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METHOD OF CONTROLLING INTERLINKED VEHICLES IN MINING AND TUNNELLING AS WELL AS ARRANGEMENT FOR CARRYING OUT THIS METHOD

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(56) Prior Art Documents
US 4465155
US 4413210
DE 4219098

(57) Claim

1. A method of controlling the direction of a plurality of interlinked vehicles moving as a single unit in a path defined between spaced wall surfaces, each of said vehicles having a controllable travelling mechanism, said method including: carrying out measurements of distance laterally to adjacent wall surfaces from each side of said plurality of interlinked vehicles from positions on said vehicles offset in the direction of movement of said vehicles using transmitting and receiving means so as to obtain measured distance values; providing a threshold value for said measured distance values; periodically interrogating and averaging out said measured distance values obtained while said transmitting and receiving means are positioned between spaced wall surfaces; filtering out measured distance values obtained while said transmitting and receiving means are positioned between spaced wall surfaces, which deviate from the preceding one of said measured distance values by a value exceeding said threshold value; and using the remaining unfiltered measured distance values and a preset value representative of the direction of movement of at least a first one of said plurality of vehicles in the direction of movement

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for operating the travelling mechanisms of each of said vehicles to align said direction of movement of said vehicles in said path.

3. An arrangement for controlling the direction of a plurality of interlinked vehicles moving as a single unit in a path defined between spaced wall surfaces supported by struts, each of said vehicles having a controllable travelling mechanism, said arrangement including: at least two ultrasonic sensors mounted in interspaced relationships relative to each other in the longitudinal direction of said vehicles on each side of said plurality of vehicles for carrying out measurements of distances laterally to adjacent wall surfaces from each side of said vehicles, the spacing between said interspaced sensors being unequal to the separation between adjacent struts which support said wall surfaces; and signalling lines for connecting said sensors to an evaluation and control circuit, said circuit including a filter for filtering out measured distance values, obtained while said sensors are positioned adjacent to said wall surfaces, which deviate from the preceding one of said measurements by a predetermined threshold value, the direction of movement of at least a first one of said plurality of vehicles being input to said circuit as a pre-set value, said circuit producing an output used for controlling the operation of the travelling mechanisms of each of said vehicles.

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COMPLETE SPECIFICATION

FOR A STANDARD PATENT

ORIGINAL

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Invention Title: "Method of controlling interlinked vehicles in mining and tunnelling as well as arrangement for carrying out this method"

The following statement is a full description of this invention, including the best method of performing it known to me:-

in a particularly simple manner in that on opposite sides of each vehicle at least two ultrasonic sensors, arranged to be offset in the direction of movement, are employed for the determinations of distance. If two ultrasonic sensors are provided on each side of each vehicle and they are offset in the direction of movement, obstacles, miners passing by or lateral excavations in the tunnel may readily be averaged out while nevertheless obtaining an altogether useful control signal, excessive deviations each being averaged and filtered out. Advantageously, the method is carried out in that the measured values are periodically interrogated and averaged out while filtering out measured values whose deviation from the preceding measured value exceeds a threshold value. In this manner, measuring errors that might be caused by persons or objects in the measuring path are extracted, it being not at all necessary for each sensor to continuously make available a valid measuring signal. The use of ultrasonic sensors, in particular, offers the advantage that the signals are largely reproducible even at a high dust load, yielding a high degree of accuracy for direction control.

Naturally, inaccuracies in the progression of lateral faces and excavations accordingly bring about inaccuracies in direction control. However, such an error is statistical, being largely averaged out from one vehicle to another if the sensors on the vehicles have appropriate interspaces in the longitudinal direction. Advantageously, the arrangement according to the invention for carrying out the method, therefore, is devised in a manner such that at least two ultrasonic sensors are arranged on each side of the vehicles, and they are interspaced in the longitudinal direction of the vehicle so as to be unequal to the excavation depth of an excavation tool or a multiple thereof. By choosing the interspacing in such a way that the accumulation of errors can be prevented, the advantage of statistical averaging out again is achieved.

The measuring signals can be processed in an intelligent manner, an increase in the accuracy of the navigation system being readily feasible by determining deviations of the lateral face progression during the advance of the vehicles or calibrating constant errors in a calibration procedure relative to a laser. Advantageously, the arrangement is configured such that couplings for the signalling lines of the sensors of neighbouring vehicles are provided, the signalling lines of a plurality of vehicles being fed to an evaluation and control circuit. By such interlinking it is possible to measure the progression of the wall line during movement and to preset a mean value. It is possible to estimate distances to tunnel timbering and walling arcs during movement, and errors relating to timbering and walling features can readily be eliminated upon knowledge of such fault sources. Finally, there is the opportunity of recorrecting the mean error after adjustment procedures relative to a laser.

