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(54) **AIR DISTRIBUTION SYSTEM FOR A VEHICLE, HVAC SYSTEM FOR A VEHICLE COMPRISING SUCH AIR DISTRIBUTION SYSTEM, AND RELATED VEHICLE**

(57) An air distribution system (1) for distributing conditioned air inside a vehicle, in particular a railway vehicle (100), comprising at least:

- a first duct (10) having a first air intake (11) for introducing conditioned air inside the first duct (10), a first conduit (12) and a second conduit (13) which extend, along a longitudinal axis (X), in a first direction and in a respective opposite second direction with reference to the first air intake (11). The first air intake (11) comprises a first splitter (14) splitting the incoming conditioned air into a first flow (1D) conveyed inside the first conduit (12), and a second flow (1R) conveyed inside the second conduit (13);

- a second duct (20) having a second air intake (21) for introducing conditioned air inside the second duct (20), a third conduit (22) and a fourth conduit (23) which extend, along the longitudinal axis (X), along said first direction and said respective opposite second direction with reference to the second air intake (21). The second air intake (21) comprises a second splitter (24) splitting incoming conditioned air into a third flow (2D) conveyed inside the third conduit (22), and a fourth flow (2R) conveyed inside the fourth conduit (23).

The invention also provides a HVAC system (200) comprising such an air distribution system, and a related vehicle (100), in particular a railway vehicle.

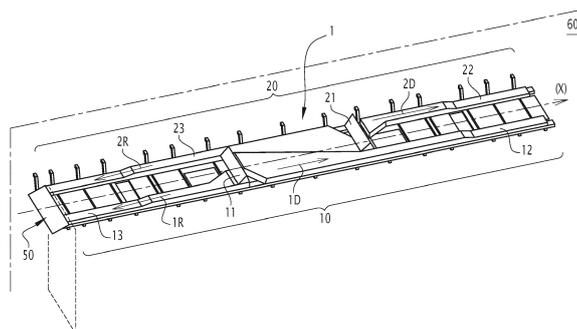


FIG.1

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Description

[0001] The present invention concerns an air distribution system for distributing conditioned air inside a vehicle, an HVAC (Heat, Ventilation and Air Conditioning) system for a vehicle comprising such an air distribution system, and a related vehicle.

[0002] The air distribution system as well as the HVAC system comprising such air distribution system, according to the present invention, are suitable in particular for being used with railway vehicles and will be described hereinafter by making particular reference to such application, without intending in any way to limit their possible application to other types of suitable vehicles.

[0003] The use of air conditioning systems, and in particular of the so-called HVAC systems, are well known in the field of vehicles, and in particular of railway vehicles, in order to provide a suitable thermal comfort and an acceptable quality of air throughout the interior of the various compartments, e.g. of each railway car of a train.

[0004] Nowadays, although the various systems used in vehicles properly perform their functionalities in a quite satisfying way, there are still some aspects worth of further improvements.

[0005] For example, if there is a failure in the HVAC system associated to a railway car, then the interior of such car might not be properly conditioned, thus creating a discomfort for passengers.

[0006] Further, from a construction point of view, it is possible that at least some of the components of existing HVAC systems need to be completely redesigned or replaced in relation to the type and size of vehicles they have to be installed to.

[0007] Concerning this issue, a typical example is represented by pantograph-based railway vehicles, where the presence of pantographs over the roof of the vehicles creates substantial constraints in terms of space available for the installation of the HVAC parts, while the same parts can be easily installed over the roof of railway vehicles not equipped with pantographs.

[0008] The present invention is aimed at mitigating at least partially such issues, and in particular at providing a solution which allows to obtain an adequate comfort inside a vehicle, even when there is a failure in one out of two HVAC units, and which can be used with as many as possible different types of vehicles.

[0009] In particular, such aim is achieved by an air distribution system for distributing conditioned air inside a vehicle, notably a railway vehicle, characterized in that it comprises at least:

- a first duct having a first air intake for introducing conditioned air inside the first duct, a first conduit and a second conduit which extend, along a longitudinal axis, in a first direction and in a respective opposite second direction with reference to the first air intake, wherein said first air intake comprises a first splitter configured to split the incoming condi-

tioned air into a first flow conveyed inside said first conduit, and a second flow conveyed inside said second conduit; and

- a second duct having a second air intake for introducing conditioned air inside the second duct, a third conduit and a fourth conduit which extend, along said longitudinal axis, along said first direction and said respective opposite second direction with reference to the second air intake, and wherein said second air intake comprises a second splitter configured to split the incoming conditioned air into a third flow conveyed inside said third conduit, and a fourth flow conveyed inside said fourth conduit.

