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(54) **METHOD FOR DETERMINING AN ORIENTATION OF A RAIL VEHICLE IN A TRAIN ASSEMBLY**

(57) A method for determining an orientation of a rail vehicle in a train assembly

- the train assembly (10) comprising a plurality of rail vehicles (1, 11, 12),
- wherein said plurality of rail vehicles are linked by a pressurized air line (17),
- wherein at least one of the rail vehicles (1, 11, 12) comprises, at a first position, in longitudinal direction (L), a first sensor (2, 13, 15), for detecting a pneumatic signal in the air line (17), and
- wherein the at least one rail vehicle (1, 11, 12) comprises, at a second position, in longitudinal direction (L), a

second sensor (3, 14, 16), for measuring a pneumatic signal in the air line (17),

the method comprising

- Sending a pneumatic signal through said air line (17),
- Detecting the pneumatic signal at the first sensor (2, 13, 15) and at the second sensor (3, 14, 16),
- Determining a signal-time shift between the pneumatic signal at the first sensor (2, 13, 15) and the pneumatic signal at the second sensor (3, 14, 16),
- Determining the orientation of the rail vehicle (1, 11, 12) from said signal-time shift.

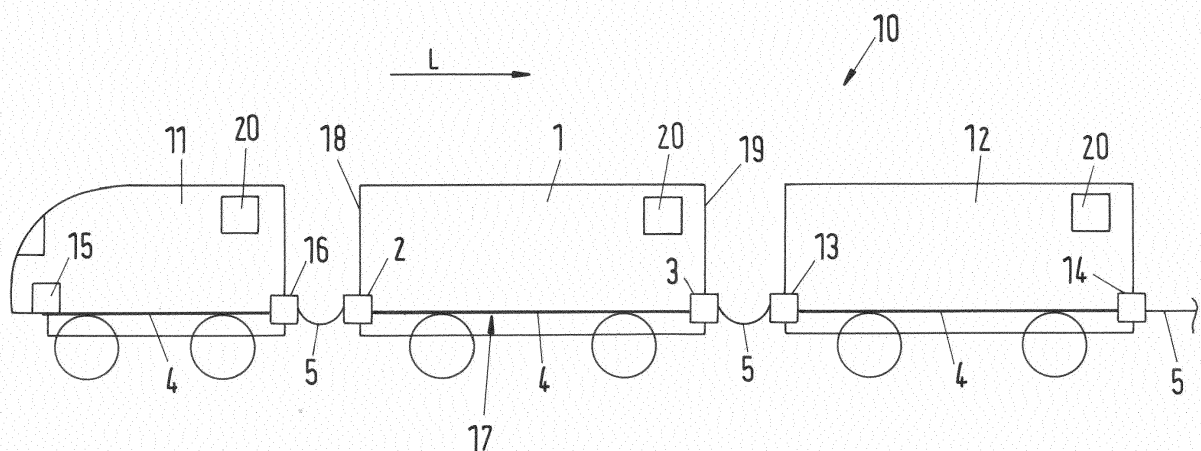


Fig.1

Description

[0001] The present invention relates to a method for determining an orientation of a rail vehicle in a train assembly, which is adapted for such method.

[0002] Orientation detection means the detection of orientation of a rail vehicle on the rail track, i.e. the orientation in longitudinal direction. Particularly, orientation detection is done in order to know how ends of a rail vehicle are oriented in a train assembly, or how ends of a rail vehicle are oriented relatively to another rail vehicle, particularly to an adjacent rail vehicle.

[0003] Nowadays, orientation detection of vehicles in railway applications is done by local communication gateways talking to each other's via cable and using various means for the orientation detection, such as e.g. side selective cabling with different voltages, or relays, which separate the cable and allow the gateways to check on one side and then on the other side if communication to a leading vehicle me by set up.

[0004] Safe detection of the orientation remains difficult and is practically impossible on older systems. Furthermore, automatic orientation detection of locomotives in trains with no electrical connection, e.g. freight trains without UIC cable, is not possible today.

[0005] US 5,986,579 relates to a method and apparatus for determining railcar order in an ECP equipped train involving the inherent propagation delay of a pneumatic signal propagation in a brake air line as measured by each car and used to determine the car order in the train. However, US 5,986,579 does not provide with a method for determining an orientation of a rail vehicle within a train assembly.

[0006] The task of the invention is to provide with a solution for one or more of these problems.

[0007] According to a basic idea of the invention, an existing pressurized air line, which is usually the air line of a brake system, i.e. the main brake pipe, is used as signal line for orientation detection. The air line connects rail vehicles of a train assembly. A rail vehicle of the train assembly, whose orientation is to be detected, is equipped with sensors that are placed at different positions in longitudinal direction. The sensors are adapted for measuring a signal, particularly a pressure wave, that propagates through the air line in longitudinal direction. A time shift between the signal at both sensors can be measured. The direction of signal extension through the air line is known and the orientation of the rail vehicle, or of more rail vehicles that are each equipped with mentioned sensors, can be determined from the time shift, i.e. from the information which one of the sensors detects the signal first and which one detects the signal later.

