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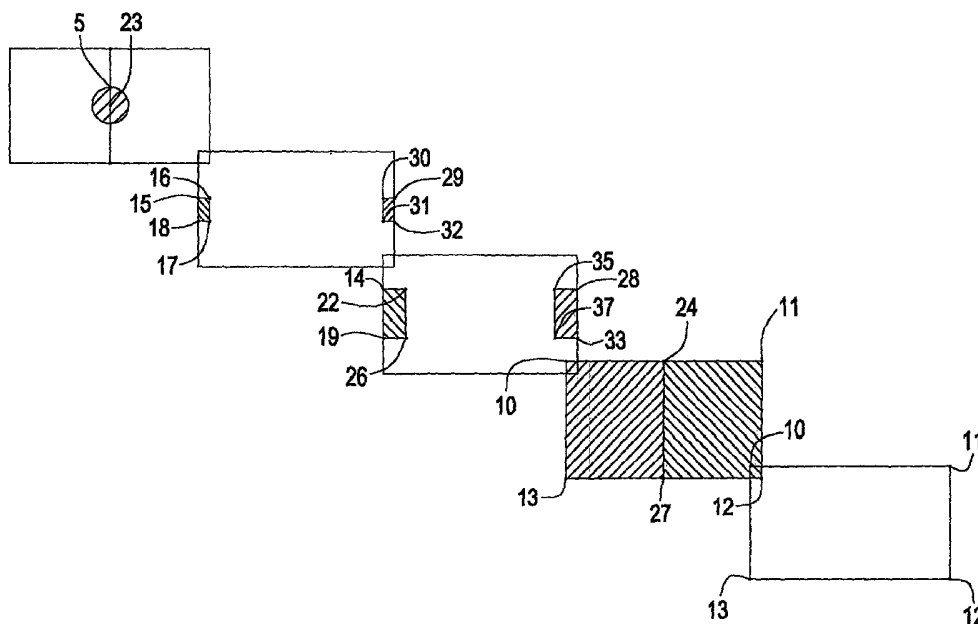
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[Continued on next page]

(54) Title: METHOD OF OPERATING AN AUTOMATED LAND MAINTENANCE VEHICLE



(57) Abstract: A method of operating an automated land maintenance vehicle over a work area is provided where the method comprises: (a) determining a work regime by dividing the work area into regions; selecting at least one instruction for the vehicle to follow with respect to each region; providing data relating to the regions and to the associated instructions to processing means; computing, by the processing means, the work regime for the vehicle from the data; and (b) providing data relating to the work regime to control means of the vehicle whereby the vehicle is operated to follow the work regime.



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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD OF OPERATING AN AUTOMATED LAND MAINTENANCE VEHICLE**TECHNICAL FIELD OF THE INVENTION**

5 This invention relates to a method of operating an automated land maintenance vehicle, particularly, although not exclusively, a vehicle in the form of a mower.

10 **BACKGROUND TO THE INVENTION**

 The aesthetic appearance of turfed sports areas such as football pitches or golf courses is very important especially if the area is shown on television. Recently
15 there has been a growing trend for ground maintenance staff to produce increasingly precise and intricate mowing patterns on the turfed surface.

 Another and probably more important aspect of the
20 job of ground maintenance staff is maintaining a good playing surface. Various factors may affect the quality of the playing surface, such as the sport being played (different sports damage different areas of the pitch), the local climate, the soil makeup and the frequency of
25 use. There has been always been a requirement for ground maintenance staff to provide a high standard of playing surface for one of two reasons; maintaining a good playing surface against high usage of the football/rugby/
30 American football/baseball and golf areas and to compete for premier sporting events such as high profile golf tournaments.

 Conventionally, intricate mowing patterns are put

onto the surface by manually pushing or driving the mower around on the surface in order to both cut the grass and to mark the desired mowing pattern. The pattern is achieved by rolling the grass in a particular direction after it has been cut, so that when the area is viewed, the shades produced by mowing in different directions define the pattern. Mowing and/or rolling a standard pattern may take several hours, while more intricate ones will take even longer. This makes for a long and boring job for the ground maintenance staff.

When maintaining a playing surface, the ground maintenance staff generally aim to maintain the grass coverage over the whole surface. Certain factors are considered before ground maintenance staff carry out any mowing or rolling. The factors include: considering areas of high wear (football pitches are prone to high wear in the goal mouth and centre spot areas), areas of water logging or dryness and areas of high maintenance wear (excessive turning of maintenance vehicles or trenching due to machines following the same path time after time). The maintenance staff will then decide which areas to mow or roll based on an assessment of the whole surface. Parts of the pitch that are subject to any of the factors indicated above may have to be avoided during a maintenance task. This will increase the time required for the task, as more turning will be needed to carry out an increased number of strokes necessary to avoid the areas that are left to rest and recover.

30

Robotic mowers operate within a predefined area, mowing the area in a random or predefined route. Domestic robotic mowers exist that mow in parallel lines

and these cover the whole mown area with the same pattern. They cannot avoid specific areas of grass unless a physical object such as a bumping board or an energised wire bound the areas.

5

When these mowers produce patterns, they are always in straight lines. Conventionally, the operator of the mower does not have the option of selecting a circular pattern or areas where grass may be deposited. Indeed
10 due to the limitations of their guidance systems and the size of the area they are designed to cut, it is not uncommon for these domestic machines to miss parts of the area, leaving uncut grass.

15 Further robotic systems exist whereby the robotic mower has a sensor and computational means for determining its position within an area. Such positional data can be used to navigate the robot in predetermined routes in order to cover the area to be mown. Positional
20 data may be captured by a variety of means, the most common being triangulation or trilateration from fixed known reference positions. Such reference points can be geostationary satellites (GPS) or ground based references that may be sensed by the robot vehicle. Optical and
25 radio based systems are the most common means of determining mobile robot positional data. This positional data may have increased accuracy when averaged with inertial navigation devices that may include odometers, compasses and accelerometers.

30

SUMMARY OF THE INVENTION

According to one aspect of the present invention, there is provided a method of operating an automated land maintenance vehicle over a work area, the method
5 comprising (a) determining a work regime by dividing the work area into regions; selecting at least one instruction for the vehicle to follow with respect to each region; providing data relating to the regions and
10 to the associated instructions to processing means; and computing, by the processing means, the work regime for the vehicle from the data; and (b) providing data relating to the work regime to control means of the
15 vehicle whereby the vehicle is operated to follow the work regime.

According to another aspect of the present invention, there is provided ground maintenance equipment comprising an automated land maintenance vehicle for
20 operation over a work area, and control means on the vehicle for controlling the operation of the vehicle, the equipment further comprising means for inputting a first set of data relating to work regions; means for inputting
25 a second set of data relating to instructions to be followed with respect to each region; processing means for computing a work regime for the vehicle from the first and second sets of data; means for providing the data relating to the work regime to the vehicle control
30 means, whereby the vehicle is operated to follow the work regime.

The vehicle may be used to perform a variety of ground maintenance tasks such as mowing, rolling,

slitting, hollow coring or aeration.

