(12) PATENT
(19) AUSTRALIAN PATENT OFFICE

(11) Application No. AU 199656047 B2
(10) Patent No. 704603

(54) Title

Wheeled vehicle, specifically a swimming-pool cleaning robot, with automatic change of travel direction when meeting an obstacle

(51)[6] International Patent Classification(s)

B62D 006/00
B62D 011/02
E04H 004/16
G05D 001/02

(21) Application No: 199656047

(22) Application Date: 1996.06.18

(30) Priority Data

(31) Number	(32) Date	(33) Country
95 07297	1995.06.19	FR

(43) Publication Date : 1997.01.09
(43) Publication Journal Date : 1997.01.09
(44) Accepted Journal Date : 1999.04.29

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(56) Related Art

US 5435031
US 5256207
EP 465453

AU9656047

(12) PATENT ABSTRACT (11) Document No. AU-A-56047/96
(19) AUSTRALIAN PATENT OFFICE

(54) Title
WHEELED VEHICLE, SPECIFICALLY A SWIMMING-POOL CLEANING ROBOT, WITH AUTOMATIC CHANGE OF TRAVEL DIRECTION WHEN MEETING AN OBSTACLE

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B62D 006/00 **B62D 011/02** **E04H 004/16** **G05D 001/02**

(21) Application No. : **56047/96** (22) Application Date : **18.06.96**

(30) Priority Data

(31) Number	(32) Date	(33) Country
95 07297	**19.06.95**	**FR FRANCE**

(43) Publication Date : **09.01.97**

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Wheeled vehicle which automatically changes travel direction when it meets an obstacle, comprising two independent front driving wheels (1); two obstacle-detection units (2) located on the front of the vehicle at each side; means of transmission for each driving wheel (1) from a motor shaft (8) through means for reversing the direction of rotation (9, 10, 11); and means of connection (7) placed between each obstacle-detection unit (2) and means of transmission for the driving wheel located on the opposite side; the means of obstacle detection (2) and the means of connection (7) being arranged in such a manner that, when the vehicle meets an obstacle, the means of detection (2) actuated by the obstacle, act through the corresponding means of connection (7), so as to actuate said means for reversing the direction of rotation, and to have the rotation of the driving wheel pass from the forward direction to the rear direction.

WHEELED VEHICLE, SPECIFICALLY A SWIMMING-POOL CLEANING ROBOT, WITH AUTOMATIC CHANGE OF TRAVEL DIRECTION WHEN MEETING AN OBSTACLE

ABSTRACT

Wheeled vehicle which automatically changes travel direction when it meets an obstacle, comprising two independent front driving wheels (1); two obstacle-detection units (2) located on the front of the vehicle at each side; means of transmission for each driving wheel (1) from a motor shaft (8) through means for reversing the direction of rotation (9, 10, 11); and means of connection (7) placed between each obstacle-detection unit (2) and means of transmission for the driving wheel located on the opposite side; the means of obstacle detection (2) and the means of connection (7) being arranged in such a manner that, when the vehicle meets an obstacle, the means of detection (2) actuated by the obstacle, act through the corresponding means of connection (7), so as to actuate said means for reversing the direction of rotation, and to have the rotation of the driving wheel pass from the forward direction to the rear direction.

(FIG. 1)

S & F Ref: 343496

AUSTRALIA

PATENTS ACT 1990

COMPLETE SPECIFICATION

FOR A STANDARD PATENT

ORIGINAL

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Invention Title: Wheeled Vehicle, Specifically a Swimming-Pool Cleaning Robot, with Automatic Change of Travel Direction when Meeting an Obstacle

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

Wheeled Vehicle, Specifically a Swimming-Pool Cleaning Robot, with Automatic Change of Travel Direction when Meeting an Obstacle

Field of the Invention

The present invention relates to a wheeled vehicle which automatically change travel direction when confronted by an obstacle.

