(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 875 337 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
08.09.2021 Bulletin 2021/36

(51) Int Cl.:
B61D 17/18 *(2006.01)* ***B61D 17/00*** *(2006.01)*
G10K 11/178 *(2006.01)*

(21) Application number: **21159261.3**

(22) Date of filing: **25.02.2021**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **02.03.2020 GB 202002994**

(71) Applicant: **Hitachi Rail Ltd.**
London, Greater London EC4M 7AW (GB)

(72) Inventors:
- **OURA, Yuta**
  London, Greater London EC1N 2PB (GB)
- **AGATSUMA, Koji**
  London, Greater London EC1N 2PB (GB)

(74) Representative: **Mewburn Ellis LLP**
Aurora Building
Counterslip
Bristol BS1 6BX (GB)

(54) RAILWAY VEHICLE NOISE LEVEL REDUCTION

(57) A method of reducing a noise level within a compartment of a railway vehicle affected by noise-producing equipment items is provided. The method includes: providing a sound database which relates operational states of the vehicle to respective noise signatures produced by the equipment items; determining the present operational state of the railway vehicle; selecting one or more noise signatures from the database corresponding to the present operational state; creating a noise cancellation signal from the selected noise signatures; and transmitting the noise cancellation signal into the compartment to reduce the noise level within the compartment.

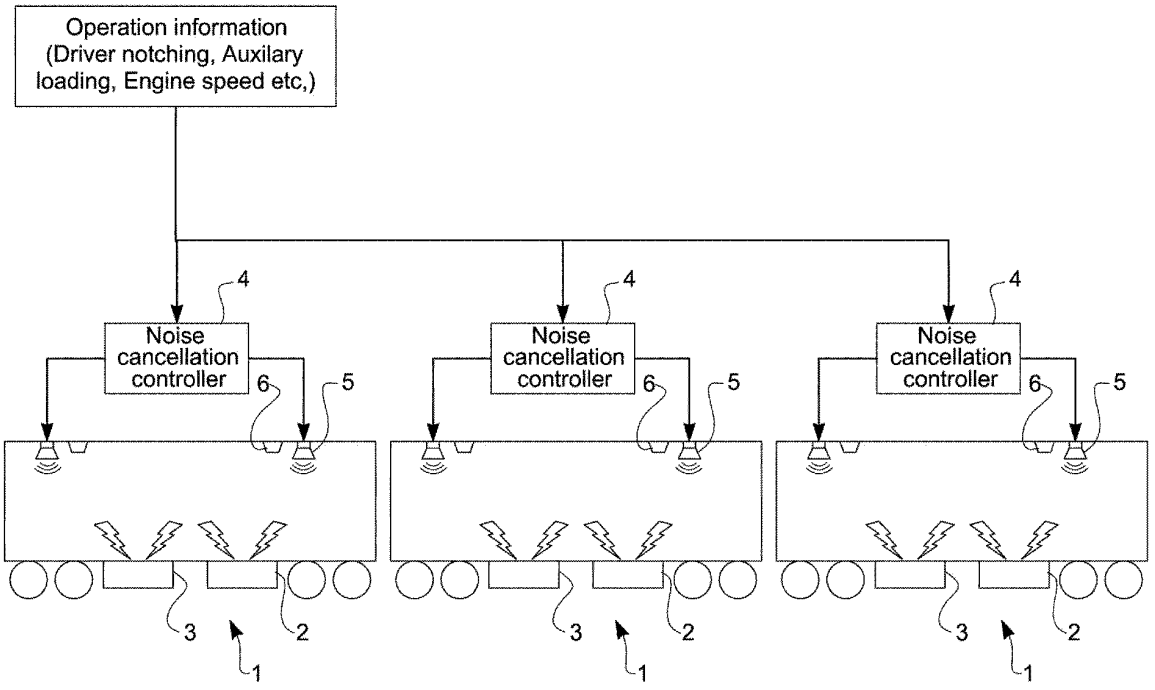

Fig. 1

EP 3 875 337 A1

Description

Field of the disclosure

[0001] The present disclosure relates to a method and system for reducing a noise level within a compartment of a railway vehicle.

Background

[0002] Electrically powered railway vehicles typically have a traction system including an overhead contactor to contact an overhead line, a voltage transformer to adjust the voltage between the overhead line, and on-board electrical equipment such as a power converter and an electric motor. Between the transformer and the converter it is also common to provide filter equipment for reducing harmonics components, such as ripples on the current generated by the power converter.

[0003] Bimodal railway vehicles also include an engine unit which drives a generator. In non-electrified regions of rail network, the overhead contactor is lowered and electrical power generated by the generator supplies the power to the converter. Another approach is to provide the vehicle with battery equipment which supplies power to the converter in non-electrified regions.

[0004] Such railway vehicles also generally have an auxiliary power system which uses some of the power to operate apparatuses for passenger comfort and safety, such as ventilation equipment, heaters, air conditioners, lighting, door systems, and audio/visual equipment.

[0005] The above-mentioned equipment items are fixed in various manners to structures of the vehicle, for example, to a bogie, a car body frame, or a passenger compartment wall, floor or ceiling. As a result, sound and vibrations may be transmitted into passenger compartments via such structures when the equipment items are operated. Although careful design of vehicle structures can suppress much of this transmission, passenger compartments can nonetheless be affected by operational noise produced by the equipment items.