BRIEF DESCRIPTION OF THE DRAWINGS

5 For a better understanding of the present invention and to show how it may be carried into effect, reference will now be made by way of example to the accompanying drawings, in which:

10 Figure 1 is a graphical representation of a soccer field with a navigation system;

Figure 2 is a graphical representation of a soccer field with an alternative navigation system;

15

Figure 3 diagrammatically represents the division of a work area into a plurality of regions;

20 Figure 4 is a graphical representation of half a soccer field showing a straightforward 90° mow/roll pattern;

25 Figure 5 is a graphical representation of half a soccer field showing a straightforward 0° mow/roll pattern;

30 Figure 6 is a graphical representation of half a soccer field showing a mowing pattern that excludes a predetermined region;

Figure 7 is a graphical representation of half a soccer field showing a mowing pattern in which a predetermined region is masked;

Figure 8 is a graphical representation of half a soccer field showing a crosshatch mow/roll pattern;

5 Figures 9 and 10 are graphical representations of half a soccer field showing circular mow/roll patterns;

Figure 11 is a graphical representation of half a soccer field showing different mow/roll patterns being
10 formed in different regions; and

Figure 12 is a flow chart showing a method of operating an automated land maintenance vehicle over a work area in accordance with the invention.

15

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

For the purposes of promoting an understanding of the principles of the invention, the figures use a soccer
20 field as an example. Methods and equipment in accordance with the present invention may be used on any ground surface, whether or not it is used for sports or recreational purposes.

25 Figure 1 shows a plan view of an autonomous mower in the form of a vehicle 57 having 3 ground engaging wheels 6,7,8 supporting a chassis/cowling 3 with a front bumper 2 and rear bumper 9.

30 The vehicle also carries a computer (not shown), which controls the travel and operation of the vehicle. Four radio emitters 1a, 1b, 1c and 1d are in fixed known surveyed positions. As shown, the emitters 1a, 1b, 1c

and 1d are situated just beyond four corners 56a, 56b, 56c and 56d of the boundary of the work area to be mown. The vehicle 57 cannot carry out work outside the boundary defined by known points 56a, 56b, 56c and 56d. The
5 vehicle 57 receives radio transmissions from the emitters 1a, 1b, 1c and 1d via an aerial 4 and can determine its position and therefore can navigate around the work area. Within the boundary defined by the emitters 1a, 1b, 1c and 1d there are several other operator defined regions.
10 The playing area of the soccer pitch is defined by corners 10, 11, 12 and 13. The pitch itself is subdivided into two penalty box regions 14, 22, 26, 19 and 35, 28, 33, 37, two goal areas 15, 16, 17, 28 and 29, 30, 31, 32 and the centre spot area defined by the centre
15 point 23 and a radius defined by the distance between the centre point 23 and a point 5. Other regions, such as pitch halves, are defined, for example, by points 10, 24, 27, 13 and 11, 24, 27, 12. Reference points 15, 18, 29, 32 define the goal post obstacles. Further markings such
20 as the arc on the penalty box are defined by the arc start and finish 21, 25 and 36, 38 and the arc centre and penalty spots 22 and 34.

Figure 2 shows the same soccer pitch with autonomous
25 vehicle 57 with a laser scanner 40 which uses known fixed reflectors 39a, 39b, 39c and 39d to determine its position within the boundary 56a, 56b, 56c and 56d.

The position of the reference points may be surveyed
30 using conventional surveying equipment and recorded in the vehicle's computer.

The coordinates of the surveyed points may then be

used to define the different regions of the work area. In the example of a soccer field the highest-level area may be the boundary 56a, 56b, 56c, 56d, the next the pitch 10, 11, 12, 13, and then sections of the pitch and obstacles, such as the goal posts at points 15, 18, 29, 32. The pitch region may be defined by using the four points that are generally known as the corners, other regions such as the goal mouth may be defined using the corner points of the rectangle that make up the goal area used in soccer pitch markings, and the centre spot region may be defined by a specified radius and a centre point which may be the centre spot of the soccer pitch. During the work regime, the vehicle will work the regions within the boundary through instructions that may be entered into the vehicle's computer via an operator interface.

Further regions within the boundary may be entered into the vehicle's computer if the operator wishes to define regions that are not currently stored in the memory of the vehicle. The operator may define regions using a computer graphical representation of the whole work area whereby the operator may select at least three points that surround a region. A program that can join the points together may be used so that a new region is created within the work area. This region can then be loaded into the memory of the vehicle and used to configure new and different work regimes. The computer graphical representation may be incorporated into the user interface on the vehicle itself or on a separate computer, for example a handheld device, which can then download the new data into the vehicle's computer.

A further method of defining a new region within the memory of the vehicle may include manually driving the vehicle to selected points within the boundary of the work area. The operator may manually drive the vehicle to a point, then, using the user interface, select the point as a coordinate of the new region. Once at least three points of the new region are selected and stored in the vehicle's memory a further program may be used to define the new region by joining the points.

10

Each region within the boundary may have a task associated with it to occur within the working operation. A task may be defined as one of the following:

15 Cut: the grass within a region is to be cut;

Roll: the ground within a region is to be rolled;

Treated: the ground within a region is to be treated; e.g. fertilised, spiked, aerated, decompacted, treated with pesticides.

20

Avoid: the region is to be avoided so that the vehicle is not permitted to enter the region;

25

Mask: the region has no work to be performed in it, but the vehicle is allowed to use the region for manoeuvring in order to perform work in other regions.

30

The travel of the vehicle to perform work in each region may be divided into working strokes and manoeuvres, manoeuvres being the route travelled between

working strokes. A working stroke may be defined by its start position and heading and its end position and heading and the width of the maintenance unit, such as a mower or roller, with which the vehicle may be operating.

5 A working stroke may be a straight line of travel, a circle or any other curve. The manoeuvres between working strokes may be calculated by computational means so that the vehicle can move between the end of one working stroke to the beginning of the next. The nature

10 of the manoeuvre may be determined by a plurality of parameters that may include the turning radius of the vehicle and the relative location of the regions that are to be maintained differently. If the work performed during a regime is simply required to cover the whole

15 region then the working strokes may be offset by a distance equal to or less than the width of the maintenance unit, with each stroke being parallel and having an opposite heading to an adjacent stroke. If, however, the work to be performed during the regime is to

20 provide a better visual pattern, the visual appearance of the pattern on the grass may be made up of stripes that are wider than the working width of the vehicle maintenance unit. For example, if the working width of the maintenance unit is one metre and the desired width

25 of the stripes cut or rolled into the grass is four metres the vehicle will have to travel four working strokes in the same direction each offset by one metre from each other. The work within the regions that have tasks associated with them may be further defined by

30 angle, direction in which the work is to be done, centre of radial cut, one way or cross hatched and the number of passes the vehicle makes in the same direction so as to define the width of the pattern to be worked into the

region.

Thus a whole work regime may include cutting/rolling straight lines in one section of the pitch,
5 cutting/rolling arcs or circles in the same or different regions of the pitch, cutting/rolling cross hatches in another area of the pitch or missing out certain worn regions completely or just using the region for manoeuvres between strokes. The work regime may further
10 comprise other maintenance tasks to be carried out in the whole of, or part of, the work area. Alternatively a work regime may just be a simple single width cut/roll over the whole pitch.

15 Figure 3 shows a soccer field broken down into 5 layers with each layer defining different working regions. The first layer defines the centre circle by the centre spot 23 and the circle radius equal to the distance between points 23 and 5. The second layer
20 defines the goal areas 15, 16, 17, 18 and 29, 30, 31, 32. The third layer defines the penalty areas 14, 19, 22, 26 and 28, 33, 35, 37. The fourth layer defines the two half areas 10, 24, 27, 13 and 24, 11, 12, 27 and the final layer defines the boundary 10, 11, 13, 12. Each
25 region within each layer may be assigned a different task for the vehicle to carry out during the work regime. In particular, if the vehicle is required to avoid a region while performing a first task, but is allowed to mask the region when performing a second, multiple work regimes
30 can be used to allow this.

