



(51) International Patent Classification:

B60K 11/04 (2006.01) **B60R 19/52** (2006.01)
B60R 13/00 (2006.01) **F01P 3/18** (2006.01)

(21) International Application Number:

PCT/SE2009/000303

(22) International Filing Date:

15 June 2009 (15.06.2009)

(25) Filing Language:

English

(26) Publication Language:

English

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: COOLING ARRANGEMENT AND A VEHICLE COMPRISING A COOLING ARRANGEMENT

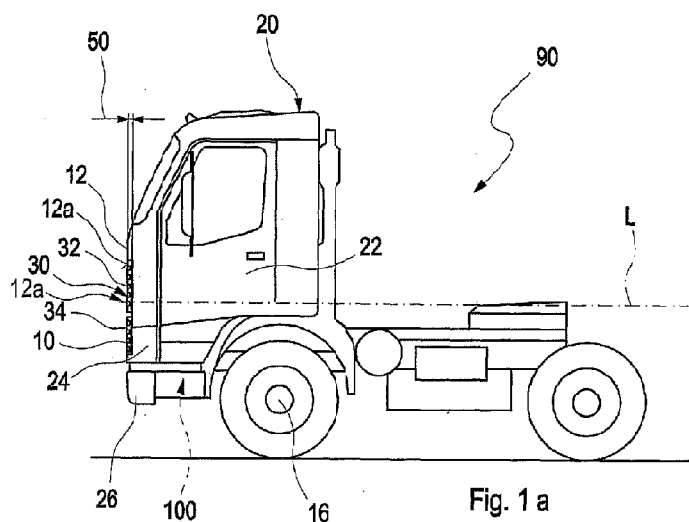


Fig. 1 a

(57) Abstract: The invention relates to cooling arrangement for a vehicle (90), wherein the arrangement comprises cooler component (120) and a casing wall (12a) for the vehicle (90) which defines an intake of ambient air to said cooler component. A front surface (130a) of said cooler component (120) is arranged in said intake substantially flush with the casing wall (12a).

Cooling arrangement and a Vehicle Comprising a Cooling arrangement

5 TECHNICAL FIELD

The invention relates to a cooling arrangement for a vehicle, wherein the arrangement comprises a cooler component and a casing wall for the vehicle which defines an intake of ambient air to said cooler component. The invention
10 further relates to a vehicle comprising the cooling arrangement, especially a commercial vehicle such as a truck.

BACKGROUND OF THE INVENTION

15 In a truck, the engine is positioned at a front region of the truck between the front wheels and normally below the operator compartment. The space between the most foremost point of the truck and the engine is densely packed with components such as coolers. Conventionally, the following cooler components are arranged between a vehicle grille and the engine: a condenser, a charge air cooler
20 and a radiator. Further components, such as a fan, a fan shroud, a front closing cross member and a cab torsion bar are also normally arranged in the space between the most foremost point of the truck and the engine. Despite the exhausted space in this area, there is a desire for achieving improved cooling performance, which requires larger (deeper) engine cooler components. An
25 alternative to squeezing the front end cooling packaging is to move the engine backwards. Several solutions are known in the art to deal with the restricted space in the vehicle. However, moving the engine backwards adversely affects the vehicle length and requires a massive redesign of the vehicle.

30 US 2006/0231234 A1 discloses a cooler arrangement comprising a plurality of heat exchangers. A radiator, a charge air cooler and a condenser are arranged in series in the flow direction of the cooling air. Space utilization is improved by using a gradation whereby a portion of the height of the radiator and charge air cooler have similar depth dimensions different from the other cooler components.

On the other hand, customers are desirous to optimize the space available for payload in a truck. In many countries, legal requirements restrict the length of a truck. Hence, optimizing payload space means to use as much of the vehicle length for storing payload by minimizing space encompassed by the cab, i.e. to make the cab as short as possible. Such optimization goal collides with the increasing required space for the cooling package in the cab.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a cooling arrangement for a vehicle, which creates conditions for an improved cooling performance, especially for cooling the vehicle engine. Another aspect of the invention is to provide a vehicle with such a cooling arrangement.

The object is achieved by the features of claim 1. The other claims and the description disclose advantageous embodiments of the invention.

Thus, the object is achieved by means of a cooling arrangement for a vehicle, wherein the arrangement comprises a cooler component and a casing wall for the vehicle which defines an intake of ambient air to said cooler component, characterized in that said cooler component is arranged at said intake in such a way that a front surface of said cooler component is arranged substantially flush with the casing wall. Said front surface of said cooler component is preferably arranged substantially flush with an external surface of the casing wall. Further, said front surface of said cooler component is preferably arranged in parallel with the casing wall, i.e. in parallel with a plane defined by the portions of the casing wall which surrounds the air intake.

The term "substantially flush with" should be interpreted in a wide sense covering not only that the front surface of the cooler component and the external surface of the casing wall are perfectly in line with each other, but also arrangements where the surfaces are somewhat displaced in relation to each other (like in the case of a conventional vehicle grille arrangement).

The term "casing wall" defines a wall with the external surface facing outwards, i.e. exposed to the external environment, and an internal surface facing inwards, i.e. towards an engine of the vehicle. In the case of a truck, the casing wall forms an engine compartment limitation wall, which extends in a plane at right angles to the truck's longitudinal direction and which is arranged below a windscreen of the cab.

It has been realized that a cooler component, such as the condenser, is of such a design that it in fact can withstand the impacts of objects, such as stones etc, which may reach the air intake during driving. More specifically, the wall thickness of the tubes of the condenser is becoming increasingly larger in order for the tubes to comply with a larger internal pressure (and thereby an improved cooling performance). By arranging the condenser cooling tubes with such larger wall thickness, the condenser will be more robust and thereby less prone to failure during an object impact.

Further, by disposing at least the front surface of the cooler component flush with the front casing wall of the vehicle, e.g. of the vehicle cab, precious construction space is saved between the most foremost point of the truck and the engine.

Consequently, other cooling components, such as a radiator, a charge air cooler and/or an EGR cooler in this space may be of larger dimensions and thereby creating conditions for an improved cooling performance. Further, in nowadays cooling arrangements, recirculation shields are used to direct air into the cooling package and to avoid recirculation of hot air. Advantageously, such recirculation shields can be avoided. Additionally, the cab can be made shorter, thus allowing more space for aggregates and/or payload in the vehicle. In other words, free space is generated which is now available for integrating more components and/or increasing the size of cooler components and/or for decreasing the length of the cab. Preferably, the cooler component forms at least part of the structure which today is the vehicle grille.

According to one embodiment, said front surface of said cooler component is arranged within a distance of 60 mm, preferably 40 mm, from an external surface of the casing wall in a direction at right angles to a plane defining the casing wall.

The external surface forms a surface of the casing wall facing away from the cooler component and an internal surface of the casing wall forms a surface facing the cooler component. By positioning the cooler component so that its front surface is within said distance of the external surface of the casing wall, precious construction space is saved in this region, which creates conditions for an improved cooling performance.

Preferably, the cooler component positioned in said intake is preferably configured for forming part of an air conditioning system of the vehicle.

According to a further embodiment, a vehicle grille is arranged in said cooling air intake and said front surface of said cooler component is integrated in the vehicle grille. Thus, the invention is not limited to that the cooler component replaces the vehicle grille, but a vehicle grille structure may still be present in the air intake. For example, the cooling tubes of the cooler component may be arranged in parallel with elongated ribs of the vehicle grille and attached to the ribs.

The vehicle grille provides a large air intake area in the front casing wall of a truck which is advantageous for efficiently cooling a medium by exchanging heat with the relative wind impinging on the grille. The available grille area is larger than the typical single heat exchanging surfaces of components in the cooling package. Thus, the same arrangement and design can be used in various sizes of cabs. It is also possible to share the grille area between two or more cooler components. Additionally, by integrating the surface portion in the grille it is possible to conduct various designs of the heat exchanging grille.