[0006] A known approach to reducing noise level within compartments of railway vehicles is to provide a noise control system that use a speaker to output a generated sound, or "anti-noise", through a speaker to attenuate engine noise. The generated anti-noise is out of phase with the engine noise and combines with the engine noise to reduce the overall noise level from the engine. The resultant mix of engine noise and anti-noise is captured and measured by a microphone, and the output of the microphone is used to determine what the generated anti-noise should be. This approach to noise control requires a feedback loop and relies on actively sensing the noise within a compartment in order to produce the correct anti-noise.

[0007] However, railway vehicles are complicated systems, which vary car-to-car in terms of noise level and noise characteristic, and a problem with the known approach is that the sound analysis (typically involving transforms and filters) needed to produce the correct anti-noise in real time in such an environment is difficult to perform.

Summary

[0008] It would thus be desirable to provide an alternative approach to noise level reduction that overcomes this problem.

[0009] According to a first aspect there is provided a method of reducing a noise level within a compartment of a railway vehicle affected by noise-producing equipment items, the method including:

providing a sound database which relates operational states of the vehicle to respective noise signatures produced by the equipment items;
determining the present operational state of the railway vehicle;
selecting one or more noise signatures from the database corresponding to the present operational state;
creating a noise cancellation signal from the selected noise signatures; and
transmitting the noise cancellation signal into the compartment to reduce the noise level within the compartment.

[0010] Advantageously, the method can create the noise cancellation signal, quickly and straightforwardly via the sound database, i.e. without complex sound analysis. In addition, non-equipment noise in the compartment, such as passenger noise, does not affect the creation of the cancellation signal.

[0011] Conveniently, the sound database may store, for each equipment item, plural noise signatures which are related by the database to values of a respective operational state of that equipment item. In this case, each operational state of the vehicle may be formed by a pattern of values of operational states of the equipment items. Further, plural noise signatures may be selected from the database, the selected noise signatures corresponding to the pattern of values of operational states of the equipment items which form the operational state of the vehicle.

[0012] The noise cancellation signal may be transmitted into the compartment by one or more speakers distributed through the compartment.

[0013] The method may further include: sensing noise within the compartment; determining an overall noise level of the sensed noise; and adjusting the level of the transmitted noise cancellation signal to reduce the overall noise level. For example, the noise may be sensed by one or more microphones distributed through the compartment. In particular, when the noise cancellation signal is transmitted into the compartment by one or more speakers distributed through the compartment, each mi-

crophone may be located adjacent a respective speaker. The level of the noise cancellation signal from each speaker can then be adjusted independently based on feedback from the adjacent microphone.

[0014] Generally, the transmitted noise cancellation signal should be out of phase with the noise within the compartment produced by the noise-producing equipment items. For example, one option to achieve this is for the sound database to store, for each noise signature and its respective operational state, a corresponding phase related to a state of a reference equipment item of the vehicle. Then, when the one or more noise signatures are selected from the database, their corresponding phases are also selected. Moreover, when the noise cancellation signal is created from the selected noise signatures and transmitted into the compartment, the selected phases can then be used to set the phases of the signatures within the signal relative to the present states of their reference equipment item. For example, the phase of a noise signature for reducing the noise from an engine can be related to a positional state of that engine, e.g. a crank shaft position of a diesel engine. Thus this approach requires pre-knowledge of the relationships between states of the reference equipment items and the phases in the compartment, relative to those states, of the noise within the compartment produced by the noise-producing equipment items.

[0015] However, another option to achieve having the transmitted noise cancellation signal be out of phase with the noise within the compartment produced by the noise-producing equipment items is based on measurement of the phase of the noise. For example, the method can further include: sensing noise within the compartment produced by the noise-producing equipment items; determining one or more phases of the sensed noise; and adjusting corresponding phases of the selected noise signatures within the transmitted noise cancellation signal such that they are out of phase with the determined phases.

[0016] Yet another option to achieve having the transmitted noise cancellation signal be out of phase with the noise within the compartment produced by the noise-producing equipment items is simply to make ad hoc adjustments of the phases of the selected noise signatures within the transmitted noise cancellation signal until the overall noise level within the compartment is reduced. Thus more particularly, the method may further include: sensing noise produced within the compartment by the noise-producing equipment items and the noise cancellation signal; determining an overall noise level of the sensed noise; and adjusting the phases of the selected noise signatures within the transmitted noise cancellation signal to reduce the overall noise level.

[0017] According to a second aspect there is provided a system for reducing a noise level within a compartment of a railway vehicle affected by noise-producing equipment items, the system including:

a sound database which relates operational states of the vehicle to respective noise signatures produced by the equipment items;

a controller which is configured to determine the present operational state of the railway vehicle, select one or more noise signatures from the database corresponding to the present operational state, and create a noise cancellation signal from the selected noise signatures for transmission into the compartment to reduce the noise level within the compartment.

[0018] The system of the second aspect thus corresponds to the method of the first aspect.

[0019] Conveniently, the controller may be a computer-based controller, e.g. comprising one or more processors, which is configured by being suitably programmed. The controller may be part of a train's overall TCMS (train control and management system).