Figures 4, 5, 8, 9, 10 and 11 show different cut/roll patterns carried out in the half-pitch area 10,

24, 27, 13. Figure 4 is a graphical representation of half a soccer field showing a straightforward 90° mow/roll pattern. Figure 5 is a graphical representation of half a soccer field showing a straightforward 0° mow/roll pattern. Figure 8 is a graphical representation of half a soccer field showing a cross-hatch mow/roll pattern. Figures 9 and 10 are graphical representations of half a soccer field showing circular mow/roll patterns. Figure 11 is a graphical representation of half a soccer field showing a combination of region mow/roll patterns.

In Figure 11, the region enclosed by points 10, 24, 27, 13, 19, 26, 22 and 14 is cut using a circular mow/roll pattern, while the region enclosed by points 14, 22, 26 and 19 is cut in a straightforward 0° mow/roll pattern.

Figure 6 shows a mower path travelled after being instructed to avoid penalty area 14, 22, 26, 19. The mower follows travel path 42a, 44a, 43a, 44b, 42b whereby the penalty area 14, 22, 26, 19 is avoided, perhaps to minimise wear or to allow for a different pattern to be created within that region. The path taken by the vehicle avoids the region completely by reversing along path 45 and then continuing the mowing by following the travel path 42c, 44c, 43b, 42d. The rest of the region is then covered by full width cuts such as 43c and 42d.

Figure 7 shows a mower path travelled after being instructed to Mask penalty area 14, 22, 26, 19. The mower travels along route 46a with the cutter unit down and raises it to travel across the penalty area along

route 49a and then lowers it before travelling along route 46b thereby not carrying out any maintenance procedure within the penalty area, and only using it to reach the continuation of 46a. The mower continues to lift the cutter unit before it enters the penalty area and carries on as normal once the penalty area has been cleared, as shown by routes 47c, 46e.

Figure 12 is a flow chart showing a method of operating an automated land maintenance vehicle over a work area in accordance with the invention. At step 101, the work area for the vehicle is defined. This may consist of placing radio emitters or laser reflectors at fixed known locations, and instructing the vehicle to operate within that area. Alternatively, the operator may manually drive the vehicle around the work area boundary, instructing the vehicle to remain within the area.

In step 102, the work regions are defined. A number of different regions are created within the work area, within which the vehicle is required to perform a particular operation.

The regions may be selected by any of the following: selecting areas on a graphical representation of the work area, providing coordinates for the region (in the appropriate form with respect to the particular guidance system being used, e.g. laser scanner, radio, GPS, etc), placing additional reference points, such as laser reflectors or radio emitters at the corners of the region or manually driving the vehicle around the boundary of the required region and instructing it to store the route

as a boundary.

At step 103, one or more tasks are assigned to the different regions. The task (as described above) may
5 comprise instructing the vehicle to: avoid a region, mask a region, or perform a maintenance task in the region. More than one maintenance task may be assigned to each region. For example, the vehicle may need to cut the
10 grass in the region and also slit the ground. Depending upon the configuration of the maintenance unit on the vehicle, the vehicle may be able to perform both tasks at once or may need to cover the region twice, once cutting the grass, and the other slitting the ground.

15 The step of assigning tasks to a region may also comprise determining a direction of travel for the vehicle in the region, allowing the vehicle to roll the grass in a desired pattern, and may also comprise selecting a particular path for the vehicle to take in
20 the region.

At step 104, the work regime for the vehicle is computed. The means for computing the work regime may be in the vehicle's computer, or may form part of the
25 separate operator interface. The work regime may comprise a number of strokes and manoeuvres for the vehicle to perform, in addition to the type of maintenance operation required. Alternatively, the work regime may comprise a number of points the vehicle must
30 reach, allowing the vehicle to decide the actual route during the work regime.

The work regime is computed taking into account all

of the different tasks assigned to each of the regions.
If a region is to be avoided, the computing means
calculates the route to be travelled by the vehicle so
that the vehicle does not enter the particular region.
5 If a region is to be masked, i.e. there is no maintenance
operation to be performed in the region, then the
computing means calculate the vehicle's route allowing
the vehicle to use the region for manoeuvres if
necessary. If a particular direction of travel in a
10 region, or particular path is required, the computing
means calculates the route accordingly.

In step 105, the work regime is provided to the
control means of the vehicle. If the computing means is
15 separate from the vehicle, this may comprise transmitting
the instructions over the air interface, or by connecting
directly to the vehicle's computer and downloading the
information.

20 In step 106, the control means of the vehicle
operates the vehicle according to the instructions
contained in the work regime.

There is thus provided an automated land maintenance
25 vehicle that has a dynamic control system so that an
operator or programmer may vary patterns or maintenance
regimes and manoeuvre travel on the pitch without having
to operate the vehicle accurately and intricately
themselves.

CLAIMS

1. A method of operating an automated land maintenance vehicle over a work area, the method
5 comprising:
- (a) determining a work regime by:
dividing the work area into regions;
selecting at least one instruction for the vehicle
to follow with respect to each region;
10 providing data relating to the regions and to the
associated instructions to processing means; and
computing, by the processing means, the work regime
for the vehicle from the data; and
- (b) providing data relating to the work regime to
15 control means of the vehicle whereby the vehicle is
operated to follow the work regime.
2. A method as claimed in claim 1, wherein the work
regime is defined as a number of strokes and manoeuvres.
20
3. A method as claimed in claim 1 or 2, wherein an
instruction comprises instructing the vehicle to perform
a maintenance procedure in the region.
- 25 4. A method as claimed in claim 1, 2 or 3, wherein
an instruction comprises allowing the vehicle to travel
through a region without performing a maintenance
operation.
- 30 5. A method as claimed in any one of claims 1 to 4,
wherein an instruction comprises instructing the vehicle
to avoid a region.

6. A method as claimed in any preceding claim, wherein a plurality of work regimes are followed in turn in a single operation on the work area.

5 7. A method as claimed in claim 3, wherein said maintenance procedure comprises mowing grass.

8. A method as claimed in claim 3, wherein said maintenance procedure comprises rolling grass in a
10 determined direction.

9. A method as claimed in claim 3, wherein said maintenance procedure comprises hollow coring.

15 10. A method as claimed in claim 3, wherein said maintenance procedure comprises slitting.

11. A method as claimed in claim 3, wherein said maintenance procedure comprises top dressing.
20

12. A method as claimed in one of claims 3 or 4, wherein the step of selecting an instruction further comprises selecting a direction of travel for the vehicle in the region.
25

13. A method as claimed in one of claims 3 or 4, wherein the step of selecting an instruction further comprises selecting a path for the vehicle to travel over in the region.
30

14. A method as claimed in claim 13, wherein the path is curved.

15. Ground maintenance equipment comprising an automated land maintenance vehicle for operation over a work area, and control means on the vehicle for controlling the operation of the vehicle, the equipment
5 further comprising:

means for inputting a first set of data relating to work regions;

means for inputting a second set of data relating to instructions to be followed with respect to each region;

10 processing means for computing a work regime for said vehicle from said first and second sets of data;

means for providing the data relating to the work regime to the vehicle control means, wherein the vehicle is operated to follow the work regime.