In a chain of automotive transport vehicles, such as is used, e.g., in a haulage installation, navigation over a given distance may be effected via measurement of the distance to the side wall of the path through which the vehicles move, i.e., to the lateral face or lateral wall, the direction being preset by the first and last vehicles and the individual intermediate vehicles being moved in a predetermined path by measurement of the distance to the side wall via a memorizing and adaptive system. Advantageously, the configuration is devised such that with a plurality of interlinked vehicles having self-contained motor drives, especially in haulage installations, the direction of the first and last vehicles is input to the control as a preset value for the orientation of the individual intermediate vehicles, wherein, in a particularly simple manner, the control includes a logic circuit for filtering out discretely changing measured distance values. Such filtering out permits the simple elimination of sensors that do not furnish suitable signals, which may be the case, for instance, with

coverings or excavations or crosscuts in the path, the control getting its information from the closest-neighbouring sensor emitting a valid signal. In order to ensure the appropriate adjustment of movement and thus the necessary corrections in navigation, the arrangement advantageously is devised such that
5 individual vehicles each include a control mechanism for providing lateral corrections the direction of movement.

Measurement of the distance to the side wall or lateral wall may be effected in an optical, electromagnetic, or acoustic manner but preferably by ultrasonic sensors. Advantageously, the control circuit includes an autoadaptive
10 learning microcomputer thereby rendering feasible the disconnection of individual elements of the vehicle chain and their displacement to another region. In that case, the first transport element must be controlled wherein the subsequent elements again are able to follow the same moving line. On the whole, an adaptive system provides for the precise orientation of the position
15 and direction of an advance working machine as well as the simple control of interlinked vehicles by the evaluation of sensor signals in a microprocessor. A direct connection to navigation and direction controlling means within the path is not required, since the orientation can directly be derived from the progression
of movement.

In accordance with one aspect of the present invention, therefore, there is provided a method of controlling the direction of a plurality of interlinked
20 vehicles moving as a single unit in a path defined between spaced wall surfaces, each of said vehicles having a controllable travelling mechanism, said method including: carrying out measurements of distance laterally to adjacent wall
surfaces from each side of said plurality of interlinked vehicles from positions on
25 said vehicles offset in the direction of movement of said vehicles using transmitting and receiving means so as to obtain measured distance values;

providing a threshold value for said measured distance values; periodically interrogating and averaging out said measured distance values obtained while said transmitting and receiving means are positioned between spaced wall surfaces; filtering out measured distance values obtained while said transmitting and receiving means are positioned between spaced wall surfaces, which deviate from the preceding one of said measured distance values by a value exceeding said threshold value; and using the remaining unfiltered measured distance values and a preset value representative of the direction of movement of at least a first one of said plurality of vehicles in the direction of movement for operating the travelling mechanisms of each of said vehicles to align said direction of movement of said vehicles in said path.

In accordance with a further aspect of the present invention there is provided an arrangement for controlling the direction of a plurality of interlinked vehicles moving as a single unit in a path defined between spaced wall surfaces supported by struts, each of said vehicles having a controllable travelling mechanism, said arrangement including: at least two ultrasonic sensors mounted in interspaced relationships relative to each other in the longitudinal direction of said vehicles on each side of said plurality of vehicles for carrying out measurements of distances laterally to adjacent wall surfaces from each side of said vehicles, the spacing between said interspaced sensors being unequal to the separation between adjacent struts which support said wall surfaces; and signalling lines for connecting said sensors to an evaluation and control circuit, said circuit including a filter for filtering out measured distance values, obtained while said sensors are positioned adjacent to said wall surfaces, which deviate from the preceding one of said measurements by a predetermined threshold value, the direction of movement of at least a first one of said plurality of vehicles being input to said circuit as a pre-set value, said circuit producing an

output used for controlling the operation of the travelling mechanisms of each of said vehicles.

In order that the invention may be more clearly understood and put into practical effect there shall now be described in detail a preferred embodiment of an arrangement and method in accordance with the invention. The ensuing description is given by way of non-limitative example only and is with reference to the accompanying drawings, wherein:

FIG. 1 is a top view of a vehicle having a self-contained motor drive and on which a conveying belt is supported, and

FIG. 2 is a top view of an interlinked conveying means including a plurality of vehicles each having its own travelling mechanism.