[0020] The database can be stored on a suitable computer readable medium of the system. The term "computer readable medium" may represent one or more devices for storing data, including read only memory (ROM), random access memory (RAM), magnetic RAM, core memory, magnetic disk storage mediums, optical storage mediums, flash memory devices and/or other machine readable mediums for storing information. The term "computer-readable medium" includes, but is not limited to portable or fixed storage devices, optical storage devices, wireless channels and various other mediums capable of storing, containing or carrying instruction(s) and/or data.

[0021] Conveniently, the sound database may store, for each equipment item, plural noise signatures which are related by the database to values of a respective operational state of that equipment item. In this case, each operational state of the vehicle may be formed by a pattern of values of operational states of the equipment items. Further, plural noise signatures may be selected from the database by the controller, the selected noise signatures corresponding to the pattern of values of operational states of the equipment items which form the operational state of the vehicle.

[0022] The system may further include one or more speakers for distribution through the compartment, the noise cancellation signal being transmitted into the compartment by the speakers.

[0023] The controller may be further configured to: receive a sensed noise within the compartment; determine an overall noise level of the sensed noise; and adjust the level of the transmitted noise cancellation signal to reduce the overall noise level. For example, the system may further include one or more microphones for distribution through the compartment to sense the noise within the compartment. In particular, when the system has one or more speakers for distribution through the compartment, each microphone may be for location adjacent a respective speaker, the level of the noise cancellation

signal from each speaker being adjusted independently based on feedback from the adjacent microphone.

[0024] As previously mentioned, generally, the transmitted noise cancellation signal should be out of phase with the noise within the compartment produced by the noise-producing equipment items. According to one option, the sound database may further store, for each noise signature and its respective operational state, a corresponding phase related to a state of a reference equipment item of the vehicle. The controller may then be further configured to: also select the corresponding phases to the one or more selected noise signatures; and to create the noise cancellation signal from the selected noise signatures with the selected phases being used to set the phases of the signatures within the signal relative to the present states of their reference equipment item. However, according to another option, the controller can be further configured to: receive a sensed noise produced within the compartment by the noise-producing equipment items, determine one or more phases of the sensed noise, and adjust corresponding phases of the selected noise signatures within the transmitted noise cancellation signal such that they are out of phase with the determined phases. And according to yet another option, the controller can be further configured to: receive sensed noise produced within the compartment by the noise-producing equipment items and the noise cancellation signal, determine an overall noise level of the sensed noise; and adjust the phases of the selected noise signatures within the transmitted noise cancellation signal to reduce the overall noise level.

[0025] According to a third aspect there is provided a railway vehicle having a compartment affected by noise-producing equipment item and fitted with the system of the second aspect for reducing a noise level within the compartment.

[0026] Further aspects of the present disclosure provide: a computer program comprising code which, when the code is executed on a computer, causes the computer to perform the method of the first aspect; and a computer readable medium storing a computer program comprising code which, when the code is executed on a computer, causes the computer to perform the method of the first aspect.

[0027] The skilled person will appreciate that except where mutually exclusive, a feature or parameter described in relation to any one of the above aspects may be applied to any other aspect. Furthermore, except where mutually exclusive, any feature or parameter described herein may be applied to any aspect and/or combined with any other feature or parameter described herein.

Brief description of the drawings

[0028] Embodiments will now be described by way of example only, with reference to the Figures, in which:

Figure 1 shows schematically a train formed of plural vehicles providing respective passenger compartments;

Figure 2 shows schematically a noise cancellation controller of one of the vehicles of Figure 1;

Figure 3 shows schematically a sound database of the noise cancellation controller of Figure 2; and

Figure 4 shows a variant noise cancellation controller.

Detailed description

[0029] Figure 1 shows schematically a train formed of plural vehicles 1 providing respective passenger compartments. Each vehicle has equipment items, such as traction control systems 2, engines 3 etc., joined to the structure of the vehicle. In operation, these equipment items are sources of acoustic noise within the passenger compartments.

[0030] However, each vehicle 1 has a noise cancellation controller 4 (discussed in more detail below), which can conveniently be implemented as a part of the train's overall TCMS. In addition, each vehicle has one or more speakers 5 for projecting sound into the passenger compartment under the control of its noise cancellation controller. Optionally, each vehicle further has one or more microphones 6 for detecting sound within the compartment and providing the detected sound to the noise cancellation controller.

[0031] Each noise cancellation controller 4 also receives operational information (e.g. via the TCMS) about the current state of the train, such as the power notching level selected by the driver, the auxiliary equipment loading, the engine speed etc.

[0032] One of the noise cancellation controllers is shown schematically in Figure 2. It contains or is operatively connected to a sound database which relates operational states of the vehicle to respective noise signatures produced by the equipment items. For example, one noise source is the power converter of the traction control system. The power converter transforms AC power from the overhead line via a voltage transformer into DC power. The power converter normally operates, and thus produces noise, continuously. In contrast, the transformer only produces noise when power is supplied from the overhead line. Propulsion equipment is another noise source, but is more dependent on operational situations. For example, an inverter and a motor may generate acoustic noise during acceleration or deceleration, but not during coasting. If the train has an engine, this generates acoustic noise when it is being operated, but conversely these periods of operation generally coincide with interruption of power from the overhead line, and hence absence of noise from the transformer. The train's auxiliary power system (which runs internal equipment such

as air conditioners, ventilators, and passenger information display and announcement systems) generally operates continuously, but its power consumption level may vary as necessary to maintain a stable passenger environment.