15

16. Ground maintenance equipment as claimed in claim 15, wherein the means for inputting said first and second sets of data comprise a handheld interface.

20 17. Ground maintenance equipment as claimed in claim 16, wherein the handheld interface further comprises said processing means for computing a work regime.

25 18. Ground maintenance equipment as claimed in any one of claims 15, 16 and 17, wherein the first and second sets of data are input using a graphical display.

30 19. Ground maintenance equipment as claimed in any one of claims 15 to 16, wherein the processing means is implemented in software.

20. Ground maintenance equipment as claimed in any one of claims 15 to 18, wherein the processing means is

implemented in hardware.

21. A method of operating an automated land
maintenance vehicle as claimed in claim 1 and
5 substantially as described herein.

22. Ground maintenance equipment substantially as
described herein with reference to and as shown in the
accompanying drawings.

10

AMENDED CLAIMS

**Received by the International Bureau on 21 July 2003 (21.07.2003) :
original claims 1-22; original claims 1 and 15 have been amended.
Claims 2-14 and 16-22 remain unchanged.**

1. A method of operating an automated land maintenance vehicle over a work area defined by a closed boundary so as to create a visually discernible pattern on the surface of the work area, the method comprising:

(a) determining a work regime by:

dividing the work area into a plurality of regions; selecting at least one instruction for the vehicle to follow with respect to each region, the instructions being such that different patterns are created by the maintenance vehicle in different regions of the work area;

providing data relating to the regions and to the associated instructions to processing means; and computing, by the processing means, the work regime for the vehicle from the data; and

(b) providing data relating to the work regime to control means of the vehicle whereby the vehicle is operated to follow the work regime.

2. A method as claimed in claim 1, wherein the work regime is defined as a number of strokes and manoeuvres.

3. A method as claimed in claim 1 or 2, wherein an instruction comprises instructing the vehicle to perform a maintenance procedure in the region.

4. A method as claimed in claim 1, 2 or 3, wherein an instruction comprises allowing the vehicle to travel through a region without performing a maintenance operation.

5. A method as claimed in any one of claims 1 to 4, wherein an instruction comprises instructing the vehicle to avoid a region.

6. A method as claimed in any preceding claim, wherein a plurality of work regimes are followed in turn in a single operation on the work area.

7. A method as claimed in claim 3, wherein said maintenance procedure comprises mowing grass.

8. A method as claimed in claim 3, wherein said maintenance procedure comprises rolling grass in a determined direction.

9. A method as claimed in claim 3, wherein said maintenance procedure comprises hollow coring.

10. A method as claimed in claim 3, wherein said maintenance procedure comprises slitting.

11. A method as claimed in claim 3, wherein said maintenance procedure comprises top dressing.

12. A method as claimed in one of claims 3 or 4, wherein the step of selecting an instruction further comprises selecting a direction of travel for the vehicle in the region.

13. A method as claimed in one of claims 3 or 4, wherein the step of selecting an instruction further comprises selecting a path for the vehicle to travel over in the region.

14. A method as claimed in claim 13, wherein the path is curved.

15. Ground maintenance equipment comprising an automated land maintenance vehicle for operation over a work area defined by a closed boundary, and control means on the vehicle for controlling the operation of the vehicle so as to create a visually discernible pattern on the surface of the work area, the equipment further comprising:

means for inputting a first set of data relating to a plurality of work regions;

means for inputting a second set of data relating to instructions to be followed with respect to each region, the instructions being such that, upon execution of said instructions, different patterns are created by the maintenance vehicle in different regions of the work area;

processing means for computing a work regime for said vehicle from said first and second sets of data;

means for providing the data relating to the work regime to the vehicle control means, wherein the vehicle is operated to follow the work regime.

16. Ground maintenance equipment as claimed in claim 15, wherein the means for inputting said first and second sets of data comprise a handheld interface.

17. Ground maintenance equipment as claimed in claim 16, wherein the handheld interface further comprises said processing means for computing a work regime.

18. Ground maintenance equipment as claimed in any one of claims 15, 16 and 17, wherein the first and second

sets of data are input using a graphical display.

19. Ground maintenance equipment as claimed in any one of claims 15 to 16, wherein the processing means is implemented in software.

20. Ground maintenance equipment as claimed in any one of claims 15 to 18, wherein the processing means is implemented in hardware.

21. A method of operating an automated land maintenance vehicle as claimed in claim 1 and substantially as described herein.

22. Ground maintenance equipment substantially as described herein with reference to and as shown in the accompanying drawings.