According to a further embodiment, the dimensions of said front surface of said cooler component in a plane are substantially the same as the dimensions of said cooling air intake in a plane in parallel to said casing wall. Preferably, the dimensions of said front surface of said cooler component in a plane are designed to match the dimensions of said cooling air intake both with regard to shape and size. Preferably, a projection of the boundaries of the cooler component lies within the boundaries of the air intake. Preferably, said front surface of said cooler component defines a substantially rectangular shape.

According to a further embodiment, said cooler component comprises a tubular system, comprising a plurality of coolant tubes configured to convey a coolant and that a plurality of the tubes defines the front surface of said cooler component.

5 Preferably, said plurality of coolant tubes are arranged in thermal contact with a structure defining the vehicle grille. The coolant tubes are preferably arranged in parallel with each other in a plane. Preferably, said cooler component comprises a stack of heat exchanging surfaces in an alternating arrangement with the coolant tubes and the coolant tubes are in thermal contact with the heat exchanging
10 surfaces.

Favourably, a cooler component portion that forms the front surface can be formed as a honeycomb pattern. The tubes and heat exchanger fins may be made of aluminium, an aluminium containing alloy or another light metal or light metal alloy,
15 for instance. The density of the pattern, e.g. a honeycomb pattern or another desired pattern, can be chosen to comply with the cooling requirements of the surface portion.

According to a further embodiment, said coolant tubes are designed for a burst
20 pressure of at least 3 MPa, preferably of at least 5 MPa. Such a pressure requires that the coolant tube walls are of considerable thickness, which in turn make the cooler component suitable for application in the air intake.

According to a further embodiment, the cooler component is formed by a
25 condenser. The condenser has been identified as a cooler component particularly suitable for application in the air intake due to its robust design.

According to a further embodiment, the cooler component is rigidly attached to the casing wall. For example, the cooler component may be fastened to the casing
30 wall beside the air intake via a bolt connection. This design creates conditions for a very compact and space efficient arrangement. Favourably, the routing of coolant conduits to the cooler component can be restricted to a cab of the vehicle and can allow for opening of a usual pivotable door (front hatch) of the cab.

According to a further embodiment, the cooling arrangement comprises a pivotable door, which comprises the cooling air intake and the cooler component is rigidly attached to the pivotable door. Thus, the cooler component may be pivotably arranged with regard to a casing wall part surrounding the pivotable door.

Preferably, the front surface of said cooler component is arranged within a distance of 100 mm from a most forward point of the vehicle in a direction at right angles to a plane defining the front casing wall. The most forward point of the vehicle represents the front point for measuring the vehicle length determined according to the European directive 97/27/EC. The European directive 97/27/EC of the European Parliament and of the council of 22 July 1997 relates to masses and dimensions of certain categories of motor vehicles and their trailers and amending Directive 70/156/EEC. The ISO standard ISO 612-1978 defines the length of a vehicle as the distance between two vertical planes to the longitudinal medial plane of the vehicle and touching the front and rear of the vehicle.

According to the European directive 97/27/EC, paragraph 2.4.1, "vehicle length" is a dimension which is measured according to ISO standard 612-1978, term No 6.1.

In addition to the provisions of that standard, when measuring the vehicle length

the following devices must not be taken into account:

- wiper and washer devices,
- front or rear marking plates,
- customs sealing devices and their protection,
- devices for securing the tarpaulin and their protection,
- lighting equipment,
- rear-view mirrors,
- rear-space watching aids,
- air-intake pipes,
- length stops for demountable bodies,
- access steps,
- ram rubbers,
- lifting platforms, access ramps and similar equipment in running order, not exceeding 200 mm, provided that the loading capacity of the vehicle is not increased,

- coupling devices for motor vehicles.

Hence the most forward point of the vehicle is the most forward point of the vehicle length without protruding objects mentioned above.

5

According to a favourable embodiment of the invention, an outlet of a coolant from the cooler component can be positioned at a lowest part of the cooler component. This provides an advantageous flow path of the coolant in the condenser. Expediently, the inlet is arranged at an upper position, of the condenser.

10

Further preferred embodiment and advantages thereof emerge from the description below, the figures and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

15

The present invention together with the above-mentioned and other objects and advantages may best be understood from the following detailed description of the embodiments, but not restricted to the embodiments, wherein is shown schematically:

20

Fig. 1a-1c a side view of a first embodiment of a vehicle according to the invention (Fig. 1a), a cut through a prior art cooling package (Fig. 1b) and a cut through an example embodiment (Fig. 1c) of a cooling package of the vehicle in Fig. 1a;

25 Fig. 2 an example embodiment of a condenser to be integrated in a vehicle grille according to the invention;

Fig. 3 a front view of an example embodiment of the vehicle in figure 1a;

Fig. 4-6 side views of three example embodiments of the invention;

Fig. 7 a schematic perspective view of the condenser installation of the embodiment shown in figure 6; and

30

Fig. 8 three different views of an example installation of a condenser.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

5 In the drawings, equal or similar elements are referred to by equal reference numerals. The drawings are merely schematic representations, not intended to portray specific parameters of the invention. Moreover, the drawings are intended to depict only typical embodiments of the invention and therefore should not be considered as limiting the scope of the invention.

10

Fig. 1a depicts a side view of a vehicle 90 in the form of a truck and more specifically a semi-trailer tractor. A semi-trailer can be connected to the semi-trailer tractor via a so-called fifth wheel. The truck comprises a cab 20 in the form of a so-called forward control cab, which is arranged above a power source (normally diesel engine) of the truck. To provide access to the engine with regard to service and maintenance the entire cab can be tilted forwards, see also figures 4b, 5b, 6b.

Fig. 1b shows a cut through a prior art cooling package and Fig. 1c a shows a cut through an example embodiment of a cooling package in the cab 20 of Fig. 1a. A casing 12 has a front casing wall which defines an intake of cooling air to at least one cooler component 102, 104, 108, 110, 112, 120, wherein, as depicted in Fig. 1a and 1c, one of the cooler components 120 is arranged in said intake in such a way that a front surface 130a of the cooler component 120 is arranged substantially flush with the front casing wall 12a.

The casing wall 12 surrounds an engine compartment comprising a cooling package 100 enclosing a multitude of cooler components 102, 104, 108, 110, 112, 120. Beneath the casing 12 of the cab 20 a front axle 16 is arranged. Further, the outer casing 12 of the cab 20 surrounds a passenger compartment above the engine compartment.

In this example embodiment, the front casing wall 12a of the cab 20 is substantially parallel with a vertical plane and exhibits a so called most-forward

point 10 (external surface) of the vehicle 90, from which the length of the vehicle 90 is measured.

Within the front part of the cab 20 a vehicle grille 30 is arranged having an upper portion 32 located in a pivotable upper part 22 of the cab 20 and a lower portion 34 located in a lower, stationary part 24 of the cab. The upper portion 32 can be pivoted towards the front for giving access to e.g. an engine 114 and the cooling package 100. The vehicle grille 30 is placed within a small distance 50 from the most forward point 10 with respect to a longitudinal vehicle axis L.

The cooler components 102, 104, 108, 110, 112, 120 of the cooling package 100 according to the prior art (Fig. 1b) are densely packed between the casing 12 and the engine 114. For instance, cooler unit 110 may be a fan, cooler unit 120 may be a condenser of an air condition system, cooler unit 112 may be a charge air cooler, cooler unit 108 may be a radiator and other cooler units 102, 104, may be other heat exchangers.

