embodiment the carrying functionality and low thermal conductivity of attachment points 39 are combined with the noise reduction capabilities and low thermal conductivity of the second attachment point 42.

10

Figure 10 discloses a similar HEV power train 43 as in figures 8a and 8b. Figure 10 discloses a variant of an attachment point that has power electronics unit carrying functionality and low thermal conductivity and which is similar to the third attachment point 14 and 15 shown in the embodiment of figure 4. Thus, this variant of an attachment point, as described above, comprises of a part of a hose 55 and a hose holder 54, both with low thermal conductivity. The hose holder 54 and hose 55 are preferably arranged on the opposite side of the power electronics unit 40 compared to attachment point 59. Thus, a decrease in the number of the attachment points 59 is possible.

20

In a further not shown embodiment of a HEV power train the attachment points 54, 55 and 59 of the embodiment shown in figure 10 can be combined with the noise damping attachment point 42 of the embodiment shown in figure 9.

30

The above mentioned inventive features can also be applied to a heavy PSHEV (power split) with several mechanical fixed gear steps in the transmission.

The invention should not be deemed to be limited to the embodiments described above, but rather a number of further variants and modifications are conceivable within the scope of the following patent claims.

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21835WO, 18-12-2007 DS

PATENT CLAIMS

5 1. Arrangement for a power electronics unit in a
hybrid vehicle power train (1, 16, 24, 42, 43),
said hybrid vehicle power train comprising a
combustion engine (2, 17, 25) arranged for
propulsion, and an electric motor/generator (3,
10 21, 28, 26, 41) arranged for propulsion, a
transmission (5, 18, 27) with a transmission
housing, said transmission is arranged to adapt
gear ratio between at least one of said propulsion
units and driven vehicle (7) wheels, said
15 motor/generator is arranged to exchange electric
power with a power electronics unit (4, 12, 22,
31, 32, 38, 40), a cooling arrangement comprising
cooling channels for cooling at least said power
electronics unit, said power electronics unit is
20 shaped substantially as a plate, where a first
biggest cross-sectional area of said plate is
extended substantially along and substantially
within a first transmission side of said
transmission housing and covering at least a part
25 of said first transmission side, said power
electronics unit is fixed to said hybrid vehicle
power train with at least one first attachment
point (10, 23, 33, 34, 39), characterized in that
all attachment points (10, 11, 13, 14, 15, 23, 33,
30 34, 35, 36, 39, 42, 54, 55, 59) has a total
thermal conductivity corresponding to less than 10
degrees temperature increase on a Kelvin-scale for
5kW of heat originating from one side of said
attachment point.

35

2. Arrangement as in claim 1, characterized in that
said electric motor/generator and said power
electronics unit are connected and fixed to each
other to form a first unit, and where said

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connection is said first attachment point formed by a plug in connection (10, 23, 33, 34).

3. Arrangement as in claim 2, characterized in that
5 said power electronics unit is also attached to
 said first transmission side via at least a second
 attachment point (11, 13, 14, 15, 35, 36) made of
 a material with low thermal conductivity.
- 10 4. Arrangement as in claim 2, characterized in that
 said plug in connection is arranged to transmit at
 least one of or both of a cooling medium for said
 cooling arrangement and electric power between
15 said motor/generator and said power electronics
 unit.
5. Arrangement as in claim 2, characterized in that
 said power electronics unit plate (12, 31, 32, 37,
20 38) is arranged to cover said first transmission
 side in such a way as to damp noise originating
 from said transmission.
6. Arrangement as in claim 2, 3 and 5, characterized
25 in that said second attachment point (11, 35, 36)
 is extended around the periphery of a side of said
 power electronics unit facing the transmission,
 and where said first transmission side, said power
 electronics unit side and said second attachment
30 point enclose a compartment comprising a medium
 with low thermal conductivity and high noise
 damping capabilities.
7. Arrangement as in the preceding claim,
 characterized in that said first and second
35 attachment points are of a material with high
 noise damping capabilities.
8. Arrangement as in one of claims 5 to 7,
 characterized in that said power electronics unit

plate comprises said power electronics unit (38) with noise damping material and in an extended part (37) only of a noise damping material, said extended part being arranged in order to better cover said first transmission side.