Background of the Invention

Such vehicles are utilized, for example, to serve as cleaning robots for liquid tanks, such as swimming pools. Various applications of such swimming-pool cleaning robots are known although, by reason of their very design, they present the inconvenience of always being diverted in the same direction when they encounter an obstacle and also the inconvenience of always being diverted practically from the same angle. As a result, these vehicles can at times encounter difficulties in freeing themselves from certain obstacles, or even not getting free (for example, if they are caught between a ladder and the swimming pool wall; furthermore, their practically constant shifting before an obstacle sends them in particular directions such that their successive trajectories finish by being superimposed and the vehicles do not traverse the entire bottom surface of the pool. Hence, their function as a vehicle is not satisfactory and the swimming pool is not cleaned in a sufficiently efficient manner.

Summary of the Invention

It is the object of the present invention to overcome or substantially ameliorate at least one of the above disadvantages.

There is disclosed herein a wheeled vehicle adapted to change travel direction when confronted by an obstacle, the vehicle comprising:

two independent driving wheels;

two obstacle-detection units disposed on a front of the vehicle, each unit having a buffer portion substantially extending across a respective half-width of the vehicle;

each driving wheel being driven by respective transmission means from a respective motor shaft, said respective transmission means comprising reversing means for reversing the direction of rotation of the driving wheel being driven thereby;

each unit being operatively connected to the respective transmission means for the driving wheel on a respective opposite side of the vehicle by means of respective connection means; and

wherein a unit or units confronted by an obstacle through said buffer portion or portions act through said respective connection means to actuate said reversing means for the corresponding driving wheel or wheels.

Preferably, one of said units is above the other, each obstacle-detection unit being a substantially arched member, a periphery section of each unit opposite said respective driving wheel extending from an adjacent periphery section of the other unit, the periphery sections substantially extending across a respective half-width of the vehicle to form said buffer portions.

The vehicle is made in a symmetrical fashion and is adapted such that its release is effected in a direction opposite to the obstacle. If the obstacle is perfectly frontal or bilateral, the two obstacle detectors are actuated simultaneously, and both driving wheels are simultaneously induced to turn in reverse direction such that in the first instance the vehicle goes backward without being diverted. In any case it substantially succeeds in freeing itself irrespective of the position (lateral, frontal, bilateral), the nature (plane, concave) and the dimension (in particular the width) of the obstacle.

In a particular preferred type of application, each respective transmission means comprises a drive pinion located at the end of the respective motor shaft, a central gear and an annular gear which are integral with the corresponding driving wheel and wherein the drive pinion can mesh with the central gear or the annular gear to determine respectively two directions of rotation of the corresponding driving wheel.

Preferably, each respective connection means comprises a pillow block supporting the respective motor shaft, the pillow block being movable in a path substantially transversely with respect to said shaft when the corresponding obstacle detection unit is actuated to actuate said reversing means.

Preferably, each respective connection means further comprises a movable follower operatively connected to an arm of the corresponding detection unit, the arm being movable between a first position wherein the arm is in a rest position during the absence of an obstacle and a second position wherein the arm is moved by an obstacle and the follower engages a cam mounted on the corresponding motor shaft to move the pillow block supporting said corresponding motor shaft to change the meshing of the drive pinion.

Preferably, each respective connection means further comprises temporary blocking means adapted to maintain the reverse rotation of the corresponding driving wheel for a sufficient period so that the vehicle can free itself from the obstacle, and to re-establish the rotation of the driving wheel to its initial direction so that the vehicle moves on a new trajectory.

Preferably, each respective blocking means comprises a blocking catch connected to the movable pillow block of the respective motor shaft, the catch being engaged resiliently when the pillow block is displaced by the cam.

Preferably, each respective temporary blocking means is adapted to maintain the reverse rotation of the driving wheel for a non-predetermined period, hence the vehicle is induced to turn from a non-predetermined and unpredictable angle such that its successive trajectories are not superimposed and are unpredictable.

Preferably, each respective temporary blocking means further comprises a transversal pin integral with the driving wheel and adapted to release the catch when the catch is engaged to free the pillow block, resilient return means being provided to return the pillow block to its initial position.