[0008] The invention provides with a simple concept for orientation detection which is independent from the used communication system, relying solely on the main brake pipe. Furthermore, train integrity can be checked in the same process.

[0009] The invention particularly provides with a meth-

od for determining an orientation of a rail vehicle in a train assembly

- the train assembly comprising a plurality of rail vehicles,
- wherein said plurality of rail vehicles are linked by a pressurized air line,
- wherein at least one of the rail vehicles comprises, at a first position, in longitudinal direction, a first sensor, for detecting a pneumatic signal in the air line, and
- wherein the at least one rail vehicle comprises, at a second position, in longitudinal direction, a second sensor, for measuring a pneumatic signal in the air line,

the method comprising

- Sending a pneumatic signal through said air line,
- Detecting the pneumatic signal at the first sensor and at the second sensor,
- Determining a signal-time shift between the pneumatic signal at the first sensor and the pneumatic signal at the second sensor,
- Determining the orientation of the rail vehicle from said signal-time shift.

[0010] In one embodiment, rail vehicles in the train assembly can independently from each other (i.e. independently from any other rail vehicle in the train assembly) be selected from a rail car or a locomotive.

[0011] A rail vehicle whose orientation is to be determined is preferably a rail car or a locomotive. A rail vehicle comprising mentioned sensors is preferably a rail car or a locomotive. The train assembly may comprise a plurality of rail cars, wherein one or more of these rail cars may comprise a first and a second sensor. The train assembly comprising a plurality of rail cars preferably also comprises at least one locomotive.

[0012] In a very beneficial embodiment, the rail vehicle, whose orientation is determined, is a locomotive. The locomotive may be a locomotive which is located within the train assembly, i.e. between two adjacent rail vehicles, or a locomotive which is located at an end of a train assembly.. It is very important to determine the orientation of a locomotive.

[0013] In a specific embodiment, the locomotive, whose orientation is detected, is not a first or a leading locomotive but a second and/or a further (e.g. third, fourth...) locomotive in a train assembly, which is present in addition to the first locomotive. Then, orientation relatively to the first locomotive can be detected.

[0014] The air line usually comprise first sections which are located within a rail vehicle, and second sections, which are located between adjacent rail vehicles.

[0015] When the pneumatic signal is sent through the air line, the pneumatic signal propagates through the rail vehicles of the train assembly that are connected by the

air line.

[0016] The air line may be a brake pipe. Sending a pneumatic signal through said air line can be done by a brake application, if the air line is a brake pipe.

[0017] The first and second sensor are connected to the air line in such a manner that a signal from the air line, particularly a pressure or flow, can be measured.

[0018] In one embodiment, the first sensor and the second sensor are a pressure sensor. A pressure sensor is adapted to determine a pressure or pressure change, as a pneumatic signal.

[0019] The distance between the first and second sensor, in longitudinal direction, may be selected in a manner suitable for accurately detecting a time shift. It may be beneficial to choose the distance between the first and the second sensor as far as possible. The first position of the first sensor may be at, near to, or adjacent to a first end of the rail vehicle. The second position of the second sensor may be at, near to, or adjacent to a second end of the rail vehicle.

[0020] In one embodiment, the pneumatic signal is sent from a leading locomotive, which is placed at a first end of the train assembly. The leading locomotive is to be distinguished from another locomotive, whose orientation is to be determined according to the method of the invention. Said another locomotive may be located at a second end of the train assembly or within the train assembly.

[0021] In one embodiment, the pneumatic signal comprises a specific pressure pattern. Such pattern may be a pattern of pressure drops that occur at specific times and/or for a specific time period. Such pattern may be used for different purposes.

[0022] In one specific embodiment the pressure pattern is used as a command that the orientation of the rail vehicle shall be determined. Information about the pattern can also be sent via another information means, like cable or radio. This would allow the communication partner to clearly identify the command for direction detection.

[0023] In another specific embodiment the pressure pattern is used as identification signal for the train assembly. Information about the pattern can also be sent via another information means, like cable or radio. This would allow control whether different elements are on in the same train. Latter is for example mandatory for multiple locomotive operation on trains with radio remote control.

[0024] In another aspect, the invention provides with a train assembly, comprising

- a plurality of rail vehicles,
- wherein said plurality of rail vehicles are linked by a pressurized air line,
- wherein at least one of the rail vehicles comprises, at a first position, in longitudinal direction, a first sensor, for detecting a pneumatic signal in the air line, and

- wherein the at least one rail vehicle comprises, at a second position, in longitudinal direction, a second sensor, for measuring a pneumatic signal in the air line.