FIG. 1 depicts a vehicle 1 including a travelling mechanism formed by crawlers 2. A loading chute 3 is provided, onto which the material to be conveyed off may be charged.

In the track a conventional navigation aid in the form of a laser beam 4 is schematically indicated. In the side wall regions, the track is secured by timbering and walling strut elements 5.

On the machine frame 6 of the vehicle 1 there rests a conveying belt or a chain conveyor 7 whose drive is schematically indicated by 8.

On the machine frame 6 a plurality of sensors 9 are visible, three such sensors 9 each being arranged on each side of the cutting machine. The sensors 9 are devised as ultrasonic transmitters and receivers, measuring the respective distance a to the adjacent lateral wall or lateral face of a tunnel. From a plurality of such values measured during the advance movement of vehicle 1, a calculated command variable for the moving course and the advance direction results such that a constant comparison to the laser beam 4 may be omitted. By the fact that the distance b between neighbouring sensors is chosen to be

unequal to the distance of struts 5 intended to secure the lateral walls and is unequal to the excavation depth of a cutting tool (not illustrated), deviations in distance measurements as they are caused by such obstacles or by the progression of the rock in the lateral face region are averaged out thereby
5 determining a sufficiently accurate mean moving direction in relation to a given moving direction.

On the rear end of the vehicle a coupling 10 is provided. Using couplings 10, a plurality of vehicles, as illustrated in FIG. 2, are interlinked, the illustration of FIG. 2 showing a plurality of interlinked vehicles 11 within a path 12. The
10 path 12 is not straight, and it has transverse excavations 13 as well as irregular excavations 14. Each vehicle 11 on opposite sides thereof has at least two sensors 9 thereby rendering feasible the precise tracing of the respectively used path by interlinking the respective signals and the automatic sequence control of consecutive vehicles as far as to the last vehicle 15 within the chain.

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The claims defining the invention are as follows:-

1. A method of controlling the direction of a plurality of interlinked vehicles moving as a single unit in a path defined between spaced wall surfaces, each of said vehicles having a controllable travelling mechanism, said method including: carrying out measurements of distance laterally to adjacent wall surfaces from each side of said plurality of interlinked vehicles from positions on said vehicles offset in the direction of movement of said vehicles using transmitting and receiving means so as to obtain measured distance values; providing a threshold value for said measured distance values; periodically interrogating and averaging out said measured distance values obtained while said transmitting and receiving means are positioned between spaced wall surfaces; filtering out measured distance values obtained while said transmitting and receiving means are positioned between spaced wall surfaces, which deviate from the preceding one of said measured distance values by a value exceeding said threshold value; and using the remaining unfiltered measured distance values and a preset value representative of the direction of movement of at least a first one of said plurality of vehicles in the direction of movement for operating the travelling mechanisms of each of said vehicles to align said direction of movement of said vehicles in said path.

2. The method as claimed in Claim 1, wherein said transmitting and receiving means includes at least two ultrasonic sensors arranged on each side of said vehicles, said sensors being offset in said direction of movement.

3. An arrangement for controlling the direction of a plurality of interlinked vehicles moving as a single unit in a path defined between spaced wall surfaces supported by struts, each of said vehicles having a controllable travelling mechanism, said arrangement including: at least two ultrasonic sensors mounted in interspaced relationships relative to each other in the longitudinal direction of said vehicles on each side of said plurality of vehicles

for carrying out measurements of distances laterally to adjacent wall surfaces from each side of said vehicles, the spacing between said interspaced sensors being unequal to the separation between adjacent struts which support said wall surfaces; and signalling lines for connecting said sensors to an evaluation and control circuit, said circuit including a filter for filtering out measured distance values, obtained while said sensors are positioned adjacent to said wall surfaces, which deviate from the preceding one of said measurements by a predetermined threshold value, the direction of movement of at least a first one of said plurality of vehicles being input to said circuit as a pre-set value, said circuit producing an output used for controlling the operation of the travelling mechanisms of each of said vehicles.

4. The arrangement as claimed in Claim 3, further including signalling lines for connecting said sensors to an evaluation and control circuit containing said filter.

5. The arrangement as claimed in Claim 3 or Claim 4, wherein each of said plurality of interlinked vehicles has a travelling mechanism, and the moving direction of the first and the last of said plurality of vehicles is input to said circuit as a preset value to be used for controlling the alignment of each intermediate one of said plurality of vehicles.

6. The arrangement as claimed in Claim 4 or Claim 5, wherein said evaluation and control circuit includes a logic circuit adapted to filter out discretely changing measured distance values.