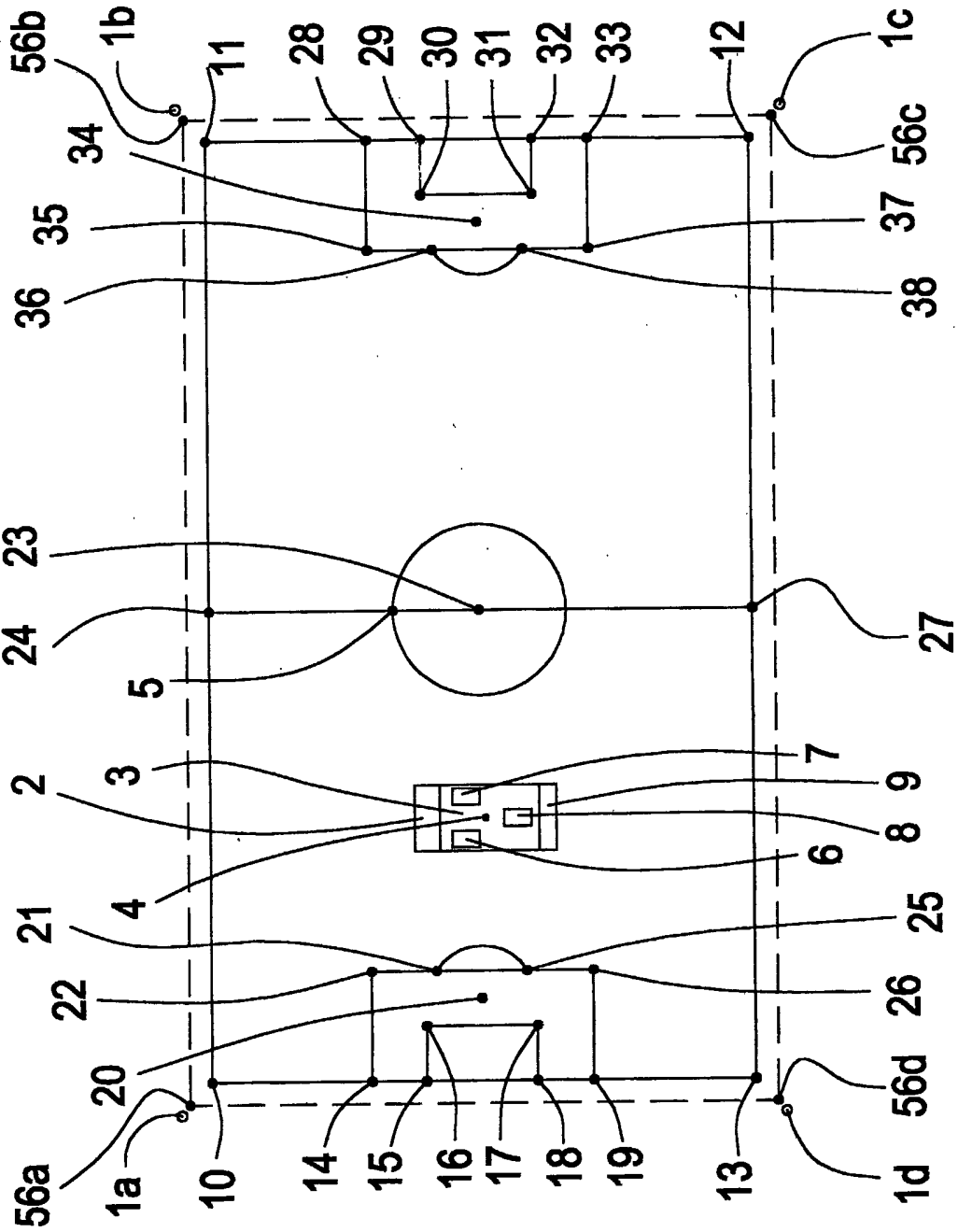


FIG.1

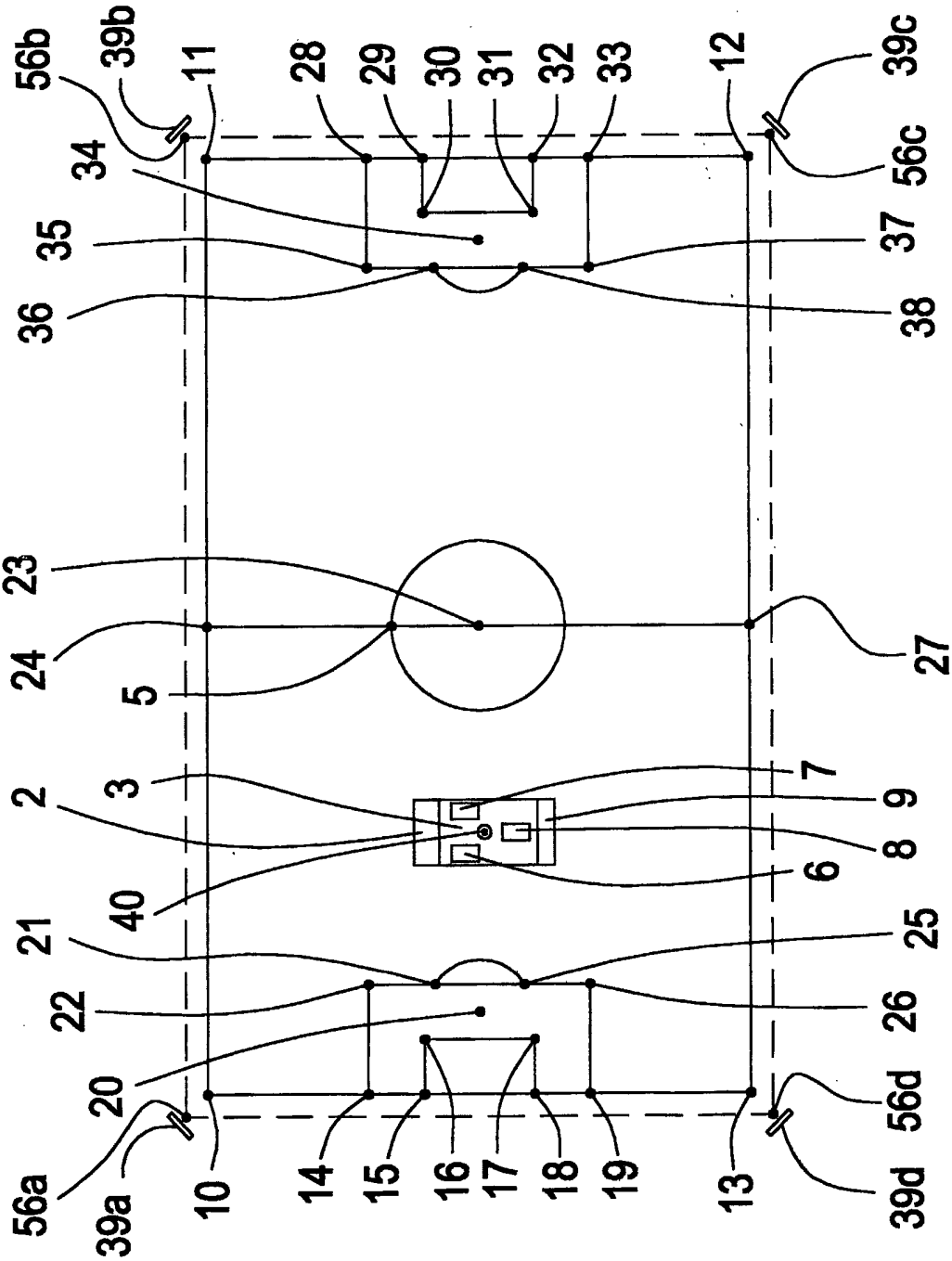
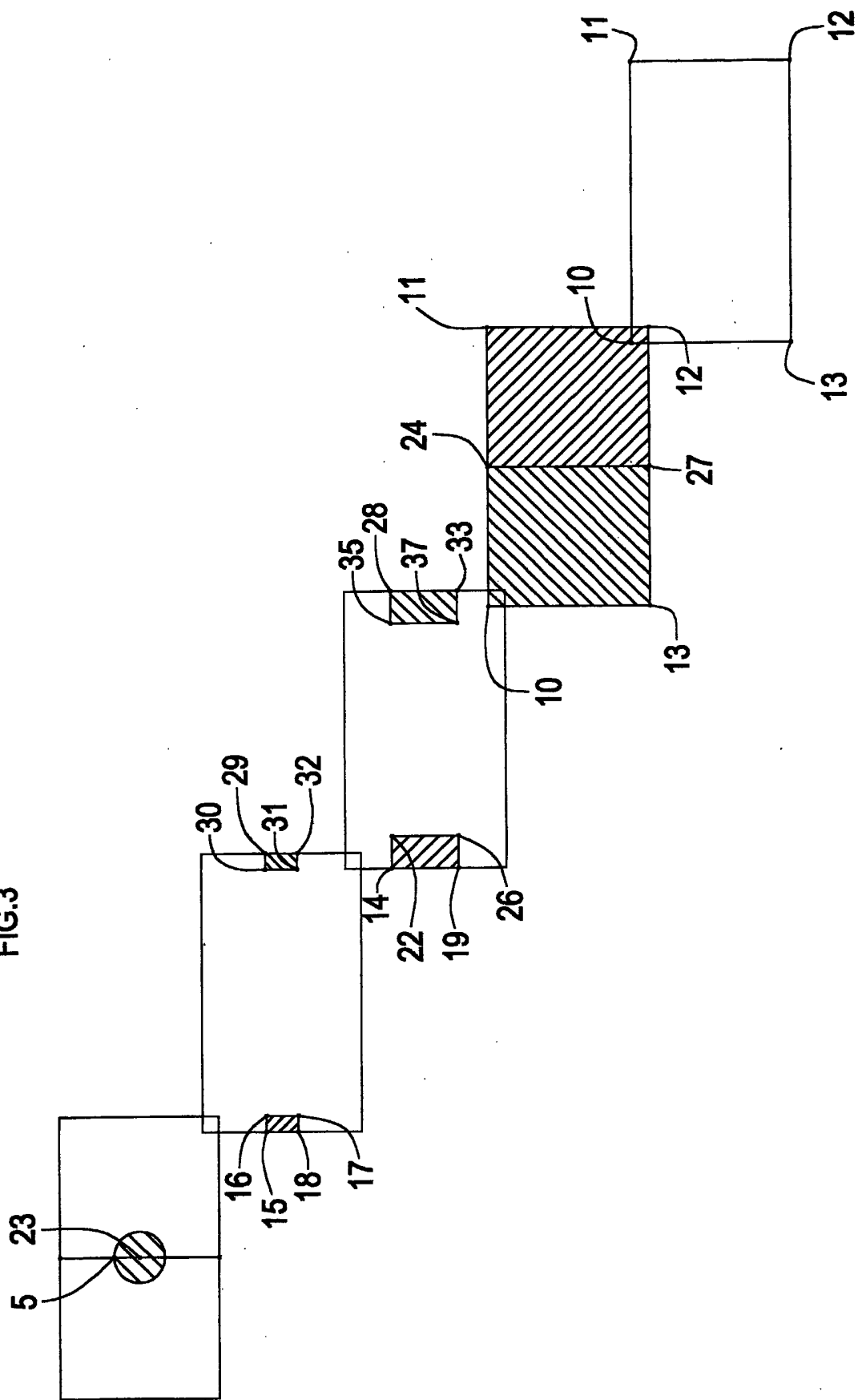