[0025] This train assembly may comprise any features described in connection with the method of the invention, singly or in combination. The train assembly may also be adapted to perform any of the method steps described in connection with the method of the invention, singly or in combination.

[0026] In a specific embodiment, the train assembly comprises a control unit, which is adapted for performing one or more of the following steps, in each possible combination:

- detecting a pneumatic signal from the first sensor and from the second sensor,
- determining a signal-time shift between the pneumatic signal at the first sensor and the pneumatic signal at the second sensor,
- determining an orientation of the rail vehicle from said signal-time shift.

[0027] The control unit can be used in a method of the invention. Each of a rail vehicle in the train assembly may comprise such control unit.

[0028] The control unit can be adapted for performing following step, preferably in addition to one or more of above mentioned steps:

- sending a pneumatic signal through the air line.

[0029] This step can preferably be performed by a control unit which is located in a leading vehicle in the train assembly, for example a leading locomotive. The leading vehicle may be the first vehicle in the assembly.

[0030] Sending a pneumatic signal through the air line can, as an alternative, be performed by a brake control unit, which may be different from above-mentioned control unit.

[0031] Hereinafter, the invention is illustrated by working examples.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0032]

Fig. 1 a train assembly

Fig. 2 a depression from a brake application in the brake pipe

Fig. 3a-c details of Fig. 2

[0033] Fig. 1 shows a train assembly 10, comprising rail vehicles, e.g. rail cars 1, 12 and locomotive 11, which is a leading locomotive. Rail vehicle 1 comprises at a first

end a first pressure sensor 2 and at a second end a second pressure sensor 3. Rail car 12 comprises a first pressure sensor 13 and a second pressure sensor 14. The locomotive 11 comprises a first pressure sensor 15 and a second pressure sensor 16. The order of vehicles can be changed. Each rail car shown in Fig. 1 can be a locomotive or vice versa.

[0034] Mentioned pressure sensors are in contact with the pressurized air line 17, which is the brake pipe of the train. Sections 4 of the brake pipe 17 are sections within vehicles, i.e. within rail cars 1, 12 and locomotive 11. Sections 5 of the brake pipe are sections between rail vehicles

[0035] The longitudinal direction L is indicated by arrow.

[0036] A method for orientation detection can be performed as follows:

[0037] Leading locomotive 11 applies a pneumatic signal on the brake pipe 17. A pressure wave (pressure drop) extends from the locomotive 11 in longitudinal direction L.

[0038] Rail cars 1, 12 in the train assembly 10 can detect this pattern. Pressure sensors 2 and 3, placed distantly from each other, here at both ends 18, 19 of the rail car 1, detect the pattern with a time difference. Pressure sensor 2 detects the pressure drop earlier than pressure sensor 3. Signals from the pressure sensors 2 and 3 are sent to the control unit 20 which detects the time difference (connections between sensors and control unit not shown). Each rail vehicle has its own control unit. This leads to the knowledge of the direction of the pressure wave relatively to the rail car 1. It is known that the pneumatic signal was sent from the locomotive, i.e. from the head of the train assembly 10. So, it is known that end 18 of rail car 1 is oriented towards the locomotive, i.e. in driving direction, and that end 19 of rail car 1 is oriented in opposite direction. If rail car 1 was be turned, within the assembly, pressure sensor 19 would detect the signal before pressure sensor 18, and it would be known that end 19 of rail car 10 is oriented towards the locomotive, i.e. in driving direction.

[0039] The same method can be performed with regard to rail car 12, and pressure sensors 13, 14, which are also connected to the central control unit 20.

[0040] Pressure sensors 15 and 16 of the locomotive are not used in this example. But they can be used in the same manner as pressure sensors 2, 3, 13, 14 when the locomotive 11 is not a leading locomotive but a second locomotive within a train assembly. Then, orientation relatively to a leading locomotive can be detected.

[0041] Fig. 2 shows a depression (from a brake application) in a brake pipe of a 750m long train with 37 wagons of 20m length each. The delay between the head of train (left curve, P2) and the end of train (right curve, P4) is clearly visible. As well is visible the delay between one end and the other end of a wagon in the middle of the train, shown by the curves P1 and P3 between the curves P2 and P4.

[0042] The graphs in Fig. 3a-3c show various details in the middle of the train. Fig. 3a shows the overall picture, in Fig. 3b and 3c a zoom has been applied to the first pressure drop scene. Fig. 3a-3c show the pressure at the beginning and at the end of the wagon measured by two sensors at 20m distance.