According to prior art in trucks, the condenser 120 is mounted to the cooling package 100 in front of the charge air cooler 112. By way of example it may have a typical front face area of 28 dm^2 (FH), a depth of 19 mm and a total heat transfer area of the ambient fin of 6.7 m^2 .

The condenser 120 is usually arranged as foremost component of the cooling package 100 directly behind the bumper 26 and the casing 12. The condenser 120 constitutes a heat exchanging device 132 (cooler component) which comprises surfaces provided for exchanging heat with the relative wind moving through the heat exchanging device 132. An embodiment example of a condenser for use in the cooling arrangement according to the invention will be described in more detail in Fig. 2.

As can be seen in an example embodiment of the invention in Fig. 1c, one of the heat exchanging devices 132, for instance the condenser 120, is arranged closely to the casing 12 and virtually flush with the front casing wall 12a within a small distance 50 from a most forward point of the casing, leaving a free space in the

cooling package 100 which can be used to increase the volume of other components of the cooling package 100 and/or for shorten the length of the cooling package 100 and consequently the length of the cab 20.

- 5 Favourably, a surface portion 130 provided for exchanging heat of at least one cooler component 102, 104, 108, 110, 112, 120 of the cooling package 100 is arranged within a distance of 100mm, especially 80mm, preferably 60 mm and advantageously 40 mm, of the most-forward point 10. For instance, the condenser 120 can be integrated in the grille 30, particularly can constitute the grille 30 of the
10 cab 20, preferably can cover a substantial part of the grille 30.

Fig. 2 illustrates an example embodiment of a condenser 120 which can be integrated in the vehicle grille 30 according to Fig. 1a, 1c.

- 15 The condenser 120 provides a multitude of rows 128 stacked one over the other of tubes 126 alternating with fins 124. The fins 124 constitute heat exchanging surfaces 130 which transfer heat from the tubes 126 to the air moving around the fins 124. The rows 128 are extending between tanks 122 which may contain a coolant.

- 20 The fins 124 can be made of moulded or extruded aluminium, for example in a honey comb pattern, to create a typical grille appearance. The pattern can have other designs and provides an additional degree of freedom of designing the grille 30. For example, a honey comb pattern with dimensions 25 x 20 mm and a
25 condenser depth of 30 mm would require a condenser 120 of dimensions 1 500 x 665 mm (1 m²) for equal performance. More dense patterns would require smaller condenser area. The effective condenser area can be regulated by the density of the pattern of the fins 124.

- 30 Fig. 3 depicts a front view of an embodiment of a vehicle cab 20 of a vehicle 90 which was shown in Fig. 1a as side view, with a condenser 120 integrated in the grille 30. The condenser can be integrated in the upper and/or lower part 32, 34 of the grille 30.

If the upper part 32 of the grille 30 is used, the condenser 120 can be mounted on the cab 20. This has the advantage that both the condenser 120 and the evaporator (not shown) of the air condition system (AC system) are placed on the cab 20 and the connection between them can consist of non-flexible (rigid) pipes instead of flexible tubes. Flexible tubes are used when there is a movement between the condenser 120 and the evaporator, which may cause coolant leaking into the air. This is avoided by the pipes.

The complete AC system can be mounted to the cab 20, which means that the AC routing would only be on the cab 20. Expediently, the routing allows for opening of the front hatch arranged in the casing 12.

Favourably, a more efficient cooling can be provided without moving the engine backwards and giving a possibility for shortening the length of the cab 20.

Fig. 4a shows a schematic side view of the forward control cab 20, wherein the cooler component 120 is attached to a chassis (frame) 410 of the vehicle. The forward control cab is pivotably arranged in relation to the chassis and is shown in a first position in figure 4a, representing an operational position during driving of the truck. The casing wall 12a is arranged to define an engine compartment. The casing wall 12a is arranged at a front of the vehicle and the casing wall 12a extends substantially at right angles to a longitudinal direction of the vehicle. Figure 4b shows the forward control cab in a second, tilted position, representing a position for inspecting/servicing of the engine or other components in the engine compartment. The position of the cooler component 120 is not effected by the tilting of the cab since it is rigidly connected to the frame 410.

Fig. 5a shows a schematic side view of the forward control cab 20, wherein the cooler component 120 is attached to the front casing wall 12a of the vehicle. The forward control cab is pivotably arranged in relation to the chassis and is shown in a first position in figure 5a, representing an operational position during driving of the truck. Figure 5b shows the forward control cab in a second, tilted position, representing a position for inspecting/servicing of the engine or other components in the engine compartment. The cooler component 120 is positioned in a second,

tilted position in relation to the frame 410 since it is attached to the front wall of the cab.

Fig. 6a shows a schematic side view of the forward control cab 20, wherein the cooler component 120 is attached to a pivotable door 610 arranged in the front casing wall 12a of the vehicle. The forward control cab is pivotably arranged in relation to the chassis and is shown in a first position in figure 6a, representing an operational position during driving of the truck. Figure 6b shows the forward control cab in a second, tilted position, representing a position for inspecting/servicing of the engine or other components in the engine compartment. The cooler component 120 is positioned in a second, tilted position in relation to the front casing wall 12a of the cab since it is attached to the pivotable door.

Fig. 7 shows a schematic perspective view of the condenser installation of the embodiment shown in figure 6. The condenser 120 comprises a tubular structure 720 extending between tanks 722, 724 containing a coolant. An inlet coolant conduit 726 is connected to a first tank 722 and an outlet coolant conduit 728 is connected to a second tank 724.

Fig. 8a shows a view from the outside of a pivotable door 810 provided with a condenser 120 according to a further embodiment. The pivotable door 810 comprises an intake for air and the condenser 120 is arranged on the inside of the door in such a way that it covers the air intake completely. Fig. 8b shows a view from the inside of the pivotable door 810 provided with the condenser 120. Fig. 8c shows a cross sectional view along the lines A-A in figure 8b. The arrows 820 indicate an incoming air flow. The condenser 120 comprises a plurality of spaced, parallel coolant tubes 830 extending in a horizontal direction when applied to the truck. Further, a cooling structure 840 with heat exchanging surfaces is arranged in thermal contact with the coolant tubes. The cooling structure comprises fins which can be made of moulded or extruded aluminium, for example in a honey comb pattern like in the embodiment shown in figure 2. A protection structure 842 may be arranged in front of the coolant tubes 830 in order to protect them from object impacts. The protection structure 842 comprises a protection means

arranged externally of each tube 830. More specifically, the protection means forms a protection wall with a shape matching the external shape of the tube 830. In this case, the protection means has a rounded shape in cross section. The protection structure 842 is preferably attached to the condenser 120 and particularly to the cooling structure and/or the coolant tubes.

According to a further example embodiment, the wall thickness of the coolant tubes of the condenser is at least 1 mm. Further, the coolant tube is preferably manufactured by extrusion. For example, the coolant tube may have a rectangular cross sectional shape with at least one internal midwall between the longer sides of the rectangle, wherein a plurality of coolant passages are formed in each coolant tube. According to one specific example, the coolant tube comprises four internal midwalls, wherein five coolant passages are formed. Each coolant passage may have a rectangular shape with sides of 1 mm and 2 mm.

The invention is not in any way limited to the above described embodiments, instead a number of alternatives and modifications are possible without departing from the scope of the following claims.

Although the invention has been described above for a truck with a forward control cab, the invention is also applicable for a so-called normal-control cab, wherein the cab is located behind the engine in the longitudinal direction of the truck. Further, the invention is not limited to trucks, but may be applicable in buses, construction machines and possibly passenger cars. Further, the invention is not limited to that the cooler component is positioned in an air intake at the front of the vehicle. For example, in the case of a bus, the engine (and the cooling arrangement) is located at the rear part of the vehicle, and the air intake is in a side casing wall of the vehicle. In such an application, the cooler component is arranged in the side casing wall.