Brief Description of the Drawings

A preferred form of the present invention will now be described by way of example only, with reference to the accompanying drawings, wherein:

Fig. 1 is a comprehensive perspective view of a mechanism equipping a vehicle, such as a swimming-pool cleaning robot,

arranged in conformance with the invention;

FIG. 2 is an enlarged more detailed view of one-half of the mechanism of FIG. 1;

FIG. 3 is a greatly enlarged perspective view, from another angle, of another portion of the mechanism of FIG. 2;

FIG. 4 is a fragmentary section of the mechanism of FIG. 3.

In FIGS. 1 through 4, and particularly in FIG. 1, only the portion of the wheeled vehicle involved in the invention is shown. The remainder of the vehicle can be arranged in any manner depending upon applications and needs. In particular, the number of wheels, the type of motorization (electric, hydraulic, mechanical, ...) as well as the work equipment and the general shape (body, dimensions, ...) can be anything provided that it does not affect the main mechanism which now is going to be more particularly taken into account.

In addition, although the arrangements peculiar to the invention have been more particularly developed with the goal of producing an improved swimming-pool cleaning robot, it is obvious that said arrangements can find applications for equipping any type of wheeled vehicle which automatically changes direction in the presence of an obstacle. The same arrangements could also be applied in a floating vehicle driven by two propulsion units spread apart transversely.

FIG. 1 shows two front wheels **1** of a vehicle which are driven independently (i.e., not fixed onto a common shaft) yet capable of being driven by a common motor (not shown).

At the front of the vehicle there are two obstacle-detection units which are arranged to detect obstacles respectively on both sides of the middle of the front. Furthermore, each obstacle-detection unit is arranged to be functional not only on a frontal half of the vehicle but also in the corresponding lateral angle, or even on the front end of the corresponding side.

Lastly, each obstacle-detection unit is associated with means of connection arranged in such manner that when the detection unit hits an obstacle it controls the reversing of the direction of rotation of the opposite driving wheel and thus initiates the pivoting of the vehicle to the opposite of the obstacle.

As can be seen in FIGS. **1** and **2**, each obstacle-detection unit consists of an elongated unit or arm **2** in the general shape of a mustache or a crescent moon which extends approximately across the front end of the vehicle. Each detector **2** has an active edge **3**

projecting toward the front and extending on a frontal half of the vehicle as well as into the angle and on the beginning of the corresponding side of the vehicle. On the other frontal half of the vehicle, edge **4** of the detector is set back toward the rear.

The two detectors **2** are arranged one above the other, while being inverted one with respect to the other in such manner that set-back edge **4** of one coincides with projecting active edge **3** of the other.

Each detector **2** is supported in free rotation on a practically vertical axis **5** by its end **6** located on the side of set back edge **4**. Lights can possibly be provided in the other detector to allow their respective free rotating movements.

This same end **6** of detector **2** is associated with the means of connection, designated overall by reference **7**, in such manner as to functionally control the rotating direction of driving wheel **1** which is located on this same side. In other words, when an obstacle acts on edge **3** of detector **2**, this detector **2** controls wheel **1** located on the opposite side.

The engagement and the reversing of the rotating direction of each driving wheel **1** are arranged as follows. Motor shaft **8** (driven by a central motor, not shown) is equipped at its free end with driving pinion **9**. Wheel **1** or the axle of wheel **1** are coaxially integrated with central gear **10** and annular gear **11** having teeth in the rim. Driving pinion **9** is located between central gear **10** and annular gear **11** and can mesh selectively with one or the other, as indicated hereinbelow.

The aforementioned means of connection are arranged as follows: A portion of end **6** of each detector **2** is fork shaped **12** co-acting with lug **13** integral with carriage **14** which is movable on a portion of fixed frame **15** following a direction approximately parallel to motor shaft **8**.

Carriage **14** carries follower **16** which extends in the direction of shaft **8**.

Approximately facing follower **16**, cam **17** rotates on shaft **8**.

Elsewhere, shaft **8** is supported by pillow block **18** which itself is supported by carriage **19** capable of sliding on fixed frame **20** following a direction approximately transversal to shaft **8**.