[0043] The graphs clearly show that by simply applying a service brake enough information can be sensed and processed necessary to detect the flow direction of the depression wave. A depression of 0.1 bar between 4.8 bar and 5 bar can be well measured at both ends of the wagon with 200ms difference. The steep slope at the beginning of the brake application is easily detectable and can be used for the data acquisition. The process is enough slow and uncritical for state of the art sensor technology.

List of reference numerals

[0044]

1	rail car
2	first sensor
3	second sensor
4	sections of the pressurized air line
5	sections of the pressurized air line
10	train assembly
11	locomotive
12	rail car
13	first sensor
14	second sensor
15	first sensor
16	second sensor
17	pressurized air line
18	first end
19	second end
20	leading locomotive

Claims

1. A method for determining an orientation of a rail vehicle in a train assembly

- the train assembly (10) comprising a plurality of rail vehicles (1, 11, 12),
- wherein said plurality of rail vehicles are linked by a pressurized air line (17),
- wherein at least one of the rail vehicles (1, 11, 12) comprises, at a first position, in longitudinal direction (L), a first sensor (2, 13, 15), for detecting a pneumatic signal in the air line (17), and
- wherein the at least one rail vehicle (1, 11, 12) comprises, at a second position, in longitudinal direction (L), a second sensor (3, 14, 16), for measuring a pneumatic signal in the air line (17),

the method comprising

- Sending a pneumatic signal through said air line (17),
 - Detecting the pneumatic signal at the first sensor (2, 13, 15) and at the second sensor (3, 14, 16),
 - Determining a signal-time shift between the pneumatic signal at the first sensor (2, 13, 15) and the pneumatic signal at the second sensor (3, 14, 16),
 - Determining the orientation of the rail vehicle (1, 11, 12) from said signal-time shift.
2. The method of claim 1, wherein the first sensor (2, 13, 15) and the second sensor (3, 14, 16) are selected from a pressure sensor or a flow sensor, wherein the pneumatic signal is a pressure or pressure change, or wherein the pneumatic signal a flow or flow change.
3. The method of one of the preceding claims, wherein the first position is at or near to a first end (18) of the rail vehicle (1).
4. The method of one of the preceding claims, wherein the second position is at or near to a second end (19) of the rail vehicle (1).
5. The method of one of the preceding claims, wherein the pneumatic signal is sent from a leading locomotive (11), which is placed at an end of the train assembly.
6. The method of one of the preceding claims, wherein the pneumatic signal comprises a specific pressure pattern.
7. The method of one of the preceding claims, wherein the specific pressure pattern is used as a command that the orientation of the rail car (1, 12) or the locomotive (11) shall be determined.
8. The method of one of the preceding claims, wherein the specific pressure pattern is used as identification signal for the train assembly (10).
9. The method of one of the preceding claims, wherein the rail vehicle is a rail car or a locomotive.
10. A train assembly, comprising
- a plurality of rail vehicles (1, 11, 12),
 - wherein said plurality of rail vehicles (1, 11, 12) are linked by a pressurized air line (17),
 - wherein at least one of the rail vehicles (1, 11, 12) comprises, at a first position, in longitudinal direction (L), a first sensor (2, 13, 15), for detecting a pneumatic signal in the air line (17), and
 - wherein the at least one rail vehicle (1, 11, 12) comprises, at a second position, in longitudinal direction (L), a second sensor (3, 14, 16), for measuring a pneumatic signal in the air line (17).
11. The train assembly of claim 10, comprising a control unit (20), which is adapted for one or more of the following steps:
- detecting a pneumatic signal from the first sensor (2, 13, 15) and from the second sensor (3, 14, 16),
 - Determining a signal-time shift between the pneumatic signal at the first sensor (2, 13, 15) and the pneumatic signal at the second sensor (3, 14, 16),
 - Determining an orientation of the rail vehicle (1, 11, 12) from said signal-time shift.
12. The method of one of claims 10 or 11, wherein the rail vehicles are independently from each other selected from a rail car or a locomotive.