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9. Arrangement as in claim 2, characterized in that a second electric motor/generator (28) with a second power electronics unit (31) are arranged in connection to said transmission (27) and which together form a second unit via a second plug in connection (33), and where said second power electronics unit is arranged along a second transmission side of said transmission housing.

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10. Arrangement as in claim 3 and/or 4, where a hose (15) for transmitting cooling medium is connected to said power electronics unit on substantially an opposite side of where said plug in connection (10) is arranged, characterized in that said second attachment point is formed of a part of said hose (15) and a cooling hose holder (14) for holding said hose, and where said hose holder is attached to said transmission housing.

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11. Arrangement as in claim 1, characterized in that said power electronics unit is only fixed to said first transmission side with at least one of said first attachment point (39, 59).

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12. Arrangement as in the preceding claim, characterized in that said first attachment point is of a screw-nut type, with a relatively small cross-sectional area.

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13. Arrangement as in one of claims 11 or 12, characterized in that a second attachment point (42) is extended around the periphery of a side of said power electronics unit facing the

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transmission, and where said first transmission side, said power electronics unit side and said second attachment point enclose a compartment comprising a medium with low thermal conductivity and high noise damping capabilities.

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14. Arrangement as in claims 11 to 13, where a hose for transmitting cooling medium is connected to said power electronics unit on substantially an opposite side of where said first attachment point (59) is arranged, characterized in that a third attachment point is formed of a part (55) of said hose and a cooling hose holder (54) for holding said hose, and where said hose holder is attached to said transmission housing.

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15. Arrangement as in one of the preceding claims, characterized in that said hybrid vehicle power train is a parallel hybrid electric vehicle power train.

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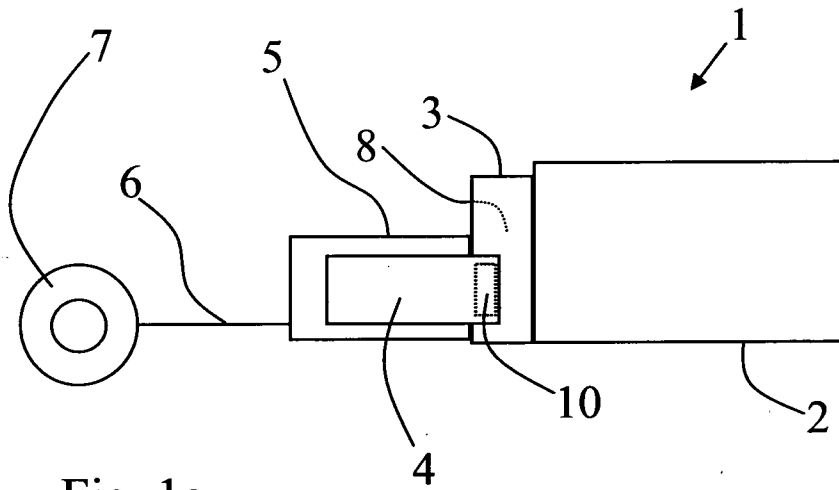