The invention does not only cover that the cooler component is somewhat retracted in relation to the external surface of the casing wall but also that the cooler component projects out from the external surface of the casing wall.

C L A I M S

1. A cooling arrangement for a vehicle (90), wherein the arrangement
5 comprises a cooler component (120) and a casing wall (12a) for the vehicle
(90) which defines an intake of ambient air to said cooler component (120),
characterized in that said cooler component (120) is arranged at said intake
in such a way that a front surface (130a) of said cooler component (120) is
arranged substantially flush with the casing wall (12a).
- 10 2. The cooling arrangement according to claim 1, characterized in that said
front surface (130a) of said cooler component (120) is arranged within a
distance of 60 mm from an external surface (10) of the casing wall (12a) in
a direction at right angles to a plane defining the casing wall (12a).
- 15 3. The cooling arrangement according to claim 1 or 2, characterized in that a
vehicle grille (30) is arranged in said cooling air intake and that said front
surface (130a) of said cooler component (120) is integrated in the vehicle
grille (30).
- 20 4. The cooling arrangement according to any preceding claim, characterized
in that the dimensions of said front surface (130a) of said cooler component
(120) in a plane are substantially the same as the dimensions of said
cooling air intake in a plane in parallel to said casing wall (12a).
- 25 5. The cooling arrangement according to any preceding claim, characterized
in that said cooler component (120) comprises a tubular system, comprising
a plurality of coolant tubes (124) configured to convey a coolant and that a
plurality of the tubes defines the front surface (130a) of said cooler
30 component (120).
6. The cooling arrangement according to claim 5, characterized in that said
cooler component (120) comprises a stack of heat exchanging surfaces
(126) in an alternating arrangement with the coolant tubes (124) and that

the coolant tubes (124) are in thermal contact with the heat exchanging surfaces (126).

- 5 7. The cooling arrangement according to claim 5 or 6, characterized in that said coolant tubes (124) are designed for a burst pressure of at least 3 MPa.
- 10 8. The cooling arrangement according to claim 3 and any one of claims 5-7, characterized in that said plurality of coolant tubes are arranged in thermal contact with a structure defining the vehicle grille.
9. The cooling arrangement according to any preceding claim, characterized in that the cooler component is formed by a condenser (120).
- 15 10. The cooling arrangement according to any preceding claim, characterized in that the cooler component (120) is rigidly attached to the casing wall (12a).
- 20 11. The cooling arrangement according to any one of claims 1-9, characterized in that the cooling arrangement comprises a pivotable door (610,810), which comprises the cooling air intake and that the cooler component (120) is rigidly attached to the pivotable door.
- 25 12. The cooling arrangement according to any preceding claim, characterized in that an outlet of a coolant from the cooler component (120) is positioned at a lowest part of the cooler component (120).
- 30 13. A vehicle (90) characterized in that it comprises a cooling arrangement according to any preceding claim.
14. A vehicle according to claim 13, characterized in that the cooler component (120) is attached to a chassis (410) of the vehicle.

15. A vehicle according to claim 13 or 14, characterized in that the casing wall (12a) is arranged to define an engine compartment.

5 16. A vehicle according to any one of claims 13-15, characterized in that the casing wall (12a) is arranged at a front of the vehicle and that the casing wall (12a) extends substantially at right angles to a longitudinal direction of the vehicle.

10 17. A vehicle according to claims 16, characterized in that said front surface (130a) of said cooler component (120) is arranged within a distance of 100 mm from a most forward point of the vehicle in a direction at right angles to a plane defining the front casing wall.

15 18. A vehicle according to any one of claims 13-17, characterized in that the vehicle is formed by a truck.