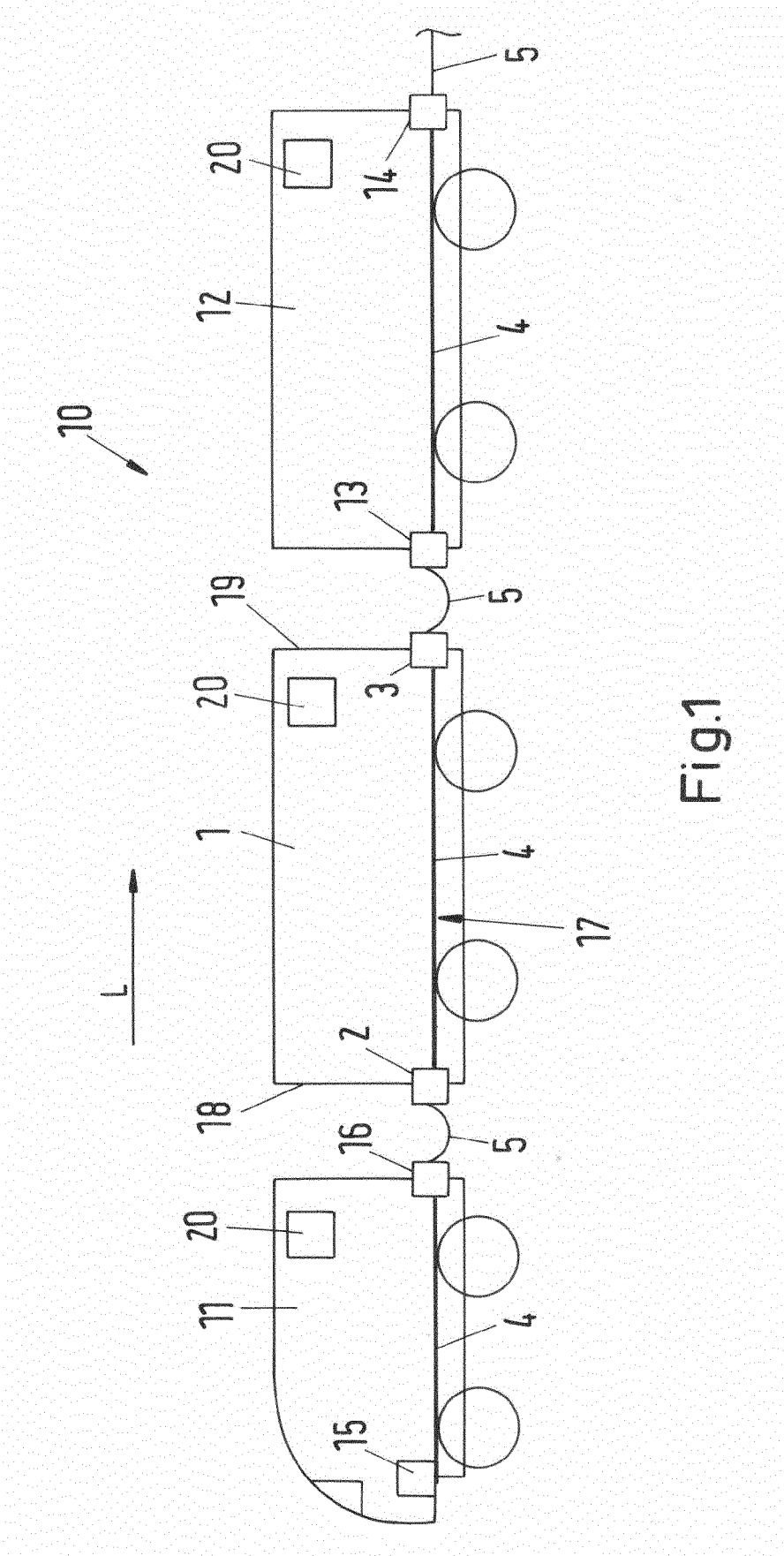


Fig.1