[0010] The above mentioned aim is also achieved by a Heat, Ventilation and Air Conditioning (hereinafter "HVAC") system for a vehicle, notably a railway vehicle, characterized in that it comprises:

- a first HVAC unit and a second separate HVAC unit for generating conditioned air suitable to be distributed inside the vehicle; and
- an air distribution system as above indicated, and in particular as described hereinafter and/or defined in one or the appended relevant claims, wherein said first duct is operatively connected to the first HVAC unit and the second air duct is operatively connected to the second HVAC unit.

[0011] Further, the present invention provides also:

- a vehicle, notably a railway vehicle, characterized in that it comprises an air distribution system as above indicated, and in particular as described hereinafter and/or defined in one or the appended relevant claims; and/or
- a vehicle, in particular a railway vehicle, characterized in that it comprises a HVAC system as above indicated, and in particular as described hereinafter and/or defined in one or the appended relevant claims.

[0012] Further characteristics and advantages will become apparent from the description of some preferred but not exclusive exemplary embodiments of an air distribution system, an HVAC system, and a related vehicle, in particular a railway vehicle, according to the invention, illustrated only by way of non-limitative examples with the accompanying drawings, wherein:

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Figure 1 is a perspective view showing a possible embodiment of an air distribution system according to the invention;

55 Figure 2 is a view schematically illustrating a part of a component usable in the air distribution system according to the present invention;

Figure 3 is a view schematically illustrating a constructive module usable for realizing the air distribu-

tion system according to the present invention; Figure 4 schematically shows an exemplary railway vehicle with two roof-mounted pantographs; Figures 5 and 6 show an air distribution system according to the present invention mounted in two different possible configurations.

[0013] It should be noted that in order to clearly and concisely describe the present disclosure, the drawings may not necessarily be to scale and certain features of the disclosure may be shown in somewhat schematic form.

[0014] Further, when the term "adapted" or "arranged" or "configured" or "shaped", is used herein while referring to any component as a whole, or to any part of a component, or to a combination of components, it has to be understood that it means and encompasses correspondingly either the structure, and/or configuration and/or form and/or positioning.

[0015] Figure 1 illustrates an air distribution system according to the invention, indicated by the overall reference number 1, which is suitable for distributing conditioned air inside an associated vehicle, an example of which is illustrated schematically in figure 4 and therein indicated by the reference number 100; for example, the vehicle 100 is a railway vehicle, as illustrated in Figure 4.

[0016] In particular, the illustrated railway vehicle 100 is of the type comprising one or more pantographs 101, in the example two pantographs 101 shown in retracted position, which are mounted on the roof 102 of the railway vehicle 100 itself.

[0017] Clearly, as those skilled in the art would easily appreciate, the air distribution system 1 according to the present invention is suitable to be applied to many different types of vehicles, and in particular to many different of railway vehicles.

[0018] Hence, the definition of railway vehicle has to be interpreted within the frame of the present invention as encompassing any type of railway cars used with or as railway vehicles, such as tramways, underground, surface trains or metros; alternatively, the vehicle is a road transport vehicle, for example a bus.

[0019] As illustrated, the air distribution system 1 comprises a first duct 10 and a second duct 20.

[0020] The first duct 10 comprises a first air intake 11 for introducing conditioned or treated air inside the first duct 10 itself, a first conduit 12 and a second conduit 13 which extend, along a longitudinal axis X, in a first direction F1 and in a respective opposite second direction R1 with reference to the first air intake 11.

[0021] The longitudinal axis X is an axis extending, for example, along the length of the railway vehicle 100, from the rear part 103 to the front part 104 and parallel to the sides 105 thereof.

[0022] Advantageously, as illustrated in figure 2, the first air intake 11 comprises a first splitter 14 configured to split the incoming conditioned air to be distributed into a first flow 1D conveyed inside the first conduit 12, and

a second flow 1R directed opposite to the first flow 1D and conveyed inside said second conduit 13.

[0023] In one possible embodiment, the first air intake 11 is, at least for part of its extension, inclined with respect to the longitudinal axis X, and hence with respect to the first conduit 12 and the second conduit 13.

[0024] In turn, the second duct 20 has a second air intake 21 for introducing conditioned air inside the second duct 20 itself, a third conduit 22 and a fourth conduit 23 which extend, along the longitudinal axis X, along the first direction F1 and the respective opposite second direction R1 with reference to the second air intake 21.