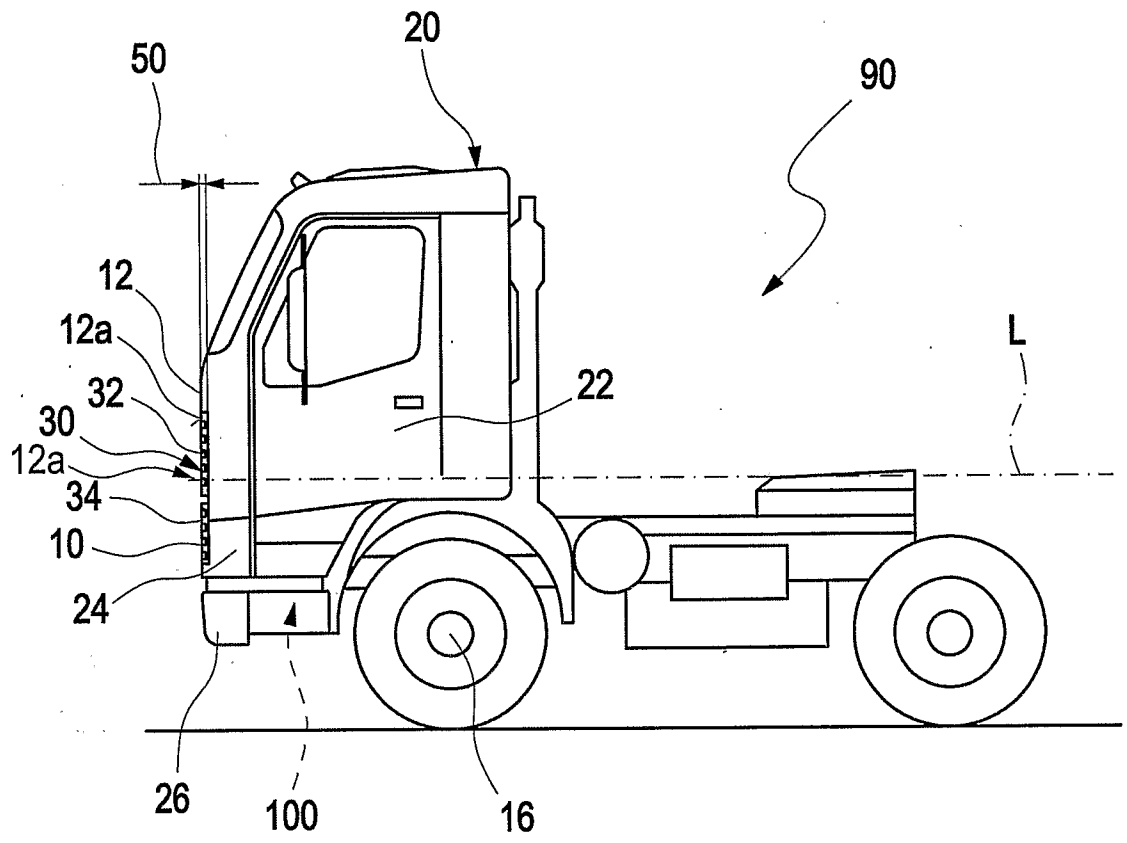


Fig. 1 a

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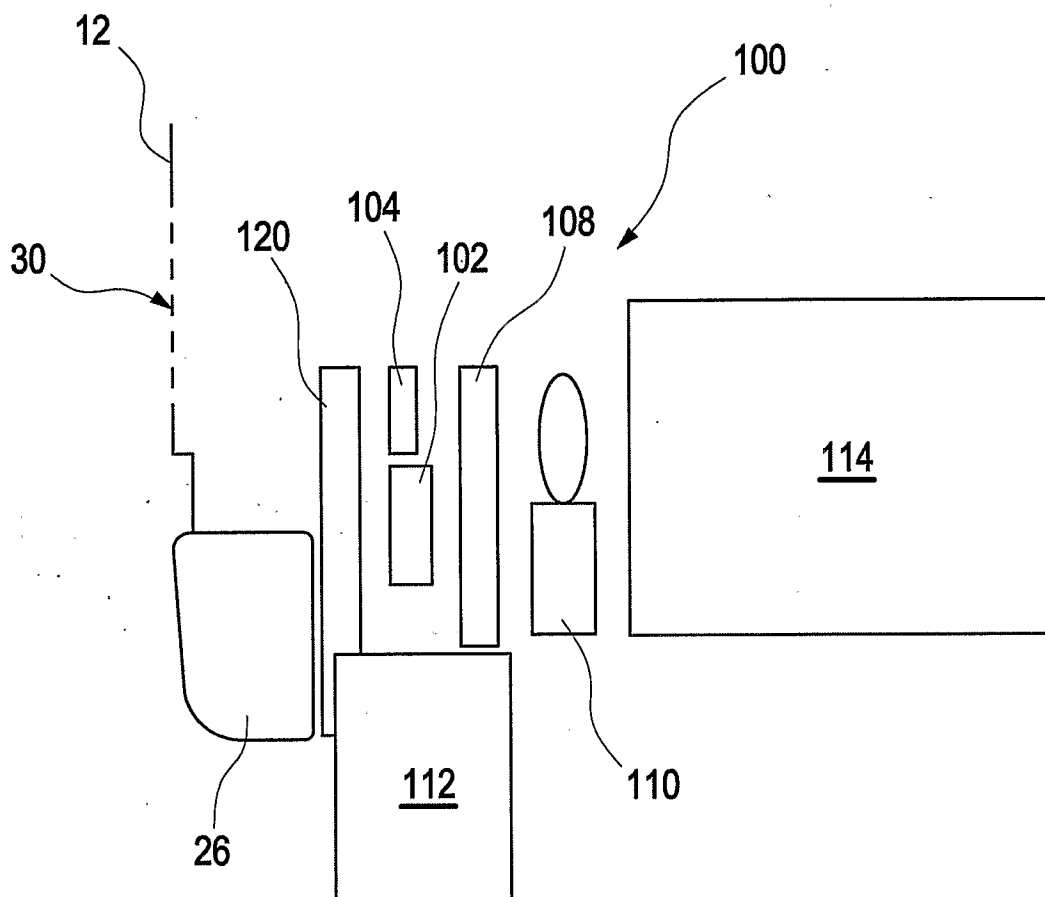


Fig. 1 b

Prior art

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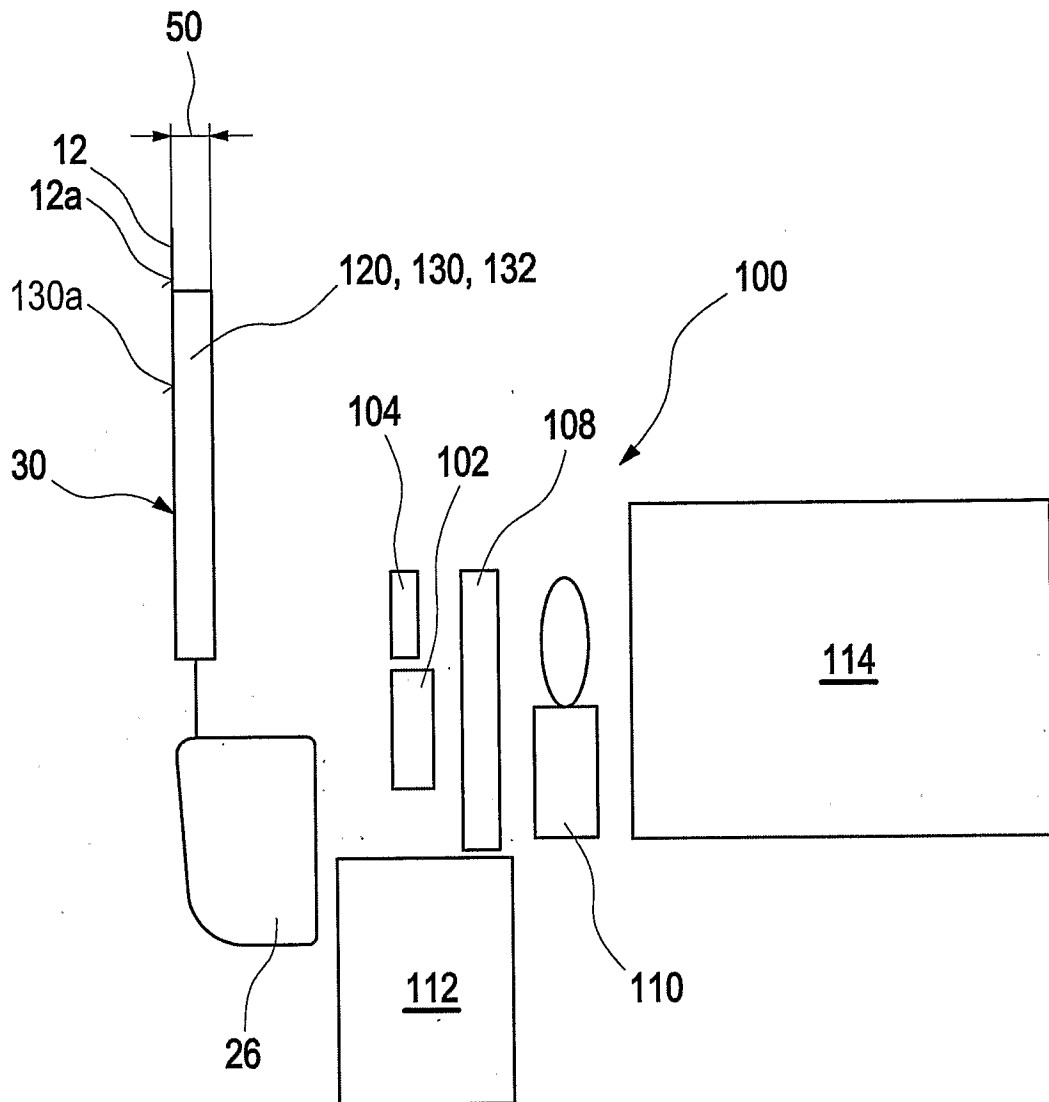