Fig. 1a

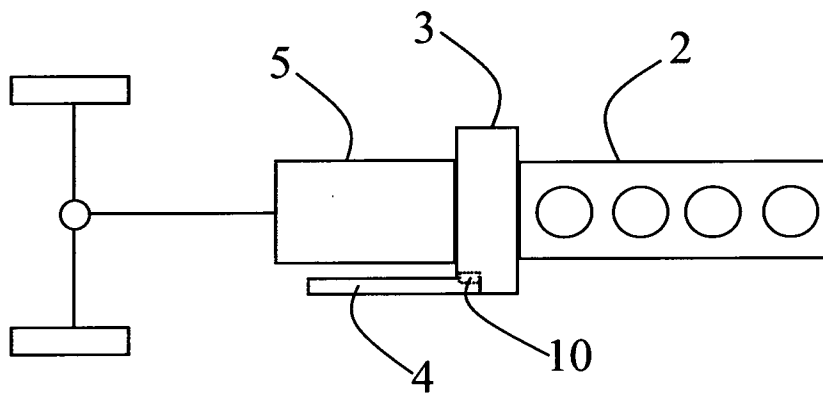


Fig. 1b

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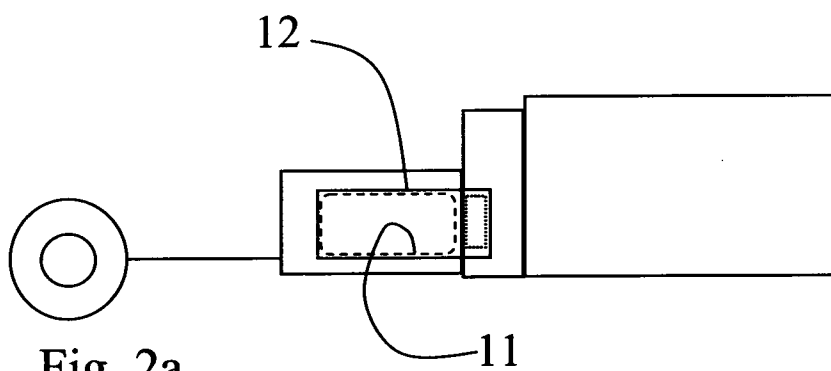