[0033] Consequently, different operational states of the vehicle correspond to different patterns of values of operational states of noise-producing equipment items and hence different combinations of noise signatures produced within each passenger compartment. Accordingly, the sound database of the noise cancellation controller provides a lookup table which stores suitable anti-noise signatures to cancel the noise produced by different equipment items depending on the values of operational states of those items. For example, as shown in Figure 3, Sound A is anti-noise for cancelling engine noise, and the database stores different Sound A signatures (A-1, A-2, A-3 etc.) depending on a value of the engine speed operational state. As a second example, Sound B is anti-noise for cancelling noise produced by propulsion equipment, and the database stores different Sound B signatures (B-1, B-2, B-3 etc.) depending on a value of the notch level operational state. As a third example, Sound C is anti-noise for cancelling noise from the auxiliary power system, and the database stores different Sound C signatures (C-1, C-2, C-3 etc.) depending on a value of the loading operational state of the auxiliary power system. Although not shown in Figure 3, the lookup table may also store for each signature a corresponding phase.

[0034] When the noise cancellation controller receives the present operational state of the vehicle (for example, electric drive mode or non-electric drive mode, speed of train, notch position, workload of auxiliary power system), it can thus select from the database suitable anti-noise signatures for the equipment items implicated in the operational state (e.g. one or none of type A, one or none of type B and one or none of type C), and combine the different sounds via a summing unit (SUM) and a sound creation unit to create a noise cancellation signal which is transmitted into the passenger compartment through the one or more speakers to reduce the noise level within the compartment. The relative phases of the combined signatures can be set according to their corresponding phases, and these can also be used to set the overall phase of the transmitted signal relative to states of one or more reference equipment items of the vehicle, i.e. so that the noise cancellation signal is out of phase with the noise in the compartment produced by the equipment items.

[0035] The anti-noise signatures are stored in the database before service operation of the vehicle. For example, some or all of the signatures can be configured from real monitored noise data, aggregated by driving the vehicle on a route. The signatures (and their phases if present) can be updated regularly (e.g. on a daily basis). However, another option is to create some or all of the signatures (and their phases if present) by simulation based on workload information of equipment items and knowledge of vibration transmission formulae for the vehicle.

[0036] Compared to known approaches for reducing noise level within passenger compartments, the above approach has an advantage that is it does not require complex sound analysis (i.e. transforms and filters) to create the noise cancellation signal, but rather can create the signal quickly and straightforwardly via the sound database. Having said that, the above approach can be combined with a sound analysis approach to improve the quality of the noise cancellation signal and providing a form of dynamic feedback.

[0037] A further advantage of the above approach is that non-equipment noise in the compartment, such as passenger noise or door operation noise, does not affect the creation of the cancellation signal.

[0038] In order to set the level of the noise cancellation signal, as shown in Figure 4, one or more microphones in the compartment may sense the overall noise level within the compartment. The sound creation unit can then use this sensed level as feedback to adjust the level of the signal to better reduce the overall noise level. Preferably the compartment has at least two such microphones, for example set in the ceiling at fore and aft positions in the compartment. Indeed, more preferably each speaker has an adjacent and corresponding microphone so that the level of the noise cancellation signal from each speaker can be adjusted independently based on feedback from its own microphone.

[0039] The noise sensed by the microphones can also be used to set the phases of the signatures within the noise cancellation signal. For example, phases of the noise produced by the noise-producing equipment items can be determined from the sensed noise so that the phases of the signatures can be set out of phase therewith. Alternatively, the relative phasing of the signatures within the noise cancellation signal can simply be adjusted until the overall noise level of the sensed within the compartment is reduced.

[0040] Conveniently, the TCMS can use the speakers 5 for purposes other than noise cancellation. For example, routine and emergency passenger announcements can be relayed over the speakers. Such announcements typically take priority over the noise cancellation signal, which may be suspended for the duration of an announcement. Noise cancellation may also be suspended when the doors of the train are open.

[0041] It will be understood that the invention is not limited to the embodiments above-described and various modifications and improvements can be made without departing from the concepts described herein. Except where mutually exclusive, any of the features may be employed separately or in combination with any other features and the disclosure extends to and includes all combinations and sub-combinations of one or more features described herein.

Claims

1. A method of reducing a noise level within a compartment of a railway vehicle affected by noise-producing equipment items, the method including:

   providing a sound database which relates operational states of the vehicle to respective noise signatures produced by the equipment items;
   determining the present operational state of the railway vehicle;
   selecting one or more noise signatures from the database corresponding to the present operational state;
   creating a noise cancellation signal from the selected noise signatures; and
   transmitting the noise cancellation signal into the compartment to reduce the noise level within the compartment.

2. The method of claim 1, wherein:

   the sound database stores, for each equipment item, plural noise signatures which are related by the database to values of a respective operational state of that equipment item;
   each operational state of the vehicle is formed by a pattern of values of operational states of the equipment items; and
   plural noise signatures are selected from the database, the selected noise signatures corresponding to the pattern of values of operational states of the equipment items which form the operational state of the vehicle.

3. The method of claim 1 or 2, wherein the noise cancellation signal is transmitted into the compartment by one or more speakers distributed through the compartment

4. The method of any one of the previous claims, further including:

   sensing noise within the compartment;
   determining an overall noise level of the sensed noise; and
   adjusting the level of the transmitted noise cancellation signal to reduce the overall noise level.