Fig. 1 c

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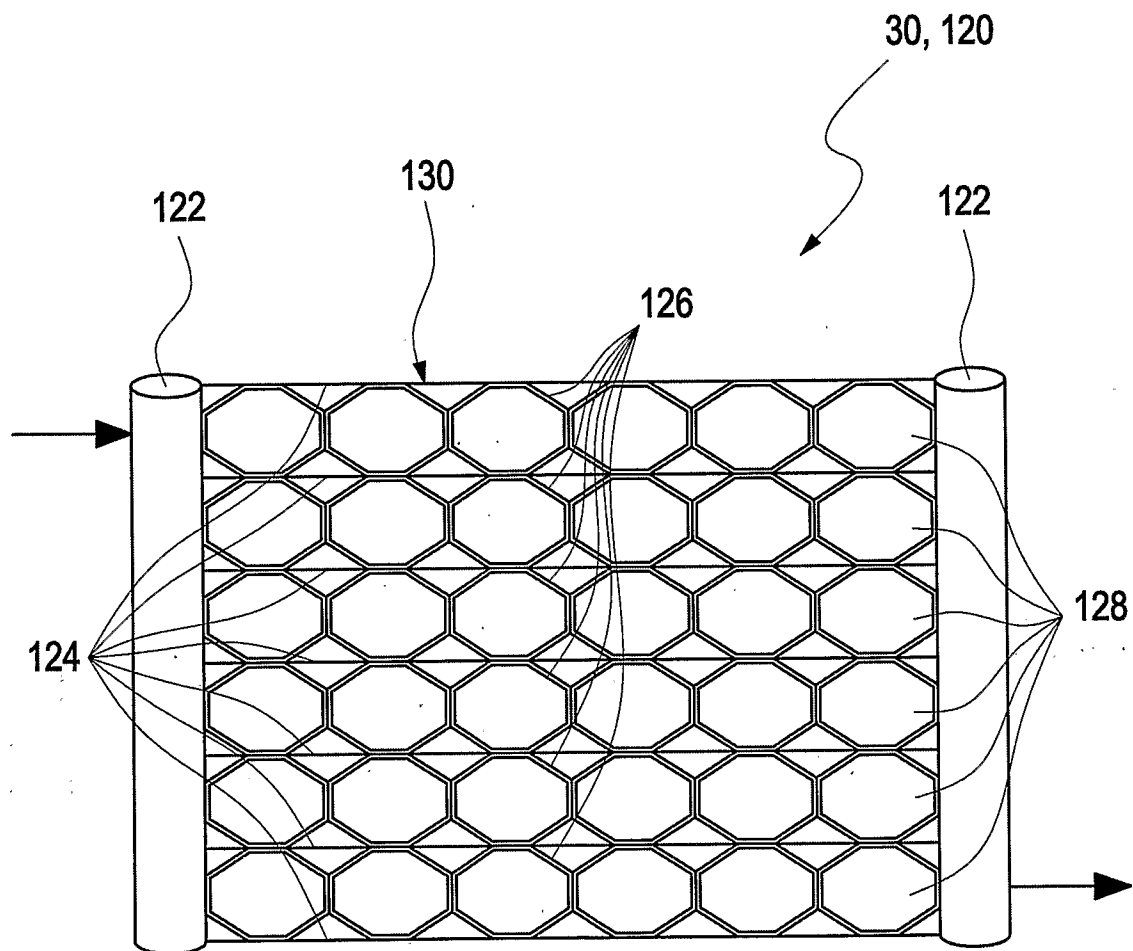


Fig. 2

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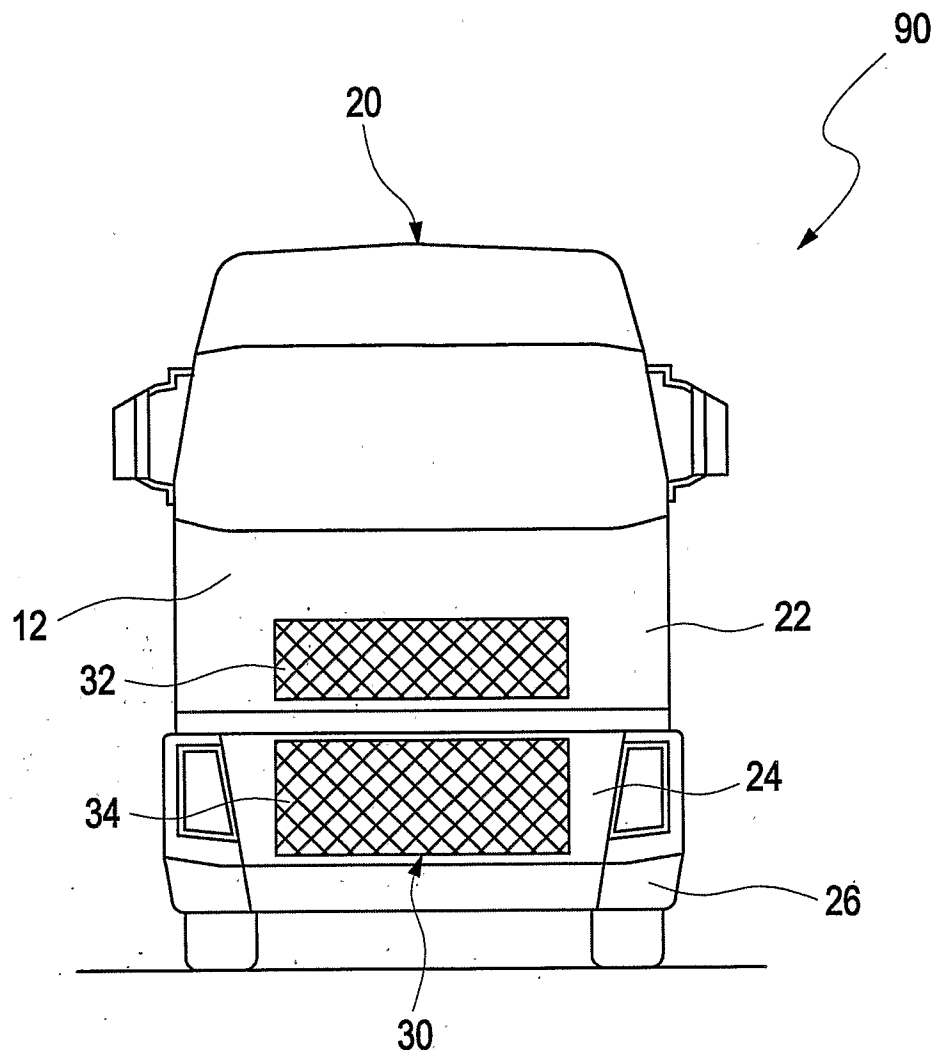