[0025] Likewise, the second duct 20 comprises a corresponding second air intake 21, substantially identical to the first air intake 11, which comprises a second splitter 24 configured to split the incoming conditioned air to be distributed inside the vehicle 100 into a third flow 2D, directed in the same direction of the first flow 1D and conveyed inside the third conduit 22, and a fourth flow 2R directed opposite to the third flow 2D, e.g. in the same direction of the second flow 1R, and conveyed inside the fourth conduit 23.

[0026] In one possible embodiment, the second air intake 21 is, at least for part of its extension, inclined with respect to the longitudinal axis X, and hence with respect to the third conduit 22 and the fourth conduit 23.

[0027] Conveniently, in one possible embodiment of the air distribution system 1, as for example illustrated in figures 5 and 6, one or more of, preferably both the first duct 10 and the second duct 20 have each a shaped body comprising a plurality of separate modules M1, M2, M3, M4 which are assembled together to form the respective first duct 10 and second duct 11.

[0028] According to a possible embodiment, and as indicated in more details in figure 5, the first duct 10 has a shaped body comprising a first central portion 16 which has, seen from a top view: a first side 17 at which there is provided the first air intake 11; an inclined second side 18, converging from one end of the first side 17 to a first side of the first conduit 12 extending in the first direction F1 along the longitudinal axis X; and a third side 19, opposite to the second side 18 with reference to the first air intake 11, which connects the first side 17 with a second side of the first conduit 12. In the embodiment illustrated, the third side 19 comprises two sections, e.g. a first section 19a constituted by an extension of the second side of the first conduit 12 towards the first air intake 11, and a second section 19b connecting the first section 19a with another end part of the first air intake 11.

[0029] In turn, the second conduit 13 extends from the first air intake 11 in the second opposite direction R1 along the longitudinal axis X, substantially aligned with the first conduit 12; in particular, in the embodiment illustrated, one side of the second conduit 13 extends directly from one end part on the first air intake 11, while on the opposite side of the second conduit 13, there is provided an inclined side 15 converging from and joining the first air intake 11 to the second conduit 13.

[0030] As illustrated, also the second duct 20 has a shaped body comprising a second central portion 26 which has, seen from a top view: a first side 27 at which there is provided the second air intake 21; an inclined second side 28, converging from one end of the first side 27 to the fourth conduit 23 extending in the second direction R1 along the longitudinal axis X, substantially parallel to the second conduit 13; and a third side 29, opposite to the second side 28 with reference to the second air intake 21, which connects the first side 27 with the fourth conduit 23. In the embodiment illustrated, the third side 29 of the second duct 20 comprises two sections, e.g. a first section 29a constituted by an extension of the second side of the fourth conduit 23 towards the second air intake 21, and a second section 29b connecting the first section 29a with another end part of the second air intake 21.

[0031] In turn, the third conduit 22 extends from the second air intake 21 in the first opposite direction F1 along the longitudinal axis X, substantially aligned with the third conduit 21 and parallel to the first conduit 12; in particular, in the embodiment illustrated, one side of the third conduit 22 extends directly from one end part on the second air intake 21, while on the opposite side of the third conduit 22, there is provided an inclined side 25 converging from and joining the second air intake 21 to the third conduit 22 itself.

[0032] For example, according to this embodiment, the first module M1 can comprise end parts of the respective first and third conduits 12 and 22, the modules M2 and M3 can comprise part of the respective air intakes 11 and 21, of the central portions 16, 26, and the initial parts of the respective first, second, third and fourth conduits 12, 13, 22 and 23, while the fourth module M4 can comprise end parts of the respective second and fourth conduits 13 and 23.

[0033] According to yet another possible embodiment, the air distribution system 1 can comprise an additional module M5, one example of which is schematically illustrated in figure 3.

[0034] As illustrated, the additional module M5 extends substantially rectilinear along the longitudinal axis X, and it is intended to be positioned at a middle part of the respective central portion 16, 26 of the first duct 10 and/or of the second duct 20 and to be assembled with the adjacent modules M2 and M3 thereof.

[0035] In particular, the additional module M5, which can be easily and suitably sized as desired, comprises two channel sections 31 and 32 which, once the module M5 is assembled, are part of and contribute to form the respective central portions 16 and 26, thus allowing for example to properly modify the overall length of the ducts 10 and 20, and hence to adapt the air distribution system 1 to railway vehicles having different lengths.

[0036] According to a possible embodiment, as illustrated in the attached figures, the first duct 10 and the second duct 20 are substantially identical to each other, apart from unavoidable minor constructive mechanical

tolerances or differences.