5. The method of claim 4, wherein the noise is sensed by one or more microphones distributed through the compartment.

6. The method of claim 5 as dependent on claim 3, wherein each microphone located adjacent a respective speaker, the level of the noise cancellation signal from each speaker being adjusted independently based on feedback from the adjacent microphone.

7. A system for reducing a noise level within a compartment of a railway vehicle affected by noise-producing equipment items, the system including:

   a sound database which relates operational states of the vehicle to respective noise signatures produced by the equipment items;
   a controller which is configured to determine the present operational state of the railway vehicle, select one or more noise signatures from the database corresponding to the present operational state, and create a noise cancellation signal from the selected noise signatures for transmission into the compartment to reduce the noise level within the compartment.

8. The system of claim 7, wherein:

   the sound database stores, for each equipment item, plural noise signatures which are related by the database to values of a respective operational state of that equipment item;
   each operational state of the vehicle is formed by a pattern of values of operational states of the equipment items; and
   plural noise signatures are selected from the database by the controller, the selected noise signatures corresponding to the pattern of values of operational states of the equipment items which form the operational state of the vehicle.

9. The system of claim 7 or 8, further including one or more speakers for distribution through the compartment, the noise cancellation signal being transmitted into the compartment by the speakers.

10. The system of any one of claims 7 to 9, wherein the controller which is further configured to:

    receive a sensed noise within the compartment;
    determine an overall noise level of the sensed noise; and
    adjust the level of the transmitted noise cancellation signal to reduce the overall noise level.

11. The system of claim 10, further including one or more microphones for distribution through the compartment to sense the overall noise level within the compartment.

12. The system of claim 11 as dependent on claim 9, wherein each microphone is for location adjacent a respective speaker, the level of the noise cancellation signal from each speaker being adjusted independently based on feedback from the adjacent microphone.

13. A railway vehicle having a compartment affected by noise-producing equipment item and fitted with the system of any one of claims 7 to 12 for reducing a noise level within the compartment.

14. A computer program comprising code which, when the code is executed on a computer, causes the computer to perform the method of any one of claims 1 to 6.

15. A computer readable medium storing the computer program of claim 14.

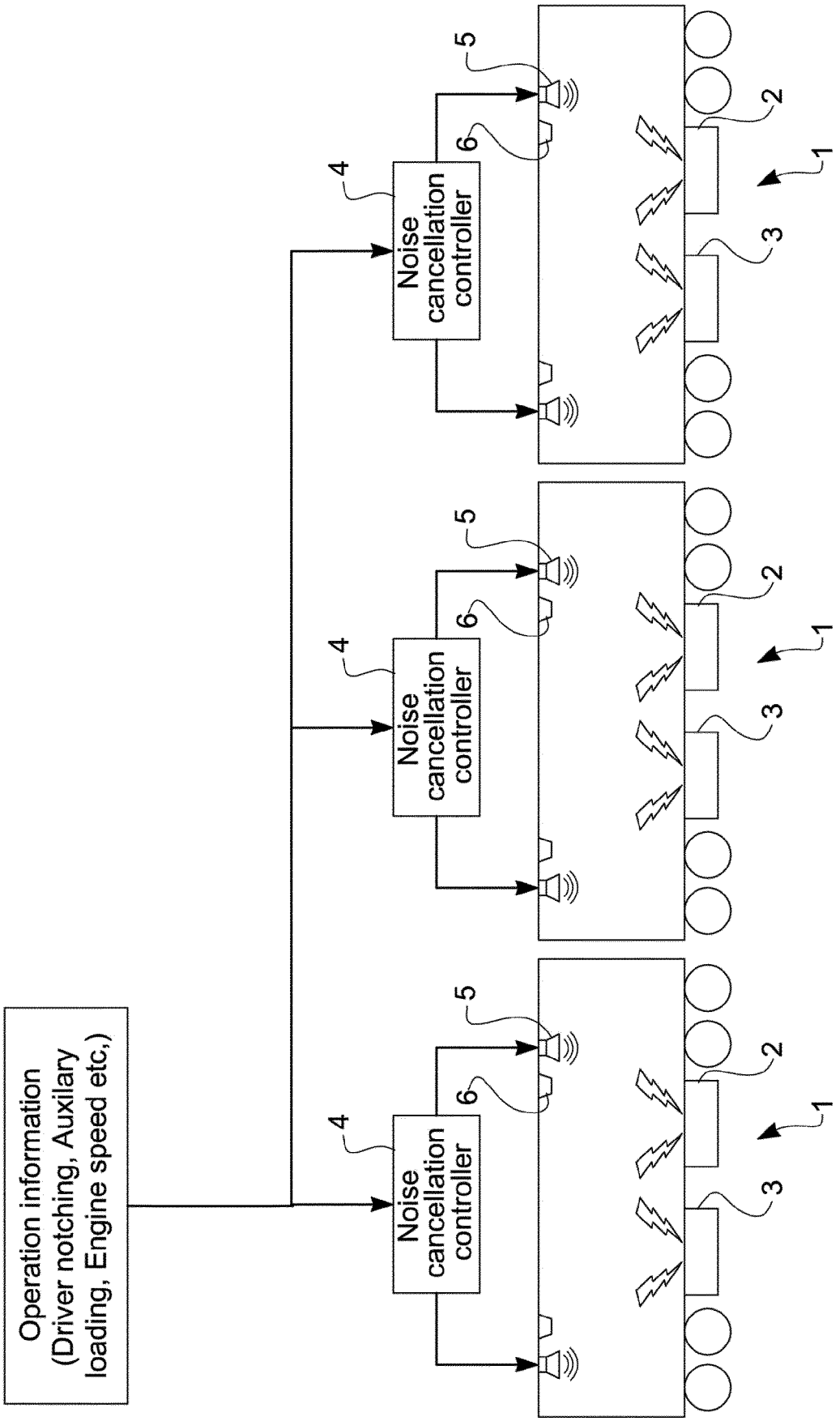
Operation information
(Driver notching, Auxilary loading, Engine speed etc,)
Noise cancellation controller
Noise cancellation controller
Noise cancellation controller
1
2
3
4
5
6