In the absence of an obstacle, detector **2** is not deviated and it keeps follower **16** shifted laterally with respect to cam **17**. Return spring **21** then keeps carriage **19** in a position at which

pillow block **18** supports shaft **8** in rest position, driving pinion **9** meshing with annular gear **11**. The corresponding rotation direction of driving wheel **1** is assumed to correspond to the forward travel of the vehicle.

When there is an obstacle which thrusts active edge **3** of detector **2** toward the rear, detector **2**, in pivoting, initiates, by the skew of its fork **12**, the displacement of follower **16** which is brought opposite cam **17**. In turning, the latter bears against the follower and shaft **8** is pushed so that driving pinion **9** leaves annular gear **11** and goes to work with central gear **10**. The latter is engaged in a direction opposite to annular gear **11** and driving wheel **1** turns in opposite direction.

To provide sufficient time while pinion **9** works with central gear **10** enabling the vehicle to free itself, means of releasable blocking are provided and are designated by reference **22** in FIGS. **2** and **3**.

The means of releasable blocking **22** comprise rod **23** sliding freely axially in passage **25** of fixed body **24** in a location facing pillow block **18** said rod **23** being fixed to said block **18**. Rod **23** has radial notch **26** which, when it is disengaged outside of body **24**, is thrust in bearing against the edge of passage opening **25** with the help of transversal spring **27** (rod **23** having a certain radial play in passage **25**). It is possible to provide passage **25** in bushing **28** screwed into body **24** so as to permit travel adjustment, as shown in FIG. **4**.

Releasing the means of blocking is accomplished as follows: Driving wheel **1** carries pin **29** which extends transversely and which, during the rotation of wheel **1**, finds a component on its trajectory, for example ring **30**, fixed to rod **23**. Here, it will be noted that notch **26** is cut into rod **23** on the same side as pin **29**. When pin **29** meets ring **30**, it pushes it and, notch **26** being thus released, spring **21** returns all of the mobile gear train to the initial position again with meshing of pinion **9** with annular gear **11**: driving wheel **1** then recovers forward rotation.

The arrangement which has just been described has an advantage in that, at the time of meeting an obstacle, pin **29** is in a random angular position with respect to ring **30**. Driving wheel **1** therefore effects a rotation of non-predetermined, unpredictable angular amplitude before being again induced to rotate in a forward direction. After having hit an obstacle the vehicle is hence going to release itself by pivoting oppositely from the obstacle with an

unpredictable angular amplitude and is going to start out again in forward direction on a new trajectory which is arranged in a random manner with respect to the preceding.

In the case where both detectors **2** are actuated simultaneously (meeting a central frontal obstacle), both driving wheels **1** are induced to turn in reverse direction in simultaneous fashion and the vehicle runs backward in practically a straight line. However, both pins **29** are not located, in principle, in the same relative angular position with regard to the two respective rings **30**: one of the two pins **29** will hence meet its associated ring **30** before the other, and then the vehicle will be induced to turn in the direction determined by said first pin meeting its associated ring, then will start out again on a new trajectory as the previously described case. Here, however, both the straight line back-up distance and the side toward which the rotation will be effected as well as the angular amplitude of this rotation, are unpredictable: the new forward trajectory is, here again, sure of being arranged randomly with respect to the preceding.

Thus it is certain that the vehicle is not going to successively travel over the same itineraries and, in the particular case of a swimming-pool cleaning robot, it is certain that, by the combination of all of the successive unpredictable trajectories, the robot will travel over the totality of the swimming-pool bottom.

As it is evident and as a result moreover of the foregoing, the invention is not at all limited to those types of application and production which have been more particularly envisioned; on the contrary it encompasses all of the variations.