7. The arrangement as claimed in Claim 4 or Claim 5, wherein said evaluation and control circuit includes an autoadaptive learning microcomputer.

8. A method of controlling the direction of a plurality of interlinked vehicles, as claimed in Claim 1, substantially as described herein with reference to the accompanying drawings.

9. An arrangement for controlling the direction of a plurality of interlinked vehicles, as claimed in Claim 3, substantially as described herein with reference to the accompanying drawings.

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DATED this 9th day of November, 1998.

VOEST-ALPINE Bergtechnik Gesellschaft m.b.H.

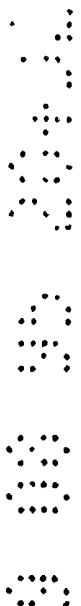
By their Patent Attorneys:

CALLINAN LAWRIE



ABSTRACT OF THE DISCLOSURE:

A method of controlling interlinked vehicles in mining and tunnelling with at least one of the vehicles having a travelling mechanism consists in that distance measurements to the lateral face are taken on either sides of the vehicles and per vehicle and side at least two ultrasonic sensors arranged to be offset in the direction of movement are used for the determination of the distance. Signalling lines of the sensors are fed to an evaluation and control circuit via vehicle couplings. The control circuit is formed by an autoadaptive learning microcomputer.



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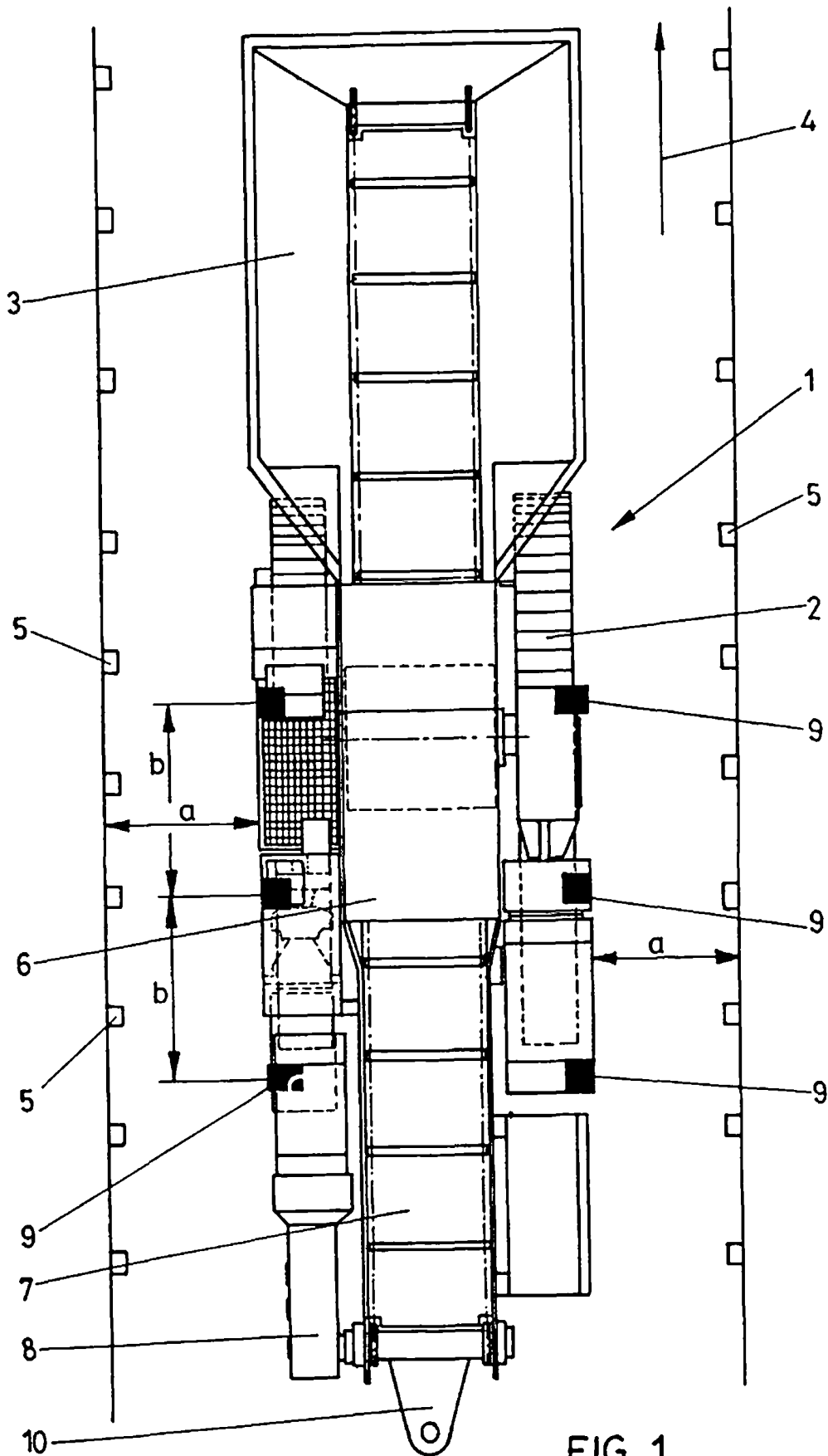