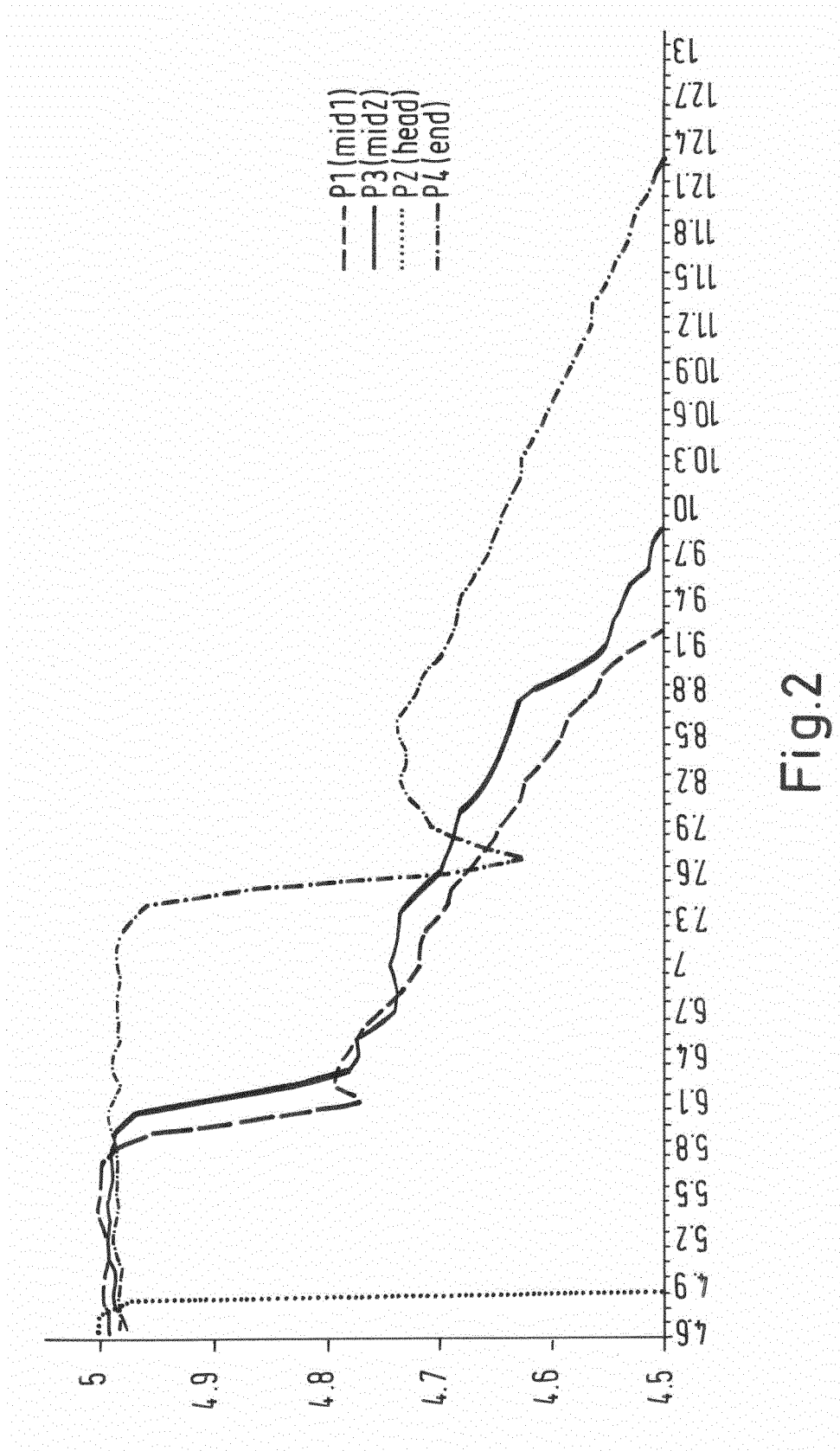
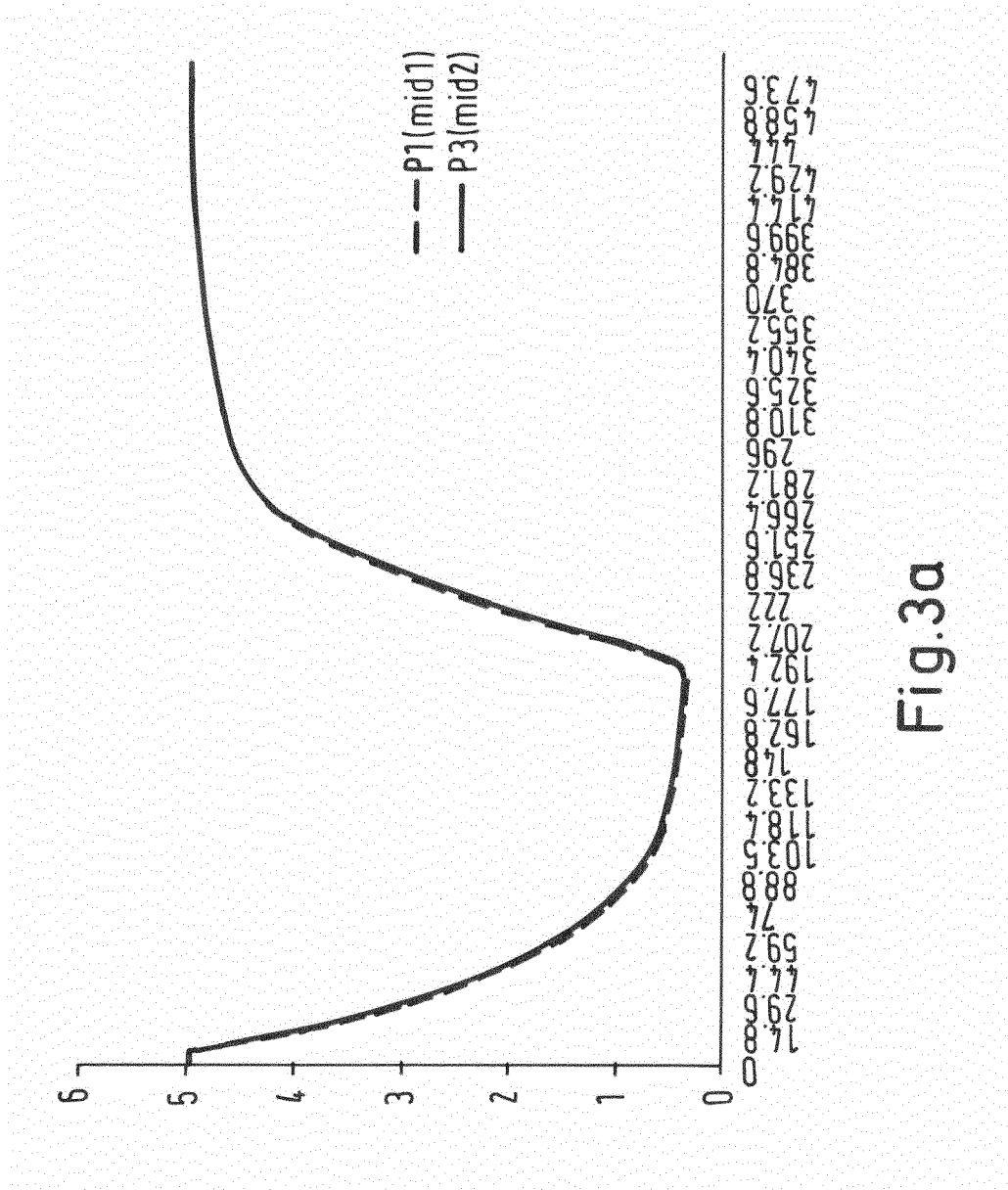