[0037] In a possible embodiment, in the air distribution system 1 according to the invention, once installed, the first duct 10 and the second duct 20, with or without the additional module M5, can be positioned as illustrated for example in figure 1 shown without the additional module M5, side by side with the inclined second side 18 of the first central portion 16 adjacent to and in contact with the inclined second side 28 of the second central portion 26.

[0038] Alternatively, as for example illustrated in figure 6 shown with the additional module M5, once installed, the first duct 10 and the second duct 20, with or without the additional module M5, can be positioned side by side with the inclined second side 18 of the first central portion 16 facing to and spaced apart from the inclined second side 28 of the second central portion 26.

[0039] In this way, the air distribution system 1 according to the present invention can be easily adapted also to vehicles, and in particular railway vehicles, having different widths.

[0040] Thus, the air distributing system 1 according to the present invention constitutes a kind of universal ducting system for being used in HVAC systems and/or with different types of vehicles.

[0041] Hence, as previously mentioned, a further aspect of the present invention relates to an Heating, Ventilation and Air Conditioning (HVAC) system, for a vehicle 100, schematically indicated in figure 6 by the reference number 200, characterized in that it comprises:

- a first HVAC unit 201 and a second separate HVAC unit 202 for generating conditioned air suitable to be distributed inside the vehicle 100, which units 201, 202 are known per se and therefore herein not described in detail; and
- an air distribution system 1, of the type previously described and in particular as defined in the appended claims, with the first duct 10 operatively connected to the first HVAC unit 201, and the second air duct 20 operatively connected to the second HVAC unit 202.

[0042] Yet further aspects of the present invention relate to:

- a vehicle 100, in particular a railway vehicle, characterized in that it comprises an air distribution system 1 of the type previously described and in particular as defined in the appended claims;
- a vehicle 100, in particular a railway vehicle, characterized in that it comprises a HVAC system 200 of the type previously described and in particular as defined in the related appended claim.

[0043] Usefully, the solution devised according to the present invention is particularly advantageous in case of pantograph-based railway vehicles, such as the one il-

lustrated in figure 4 with two pantographs 101 mounted on the roof 102 of the railway vehicle 100.

[0044] In this case, a first HVAC unit 201 and a second HVAC unit 202 for generating the conditioned air to be distributed inside the vehicle 100 can be conveniently mounted on the roof 102 at a central part thereof between the two pantographs 101, with the air distribution system 1 installed for example with the first and second ducts 10, 20 below the roof 102 of the railway vehicle 100, e. g. in the space between the roof 102 and an internal ceiling of the internal compartment of the vehicle 100 itself.

[0045] In practice, according to the present invention, the whole air distribution system 1 is formed by two subparts which can function together and both split the respective flow of conditioned air to be distributed in a forward direction and in a rearward direction. If one of the two subparts fails for whatever reason, the other one allows in any case to have a substantially uniform distribution of conditioned air inside the full length of the vehicle thanks to such splitting into the two opposite directions F1 and R1.

[0046] Further, each of the two subparts has one channel which ends in correspondence of a cabin booster 50 and therefore can always guarantee the supply of treated air also inside the driver cab.

[0047] Further, the two ducts 10 and 20 of the air distribution system 1 are positioned symmetrically to each other with respect to a vertical plan 60 parallel to the two lateral sides of the vehicle and virtually dividing longitudinally the vehicle in two equal parts, and the same occurs when considering the whole HVAC system 200 with the two HVAC units 201, thus contributing in better dynamics of the vehicle.

[0048] Hence, it is evident from the foregoing description and appended claims that the air distribution system 1, the HVAC system 200, and the related vehicle 100, according to the present invention, achieve the intended aim and objects, since they allow a proper conditioning of the interior of a vehicle, including the driver cabin, even when there is a failure, and according to a solution which can be utilized with vehicles of different sizes with very minor constructive modifications of even without any modification.

[0049] The air distribution system 1, the HVAC system 200, and the related vehicle 100 thus conceived are susceptible of modifications and variations, all of which are within the scope of the inventive concept as defined in particular by the appended claims; for example, one or more components or any part thereof may be differently shaped with respect to what previously described; each module, such as for example the module M5 previously described, can be realized as a unique piece, or by two or more submodules which can be assembled to or disassembled from each other.

[0050] All the details may furthermore be replaced with technically equivalent elements.