Fig. 1

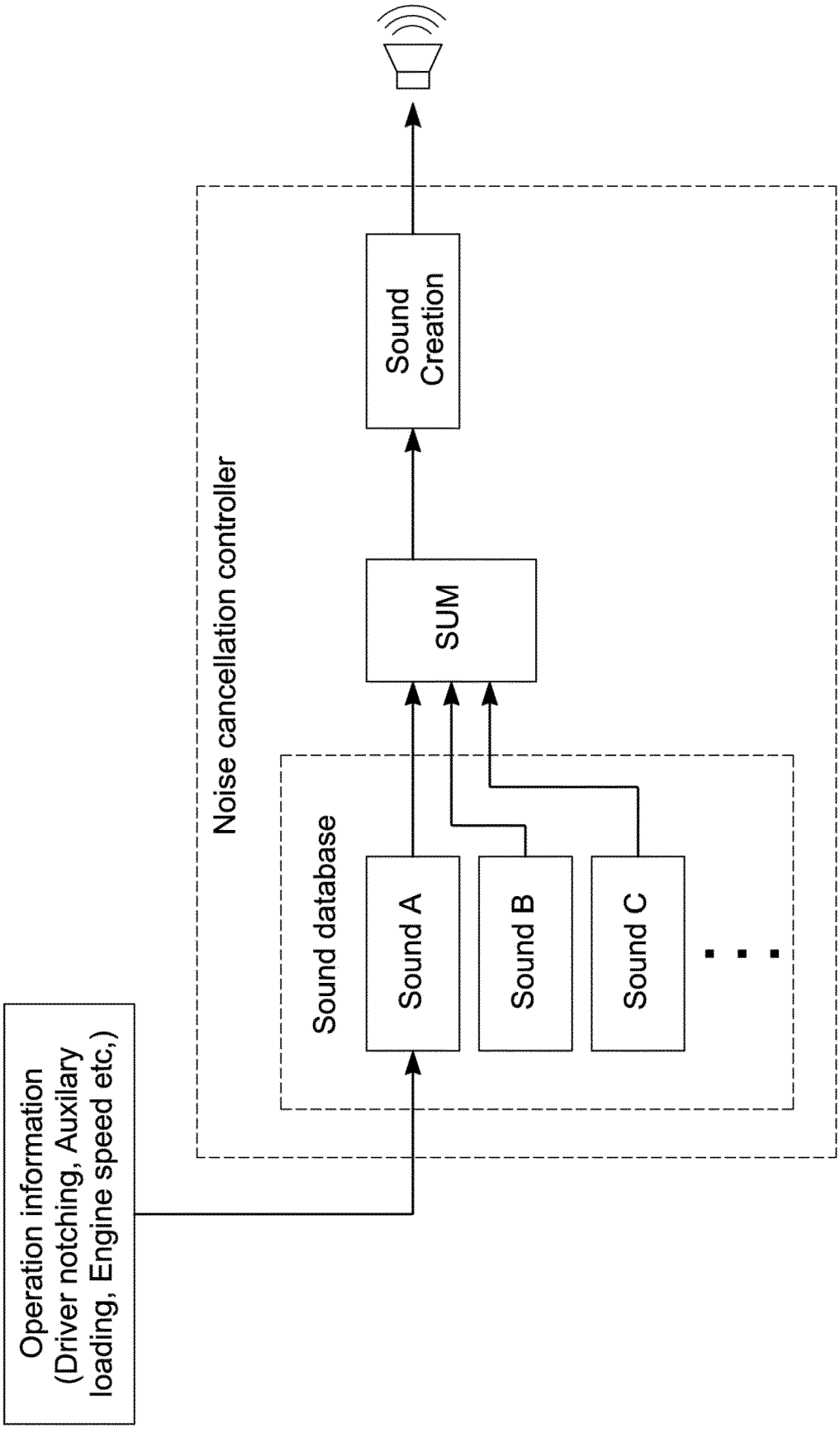
Operation information
(Driver notching, Auxilary
loading, Engine speed etc,)
Noise cancellation controller
Sound database
Sound A
Sound B
Sound C
SUM
Sound
Creation