FIG.2

FIG.3



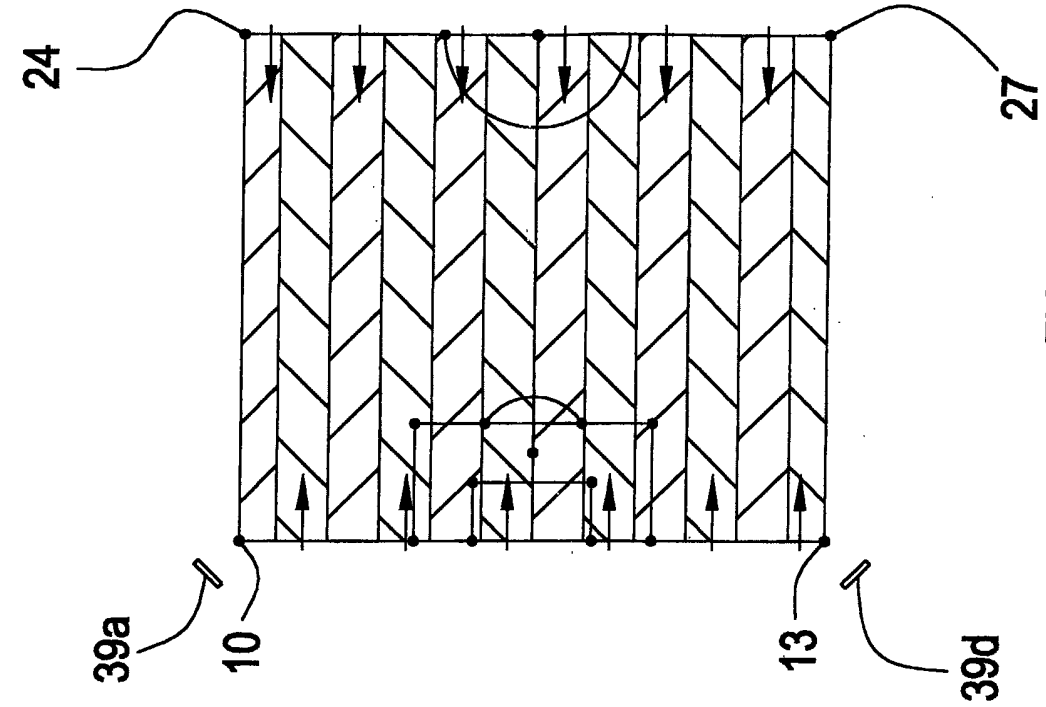


FIG.5

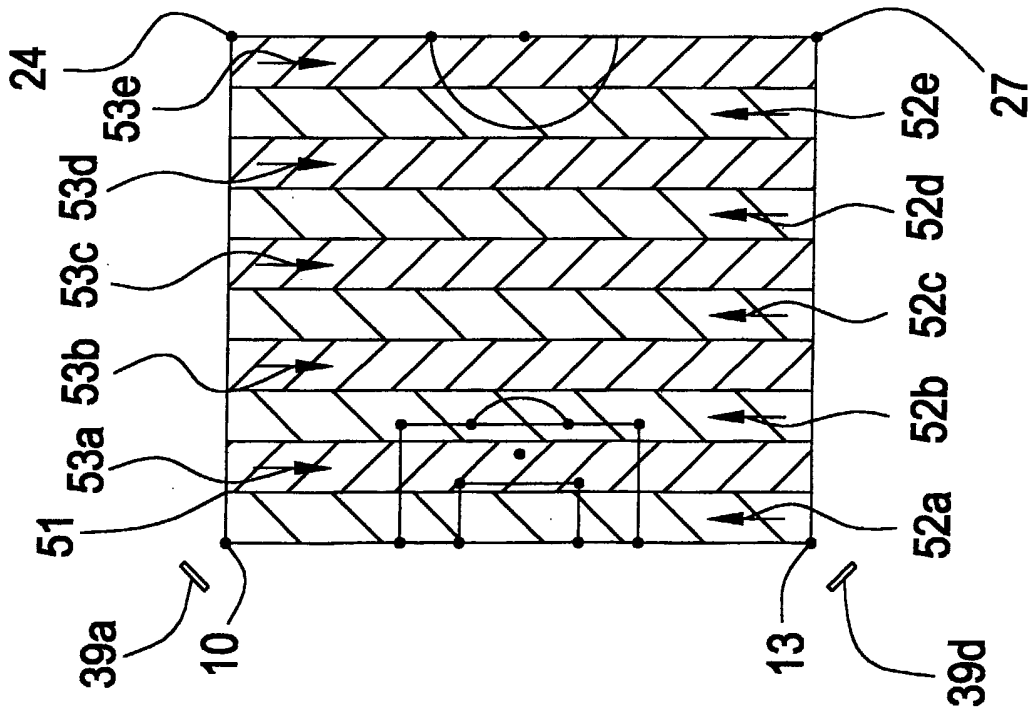


FIG.4

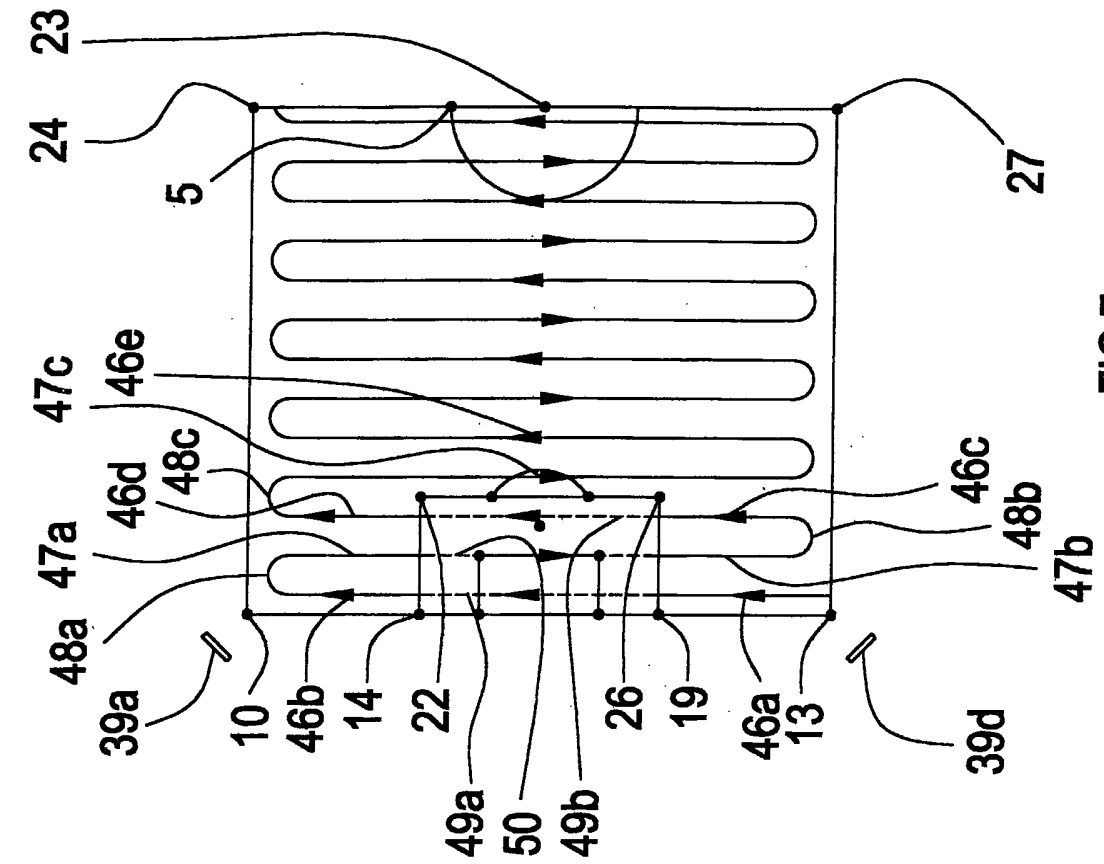