Fig. 2a

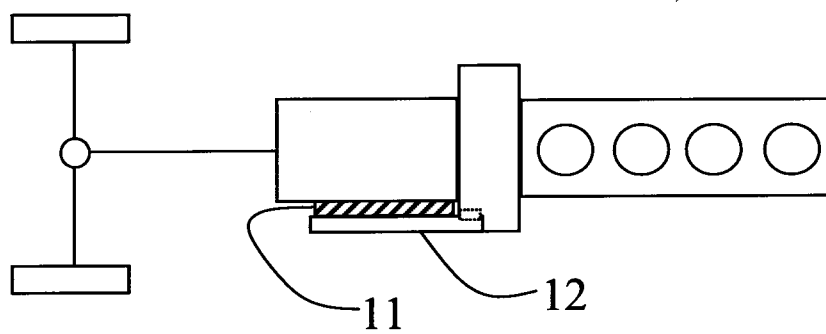


Fig. 2b

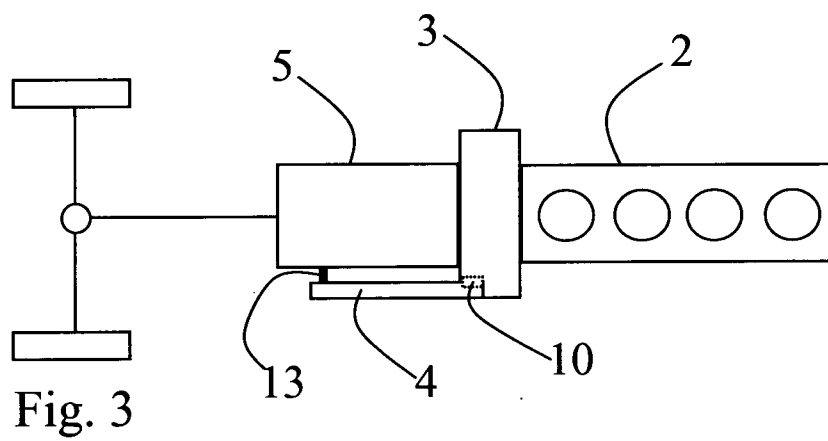
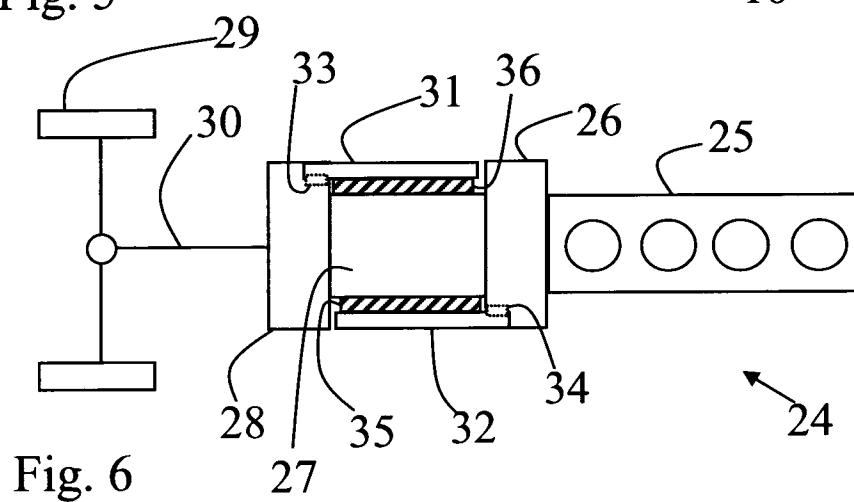
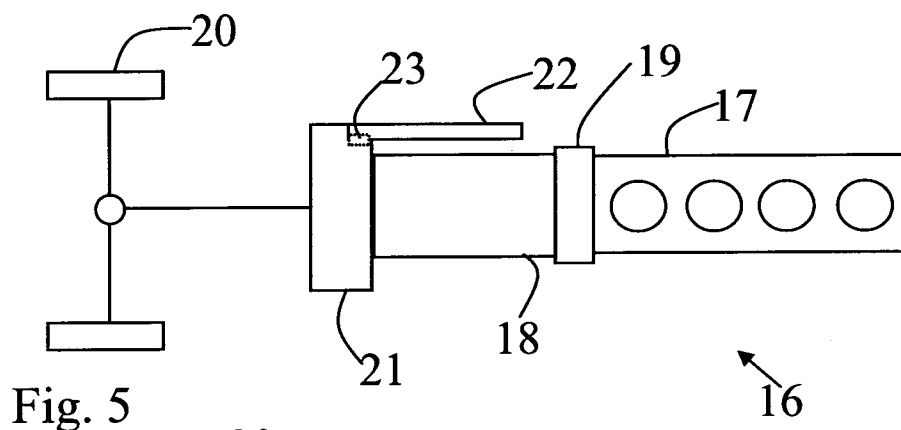
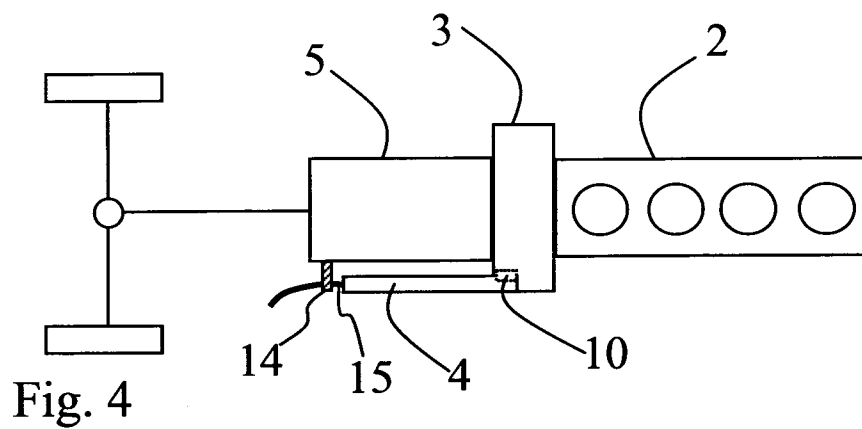
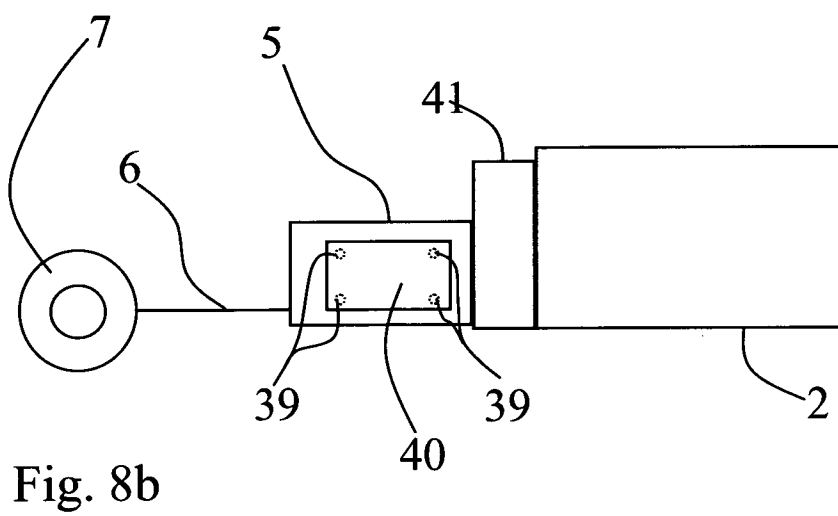
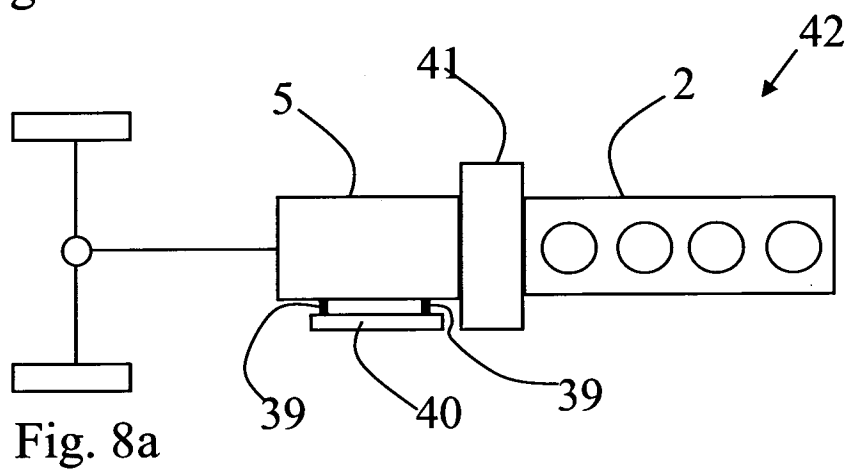
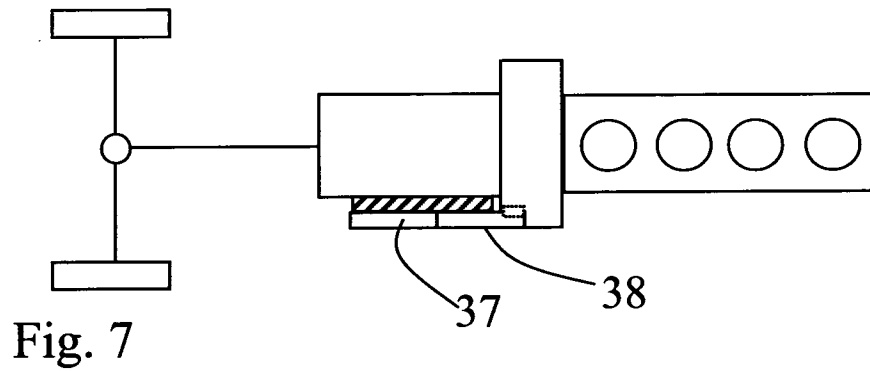