FIG. 1

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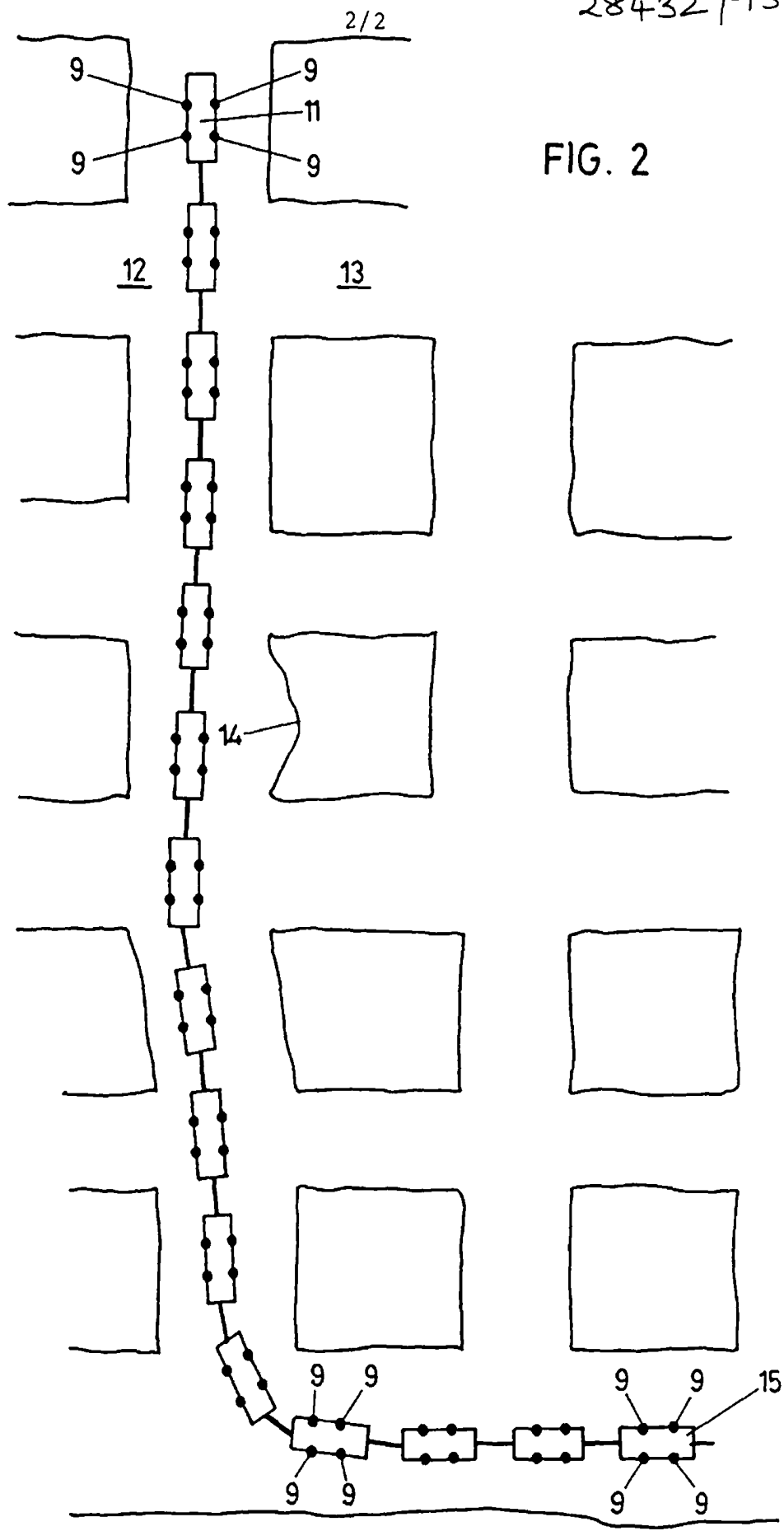


FIG. 2

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