FIG. 6

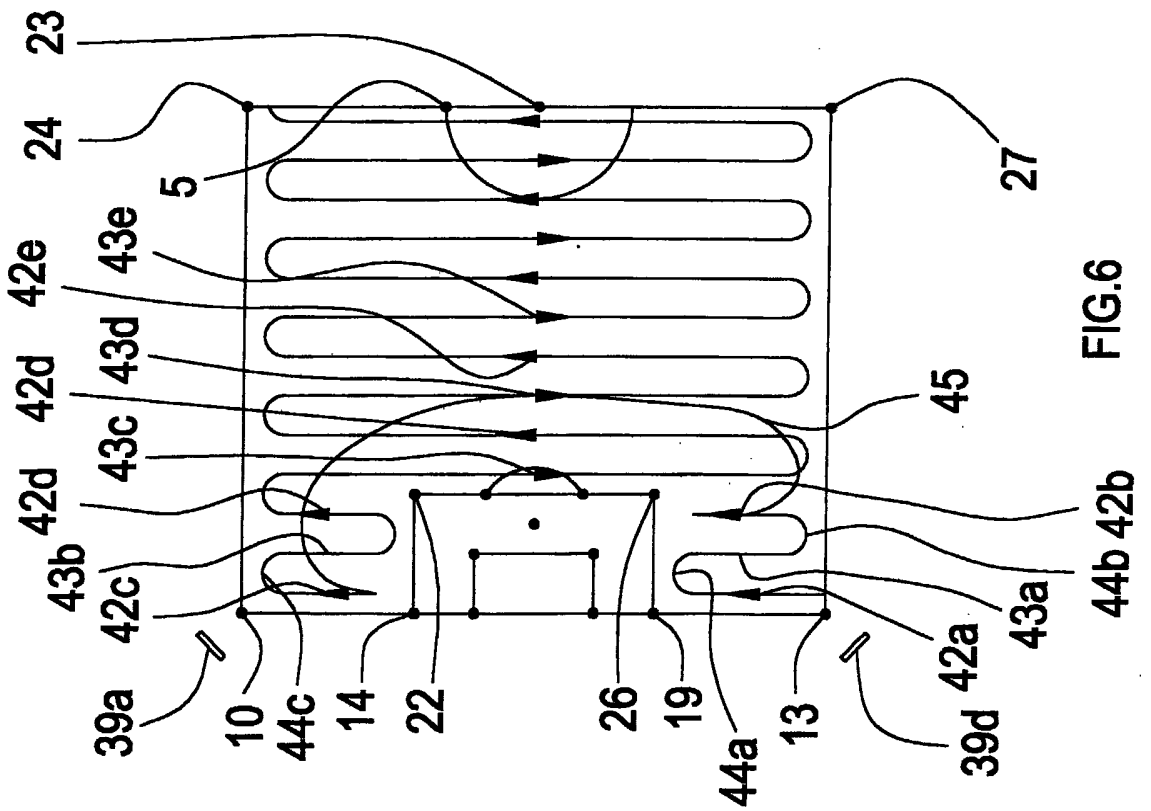


FIG. 7

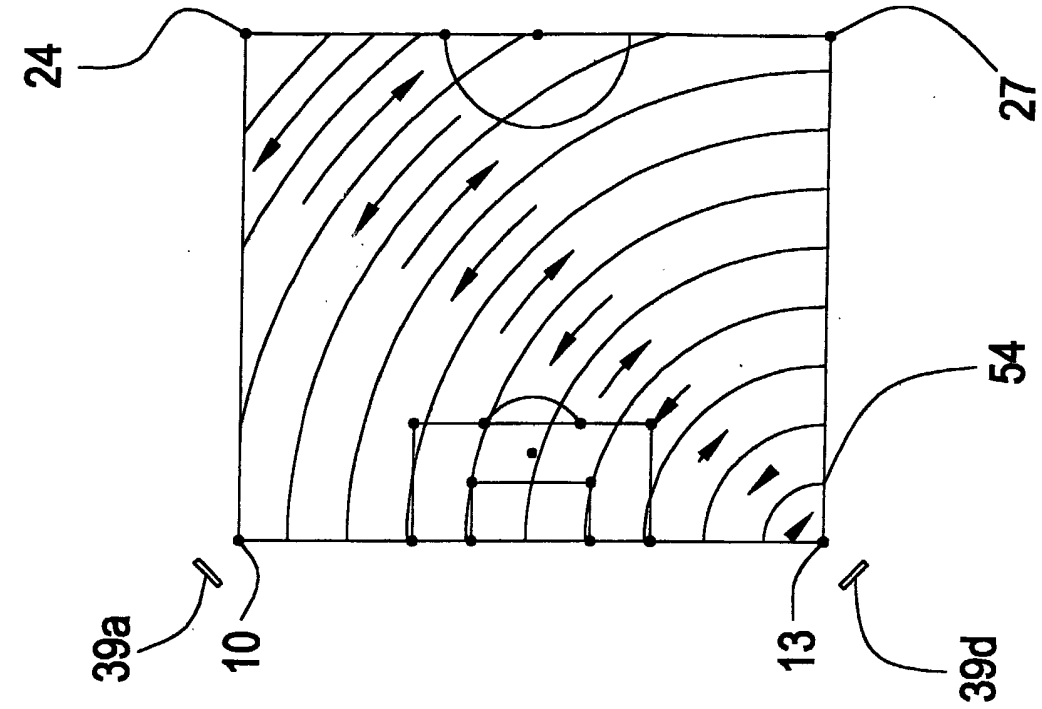


FIG.9