Claims

1. An air distribution system (1) for distributing conditioned air inside a vehicle (100), notably a railway vehicle (100), **characterized in that** it comprises at least:
 - a first duct (10) having a first air intake (11) for introducing conditioned air inside the first duct (10), a first conduit (12) and a second conduit (13) which extend, along a longitudinal axis (X), in a first direction and in a respective opposite second direction with reference to the first air intake (11), wherein said first air intake (11) comprises a first splitter (14) configured to split the incoming conditioned air into a first flow (1D) conveyed inside said first conduit (12), and a second flow (1R) conveyed inside said second conduit (13); and
 - a second duct (20) having a second air intake (21) for introducing conditioned air inside the second duct (20), a third conduit (22) and a fourth conduit (23) which extend, along said longitudinal axis (X), along said first direction and said respective opposite second direction with reference to the second air intake (21), and wherein said second air intake (21) comprises a second splitter (24) configured to split the incoming conditioned air into a third flow (2D) conveyed inside said third conduit (22), and a fourth flow (2R) conveyed inside said fourth conduit (23).
2. An air distribution system (1) according to claim 1, wherein one or more of said first duct (10) and said second duct (20) have each a shaped body comprising a plurality of separate modules (M1, M2, M3, M4) assembled together to form the respective first duct (10) and second duct (11).
3. An air distribution system (1) according to claim 1 or claim 2, wherein at least one of said first air intake (11) and of said second air intake (21) is, for at least part of its respective extension, inclined with respect to said longitudinal axis (X).
4. An air distribution system (1) according to any of the preceding claims, wherein said first duct (10) has a shaped body comprising a first central portion (16) having a first side (17) at which there is provided said first air intake (11), an inclined second side (18), converging from the first side (17) to the first conduit (12) extending in said first direction along the longitudinal axis (X), and a third side (19), opposite to the second side (18) with reference to the first air intake (11), connecting the first side (17) with the first conduit (12), and wherein the second conduit (13) extends from said first air intake (11) in said second opposite

direction along the longitudinal axis (X) substantially aligned with the first conduit (12).

- 5. An air distribution system (1) according to claim 4, wherein said second duct (20) has a shaped body comprising a second central portion (26) having a first side (27) at which there is provided said second air intake (21), an inclined second side (28), converging from the first side (27) to the fourth conduit (23) extending in said second direction along the longitudinal axis (X), and a third side (29), opposite to the second side (28) with reference to the second air intake (21), connecting the first side (27) with the fourth conduit (23), and wherein the third conduit (22) extends from said second air intake (21) in said first direction along the longitudinal axis (X) substantially aligned with the fourth conduit (23). 5
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- 6. An air distribution system (1) according to claim 5 when depending on claim 2, wherein it comprises an additional module (M5) extending substantially rec-tilinear along said longitudinal axis (X) and intended to be positioned at a middle part of the respective central portion (16, 26) of said first duct (10) and/or of said second duct (20). 20
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- 7. An air distribution system (1) according to claim 5 or claim 6, wherein said first duct (10) and said second duct (20), once installed, are positioned side by side with the inclined second side (18) of the first central portion (16) adjacent to and in contact with the inclined second side (28) of the second central portion (26), or with the inclined second side (18) of the first central portion (16) facing to and spaced apart from the inclined second side (28) of the second central portion (26). 30
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- 8. A Heating, Ventilation and Air Conditioning (HVAC) system (200) for a vehicle (100), notably a railway vehicle, **characterized in that** it comprises: 40
 - a first HVAC unit (201) and a second separate HVAC unit (202) for generating conditioned air suitable to be distributed inside the vehicle (100); and 45
 - an air distribution system (1) according to any one of claims 1 to 7, wherein said first duct (10) is operatively connected to the first HVAC unit (201) and the second air duct (20) is operatively connected to the second HVAC unit (202). 50

- 9. A vehicle (100), in particular a railway vehicle, **characterized in that** it comprises an air distribution system according to any one of claims 1 to 7, or a HVAC system (200) according to claim 8. 55

- 10. A vehicle (100) according to claim 9, wherein it comprises one or more pantographs (101) mounted on

the roof (102) of the vehicle (100), and wherein first and second HVAC units (201, 202) are mounted on said roof (102) with the air distribution system (1) installed with said first and second ducts (10, 20) below the roof (102) inside the railway vehicle (100).