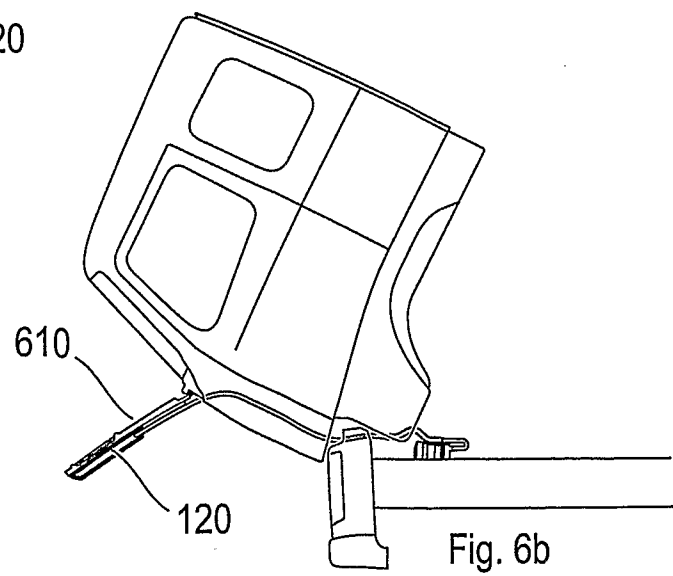
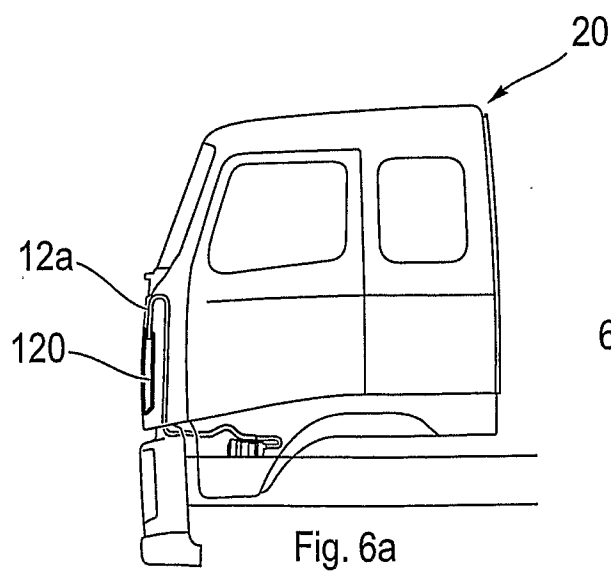
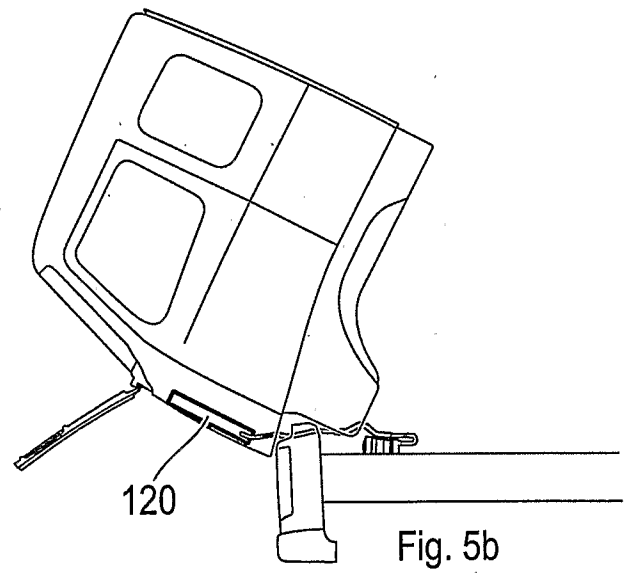
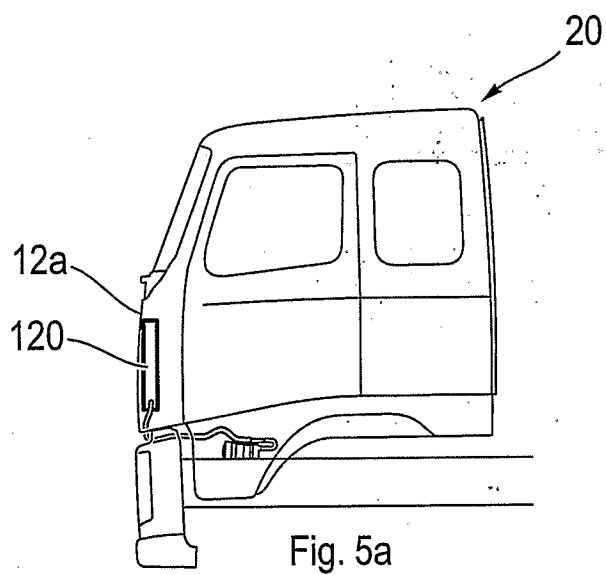
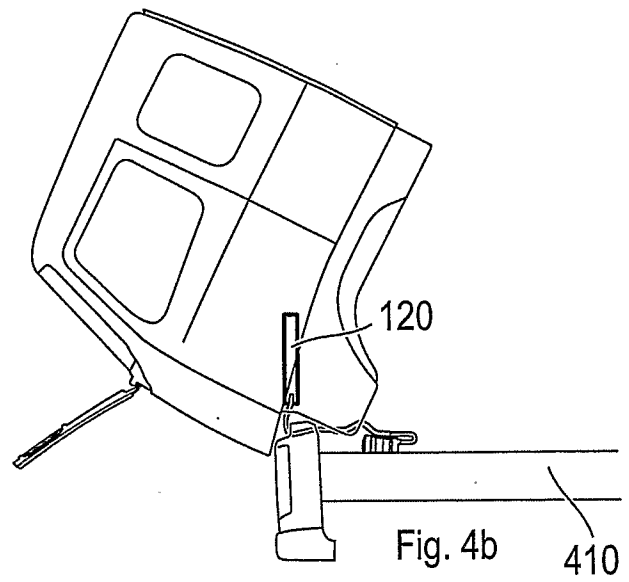
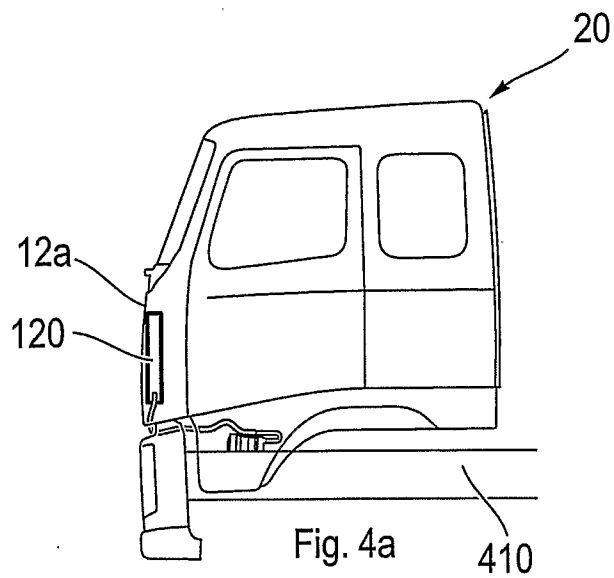