Fig. 3

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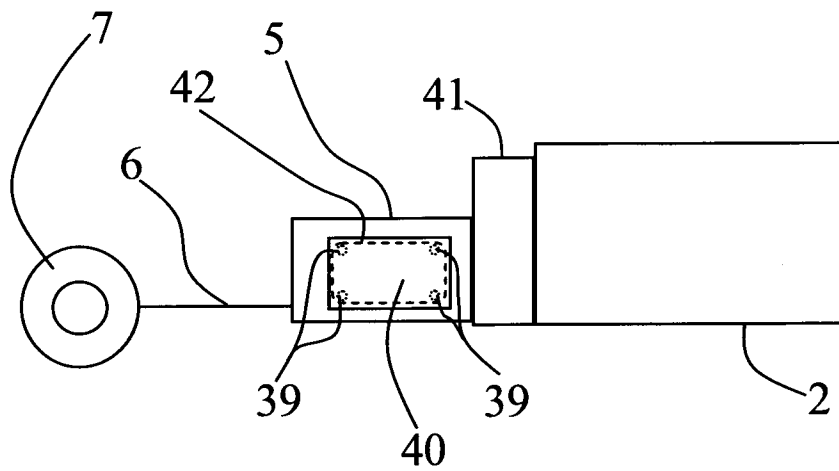