Fig. 2

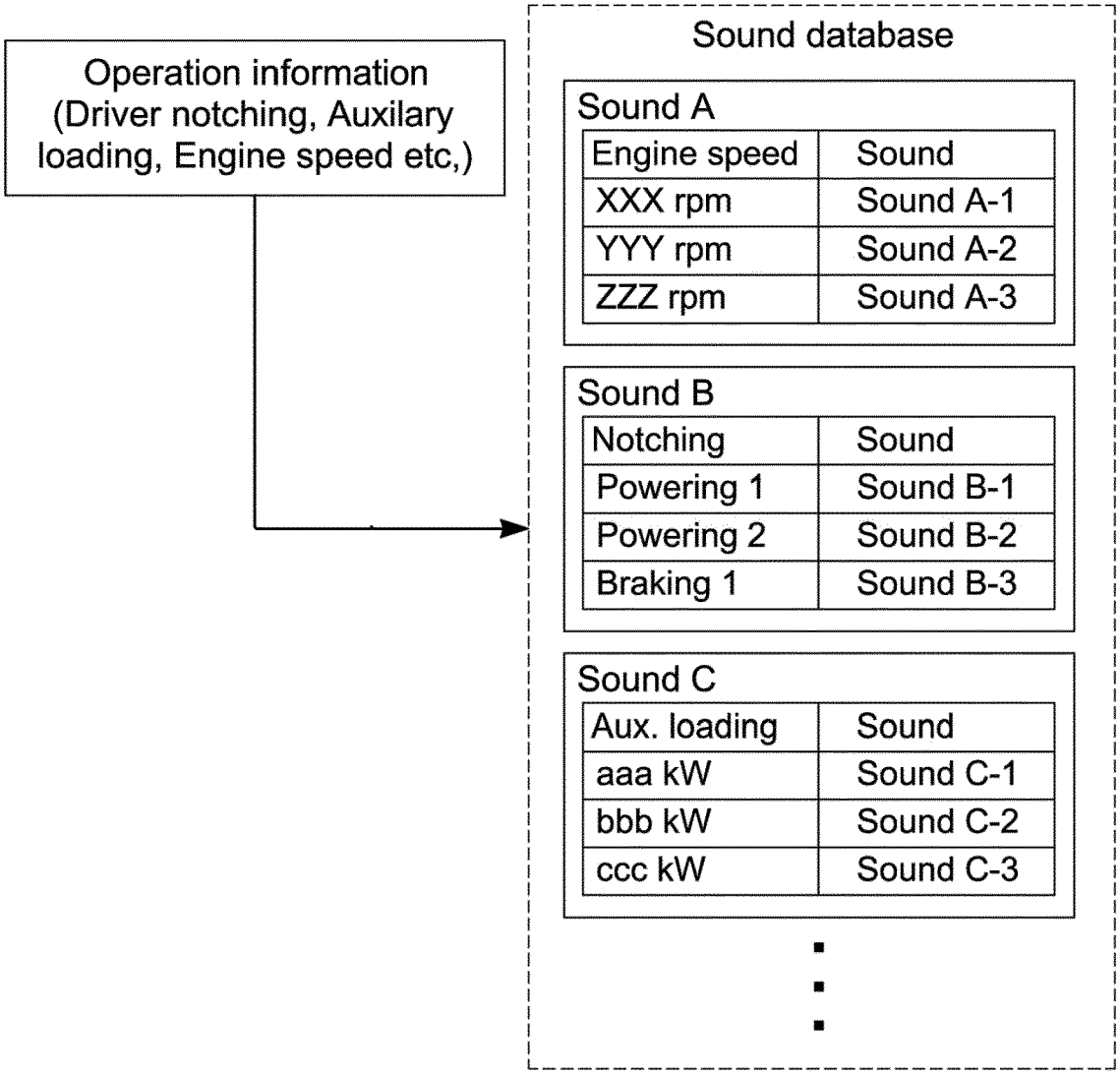
Operation information
(Driver notching, Auxilary loading, Engine speed etc,)
Sound database
Sound A
Engine speed
Sound
XXX rpm
Sound A-1
YYY rpm
Sound A-2
ZZZ rpm
Sound A-3
Sound B
Notching
Sound
Powering 1
Sound B-1
Powering 2
Sound B-2
Braking 1
Sound B-3
Sound C
Aux. loading
Sound
aaa kW
Sound C-1
bbb kW
Sound C-2
ccc kW
Sound C-3