Fig.2



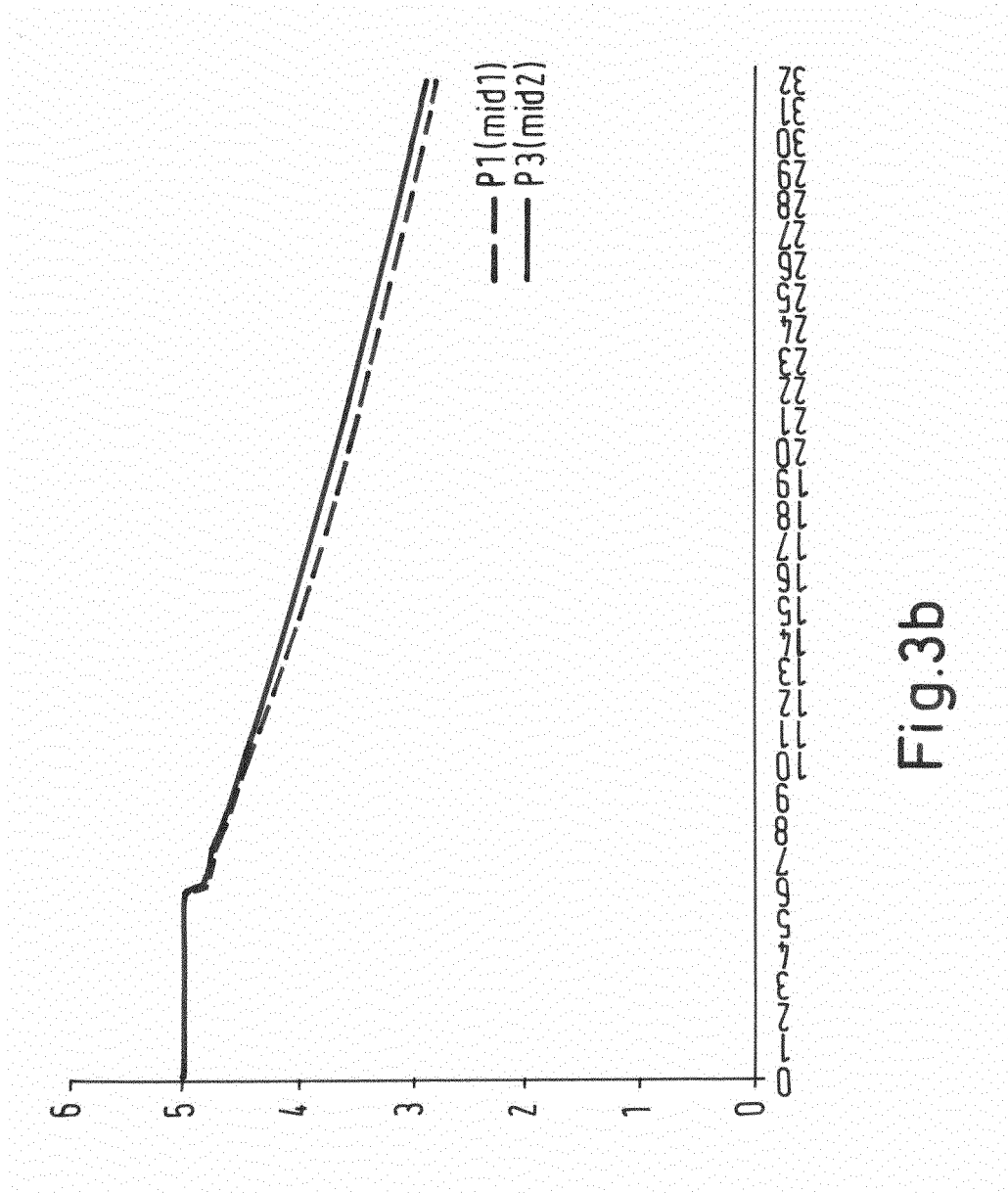


Fig.3b

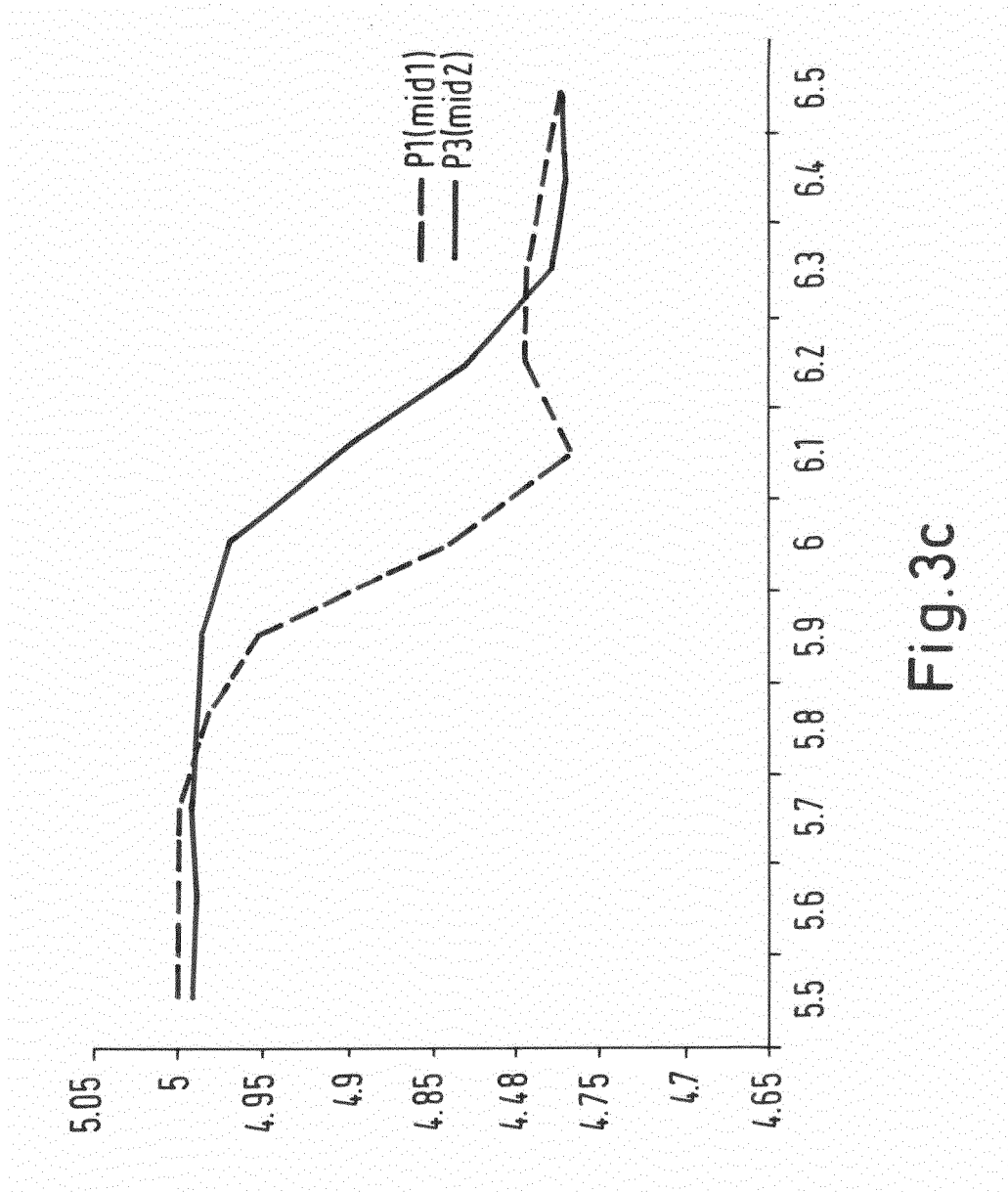


Fig.3c



EUROPEAN SEARCH REPORT

Application Number
EP 16 17 9751

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DOCUMENTS CONSIDERED TO BE RELEVANT			
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			TECHNICAL FIELDS SEARCHED (IPC)
			B61L
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 3 January 2017	Examiner Mäki-Mantila, M
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	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 16 17 9751

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