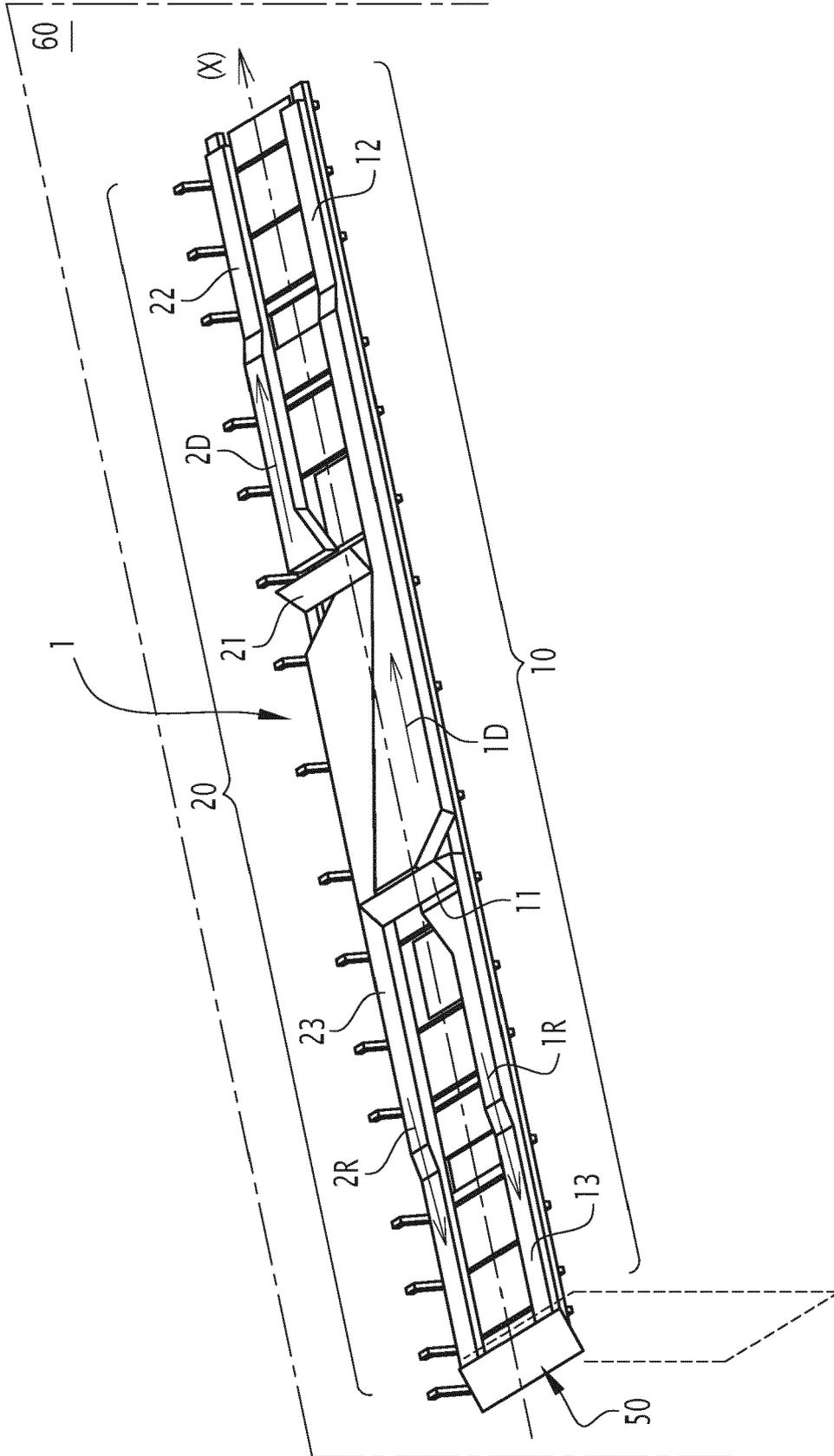


FIG.1

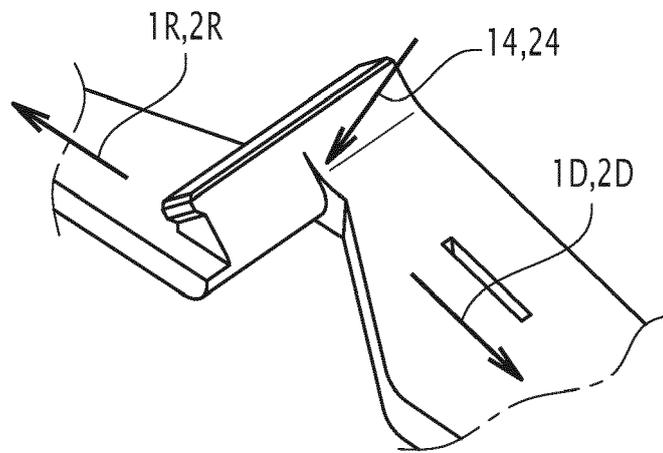


FIG.2

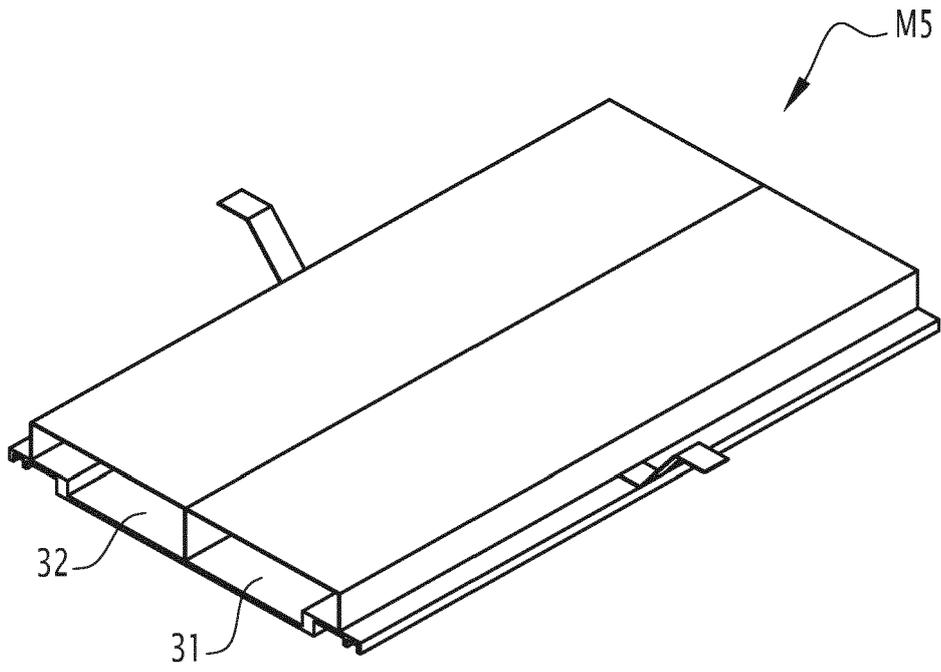


FIG.3

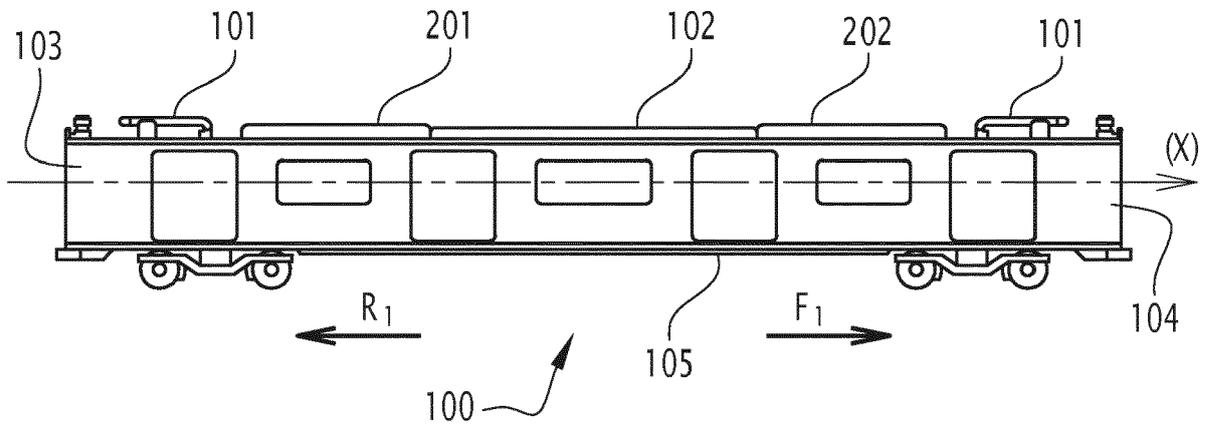


FIG.4

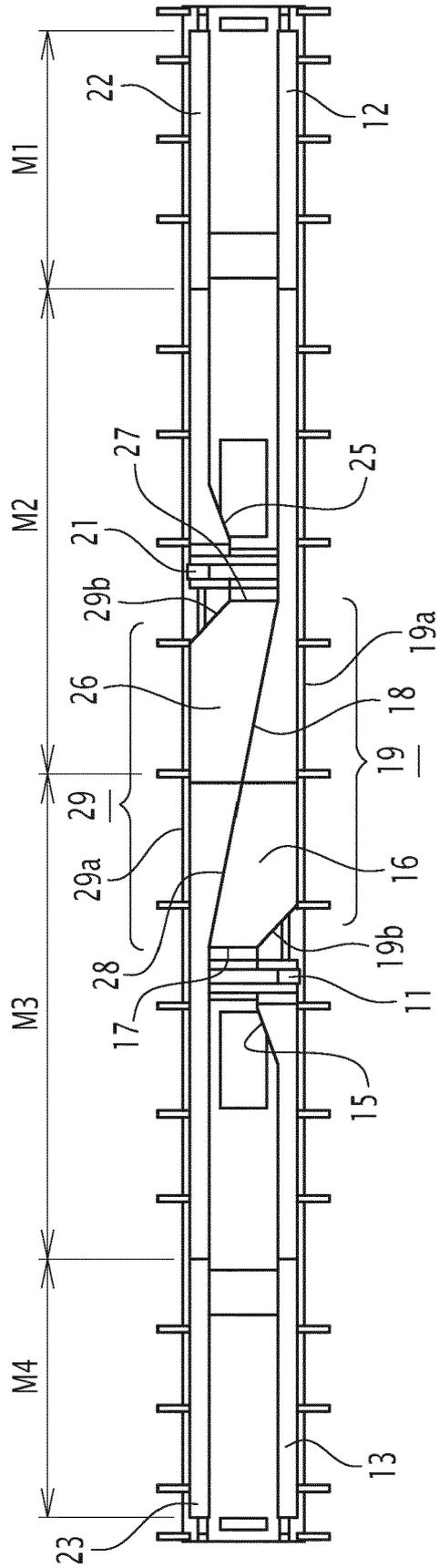