The claims defining the invention are as follows:

1. A wheeled vehicle adapted to change travel direction when confronted by an obstacle, the vehicle comprising:

two independent driving wheels;

two obstacle-detection units disposed on a front of the vehicle, each unit having a buffer portion substantially extending across a respective half-width of the vehicle;

each driving wheel being driven by respective transmission means from a respective motor shaft, said respective transmission means comprising reversing means for reversing the direction of rotation of the driving wheel being driven thereby;

each unit being operatively connected to the respective transmission means for the driving wheel on a respective opposite side of the vehicle by means of respective connection means; and

wherein a unit or units confronted by an obstacle through said buffer portion or portions act through said respective connection means to actuate said reversing means for the corresponding driving wheel or wheels.

2. The vehicle of claim 1 wherein one of said units is above the other, each obstacle-detection unit being a substantially arched member, a periphery section of each unit opposite said respective driving wheel extending from an adjacent periphery section of the other unit, the periphery sections substantially extending across a respective half-width of the vehicle to form said buffer portions.

3. The vehicle of claim 1 or 2, wherein each respective transmission means comprises a drive pinion located at the end of the respective motor shaft, a central gear and an annular gear which are integral with the corresponding driving wheel and wherein the drive pinion can mesh with the central gear or the annular gear to determine respectively two directions of rotation of the corresponding driving wheel.

4. The vehicle of any one of the preceding claims, wherein each respective connection means comprises a pillow block supporting the respective motor shaft, the pillow block being movable in a path substantially transversely with respect to said shaft when the corresponding obstacle detection unit is actuated to actuate said reversing means.

5. The vehicle of claim 4, when appended to claim 3, wherein each respective connection means further comprises a movable follower operatively connected to an arm of the corresponding detection unit, the arm being movable between a first position wherein the arm is in a rest position during the absence of an obstacle and a second position wherein the arm is moved by an obstacle and the follower engages a cam mounted on the corresponding motor shaft to move the pillow

block supporting said corresponding motor shaft to change the meshing of the drive pinion.

6. The vehicle of claim 5 wherein each respective connection means further comprises temporary blocking means adapted to maintain the reverse rotation of the corresponding driving wheel for a sufficient period so that the vehicle can free itself from the obstacle, and to re-establish the rotation of the driving wheel to its initial direction so that the vehicle moves on a new trajectory.

7. The vehicle of claim 6 wherein each respective blocking means comprises a blocking catch connected to the movable pillow block of the respective motor shaft, the catch being engaged resiliently when the pillow block is displaced by the cam.

8. The vehicle of claim 6 or 7 wherein each respective temporary blocking means is adapted to maintain the reverse rotation of the driving wheel for a non-predetermined period.

9. The vehicle of claim 8 wherein each respective temporary blocking means further comprises a transversal pin integral with the driving wheel and adapted to release the catch when the catch is engaged to free the pillow block, resilient return means being provided to return the pillow block to its initial position.

10. A wheeled vehicle substantially as hereinbefore described with reference to the accompanying drawings.

11. A swimming pool cleaner substantially as hereinbefore described with reference to the accompanying drawings.

Dated 3 December, 1998
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56047/96

FIG.2.

FIG.1.

FIG.3.

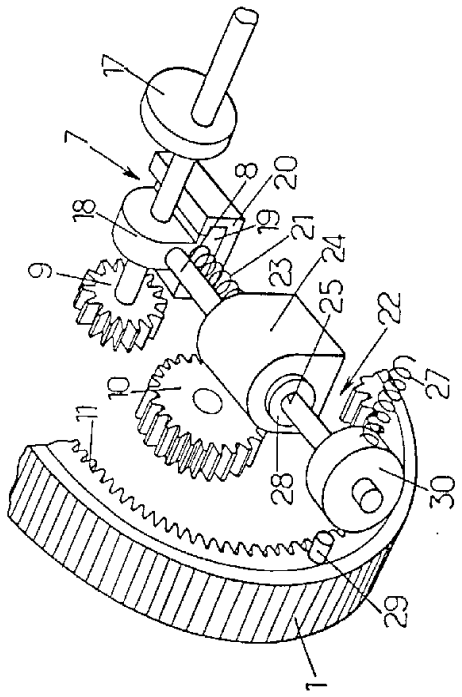

FIG.4.