Fig. 9

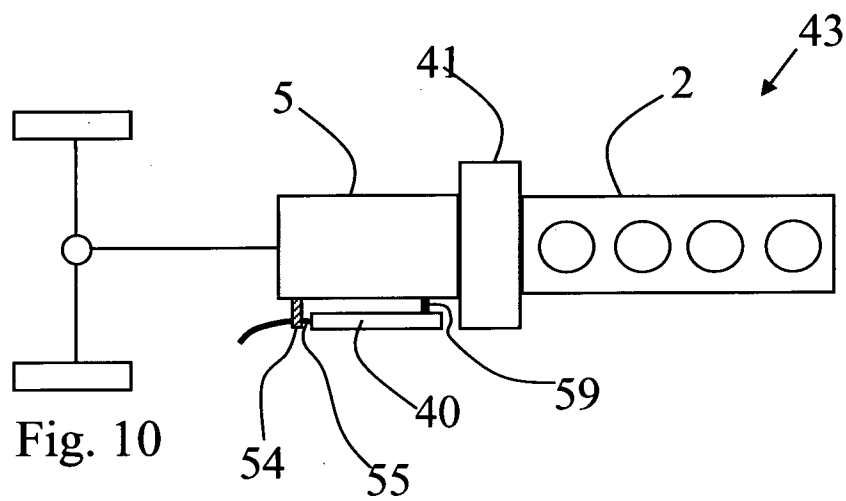


Fig. 10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2007/001149

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: H02K, B60K, H05K, B60R

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, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0131856 A1 (M.A.N. MASCHINENFABRIK AUGSBURG-NÜRNBERG AKTIENGESellschaft), 23 January 1985 (23.01.1985), abstract --	1-15
A	EP 0921291 A1 (RENAULT), 9 June 1999 (09.06.1999), abstract --	1-15
A	DE 10204592 A1 (VOLKSWAGEN AG), 7 November 2002 (07.11.2002), abstract --	1-15
A	DE 102005003881 A1 (VOLKSWAGEN AG), 27 July 2006 (27.07.2006), abstract -- -----	1-15

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

15 Sept 2008

Date of mailing of the international search report

17 -09- 2008

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Sara Thulin/PR
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2007/001149

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 1-15 in part
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

See extra sheet.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Box II.2

Claims 1-15 in part.

In claim 1 the electronics unit is said to be fixed to said hybrid vehicle power train.

In the description the electronics unit is fixed to the electric motor/generator and the transmission in a specific manner to obtain the noise reduction which is considered to be one of the main objects of the invention.

The description does not refer to any other way of attaching the electronics unit.

Consequently, the claims lack support within the meaning of Article 6 of the PCT. The claims are not fully supported by the description.

The search has been restricted to an electronics unit fixed to the electric motor/generator and to the transmission.

International patent classification (IPC)**B60K 6/20** (2007.10)**B60R 13/08** (2006.01)**H05K 7/20** (2006.01)**Download your patent documents at www.prv.se**

The cited patent documents can be downloaded at www.prv.se by following the links:

- In English/Searches and advisory services/Cited documents (service in English) or
- e-tjänster/anförda dokument (service in Swedish).

Use the application number as username.

The password is **ZQLWVAAEET**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/06/2008

International application No.

PCT/SE2007/001149

EP	0131856	A1	23/01/1985	SE	0131856	T3	
				AT	24446	T	15/01/1987
				DE	3325636	A	24/01/1985
				DE	3461763	D	00/00/0000

EP	0921291	A1	09/06/1999	FR	2771775	A,B	04/06/1999
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DE	10204592	A1	07/11/2002	NONE			
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DE	102005003881	A1	27/07/2006	NONE			
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