FIG.5

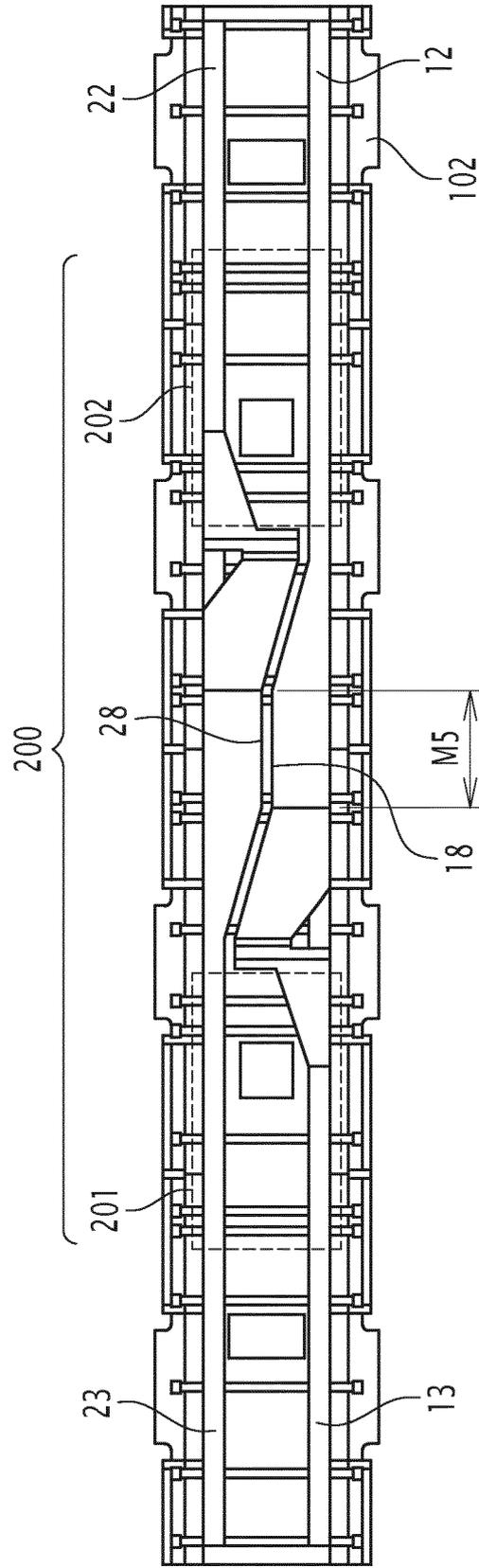


FIG. 6



EUROPEAN SEARCH REPORT

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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
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Place of search		Date of completion of the search	Examiner
Munich		11 June 2021	Denis, Marco
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ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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