Fig. 3

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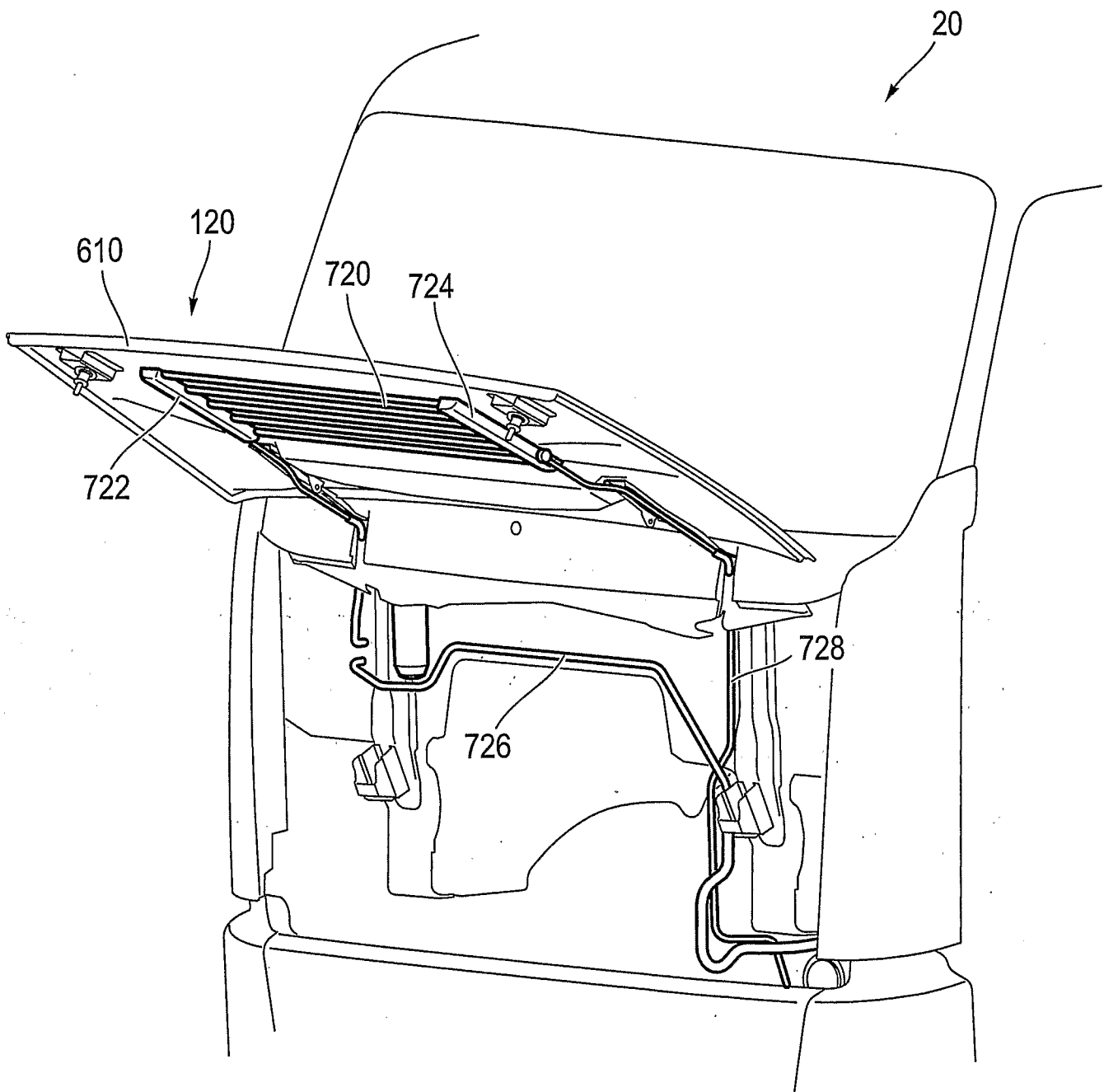
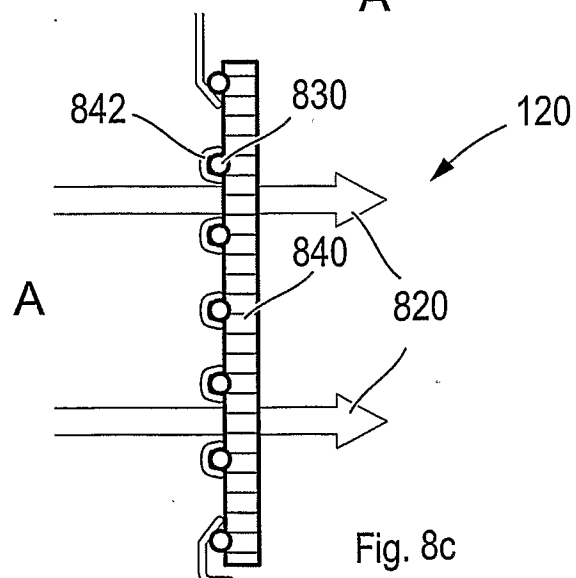
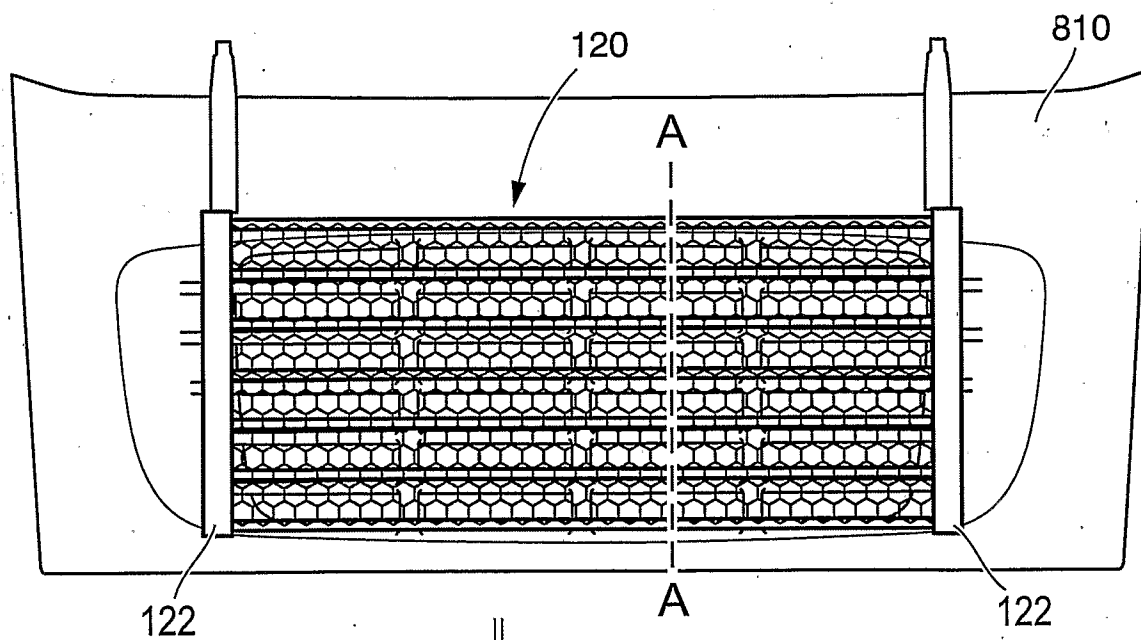
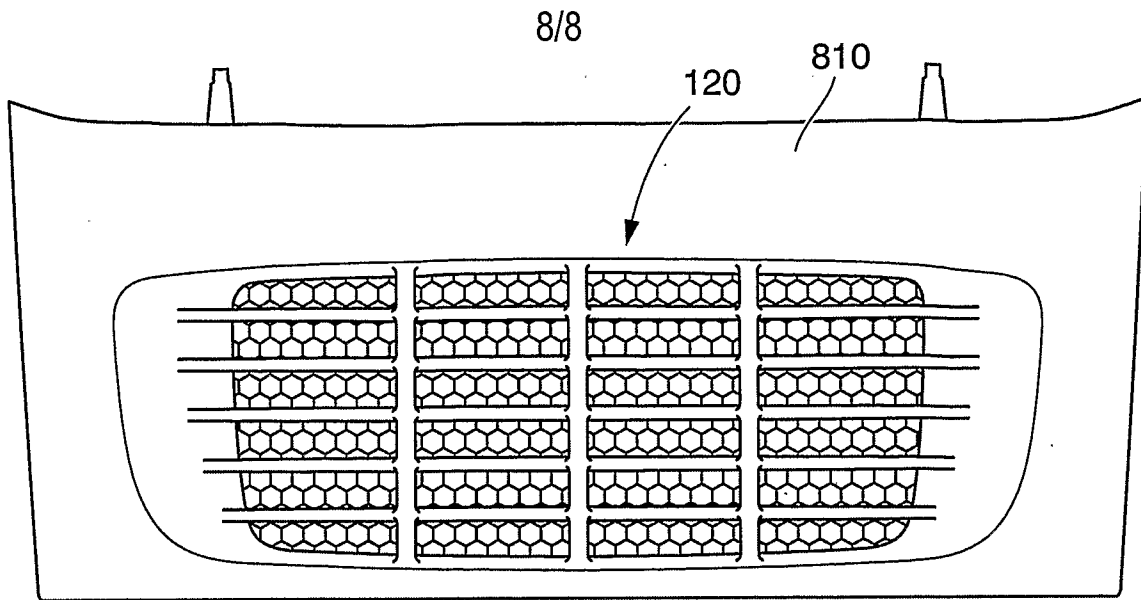


Fig. 7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2009/000303

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, B60R, F01P, F28F

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.
X	GB 1336706 A (DORIS ADA HEATHCOLEMAN), 7 November 1973 (07.11.1973), page 1, line 40 - line 55, figures 1-5 --	1-18
X	US 2100490 A (E.V. RIPPINGILLE), 30 November 1937 (30.11.1937), page 1, column 1, line 43 - column 2, line 7, figures 1-3 --	1-18
X	US 1882319 A (E.R. GURNEY), 11 October 1932 (11.10.1932), figures 1,2 --	1,13

☒ Further documents are listed in the continuation of Box C.

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Date of the actual completion of the international search

11 February 2010

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INTERNATIONAL SEARCH REPORT

International application No.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 346464 A (W. & G. DU CROS LIMITED, MOTOR ENGINEERSET AL), 16 April 1931 (16.04.1931), figure 1 --	1,13,14,18
A	US 4505348 A (GADEFELT ET AL), 19 March 1985 (19.03.1985), figures 1,2 -- -----	1

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SE2009/000303

GB	1336706	A	07/11/1973	NONE			
US	2100490	A	30/11/1937	NONE			
US	1882319	A	11/10/1932	NONE			
GB	346464	A	16/04/1931	NONE			
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				GB	2123766	A,B	26/06/1985
				SE	437787	B,C	27/06/1985
				SE	8107692	A,L	23/06/1983