Fig. 3

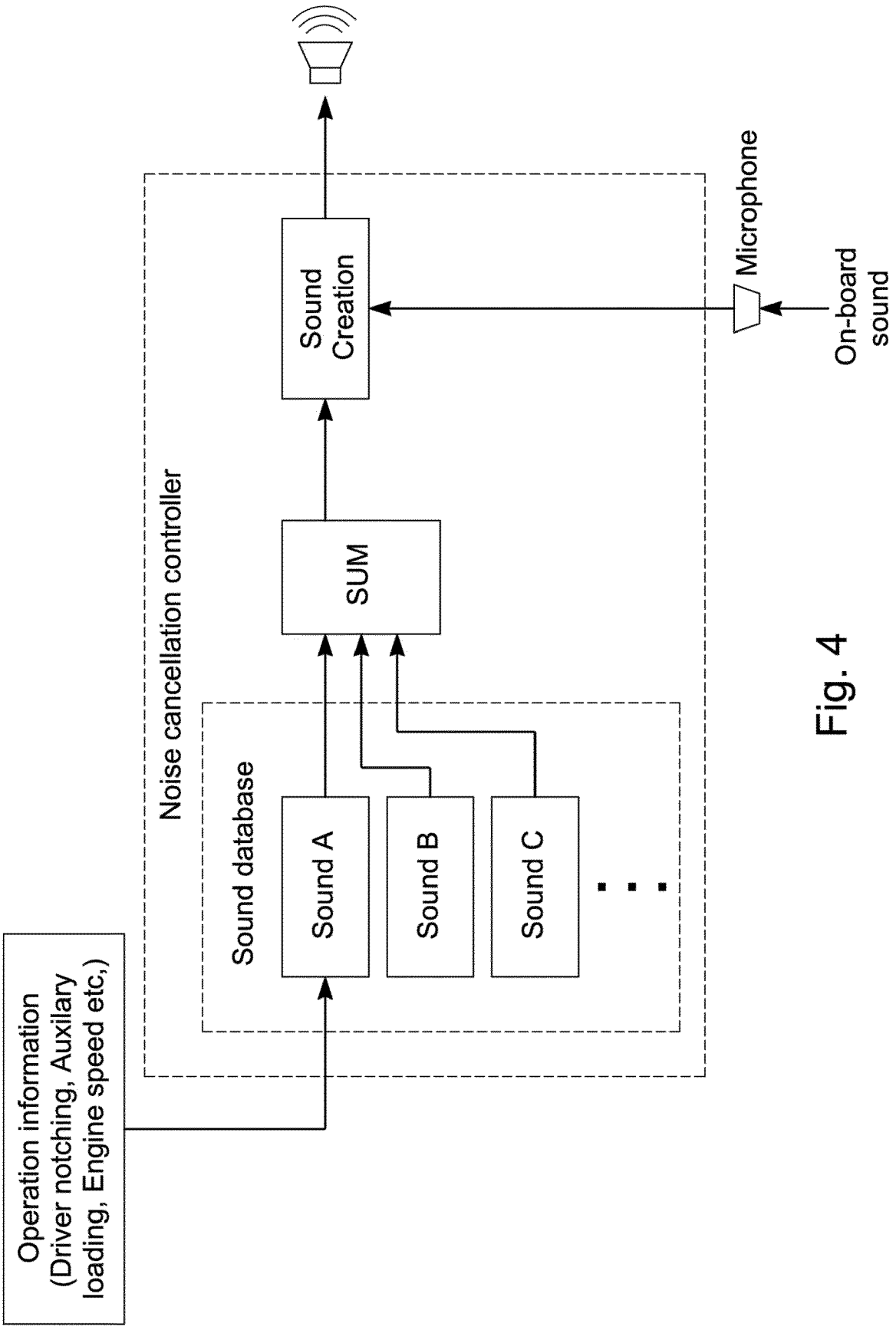
Operation information
(Driver notching, Auxilary loading, Engine speed etc,)
Noise cancellation controller
Sound database
Sound A
Sound B
Sound C
SUM
Sound Creation
Microphone
On-board sound

Fig. 4

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 21 15 9261

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	CN 109 501 821 A (UNIV SOUTHWEST JIAOTONG) 22 March 2019 (2019-03-22) * the whole document *	1,7,13 2-6, 8-12,14, 15	INV. B61D17/18 B61D17/00 G10K11/178
Y	US 10 347 236 B1 (BASTYR KEVIN J [US] ET AL) 9 July 2019 (2019-07-09) * column 3, line 13 - column 9, line 23; figures 1-6 *	2-6, 8-12,14, 15	
A	CN 108 156 555 A (CRRC ZHUZHOU INST CO LTD) 12 June 2018 (2018-06-12) * the whole document *	1-15	
A	US 2013/208906 A1 (ASAO YOSHIFUMI [JP] ET AL) 15 August 2013 (2013-08-15) * paragraph [0026] - paragraph [0104]; figures 1-10B *	1-15	
A	US 10 453 440 B1 (KURZ BRIAN E [US]) 22 October 2019 (2019-10-22) * column 4, line 37 - column 13, line 7; figures 1-3 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) B61D G10K
A	EP 3 188 181 A1 (HARMAN INT IND [US]) 5 July 2017 (2017-07-05) * paragraph [0010] - paragraph [0040]; figures 1-3 *	1-15	
A	US 2019/019494 A1 (WHEELER JOSHUA R [US] ET AL) 17 January 2019 (2019-01-17) * paragraph [0019] - paragraph [0028]; figures 1-8 *	1-15	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 July 2021	Lendfers, Paul

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 15 9261

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

22-07-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 109501821 A	22-03-2019	NONE	
US 10347236 B1	09-07-2019	CN 110211561 A	06-09-2019
		EP 3534361 A1	04-09-2019
		JP 2019151323 A	12-09-2019
		KR 20190103952 A	05-09-2019
		US 10347236 B1	09-07-2019
CN 108156555 A	12-06-2018	NONE	
US 2013208906 A1	15-08-2013	JP 2013178471 A	09-09-2013
		US 2013208906 A1	15-08-2013
US 10453440 B1	22-10-2019	CA 3045823 A1	05-04-2020
		US 10453440 B1	22-10-2019
EP 3188181 A1	05-07-2017	EP 3188181 A1	05-07-2017
		US 2017193975 A1	06-07-2017
US 2019019494 A1	17-01-2019	CN 109243422 A	18-01-2019
		DE 102018116651 A1	17-01-2019
		US 2019019494 A1	17-01-2019

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82