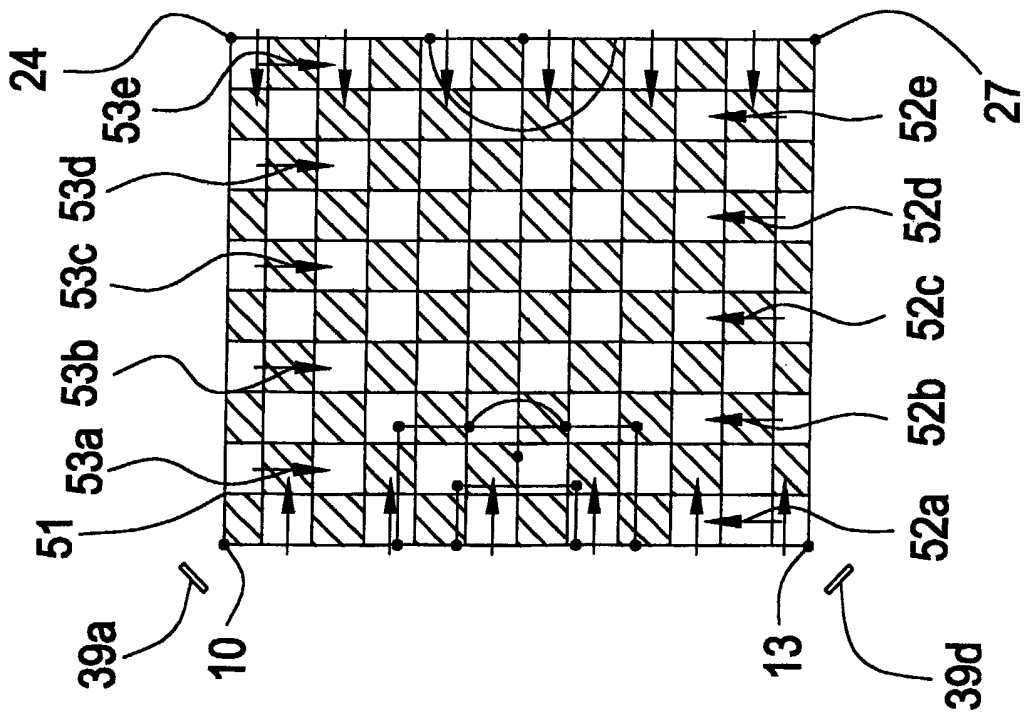


FIG.8

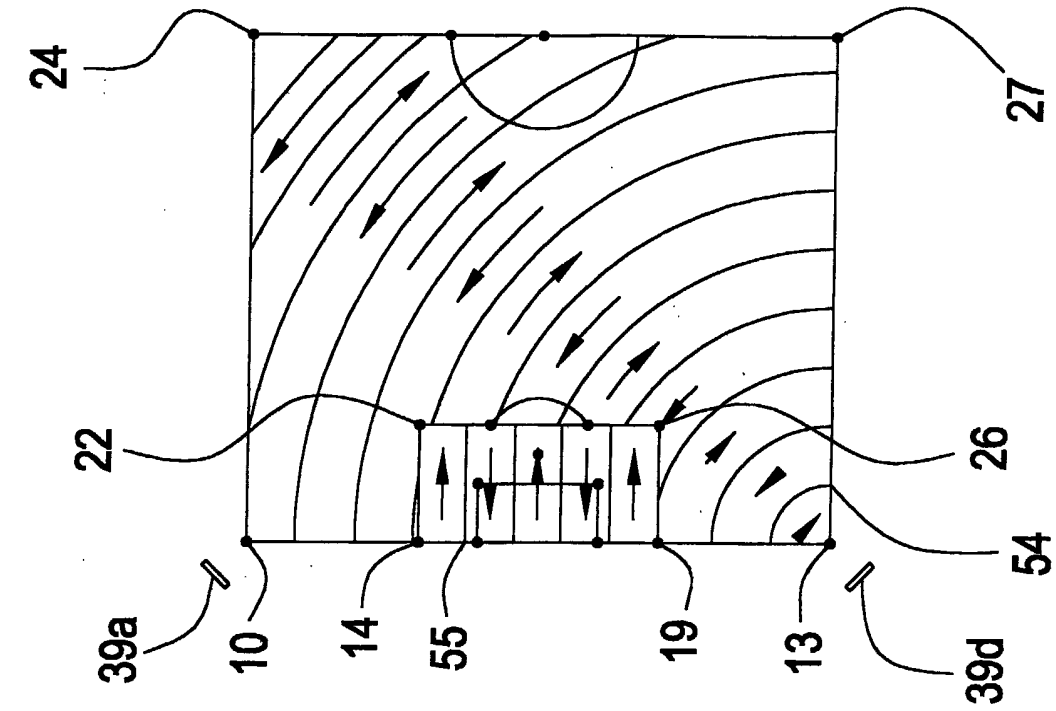


FIG.10

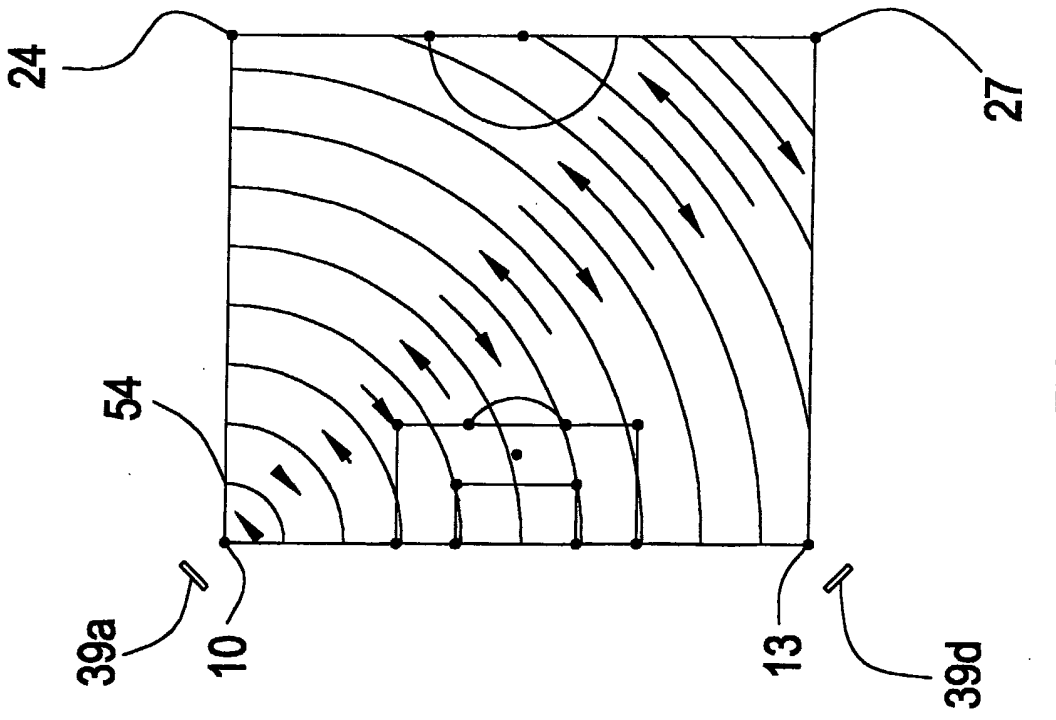


FIG.11

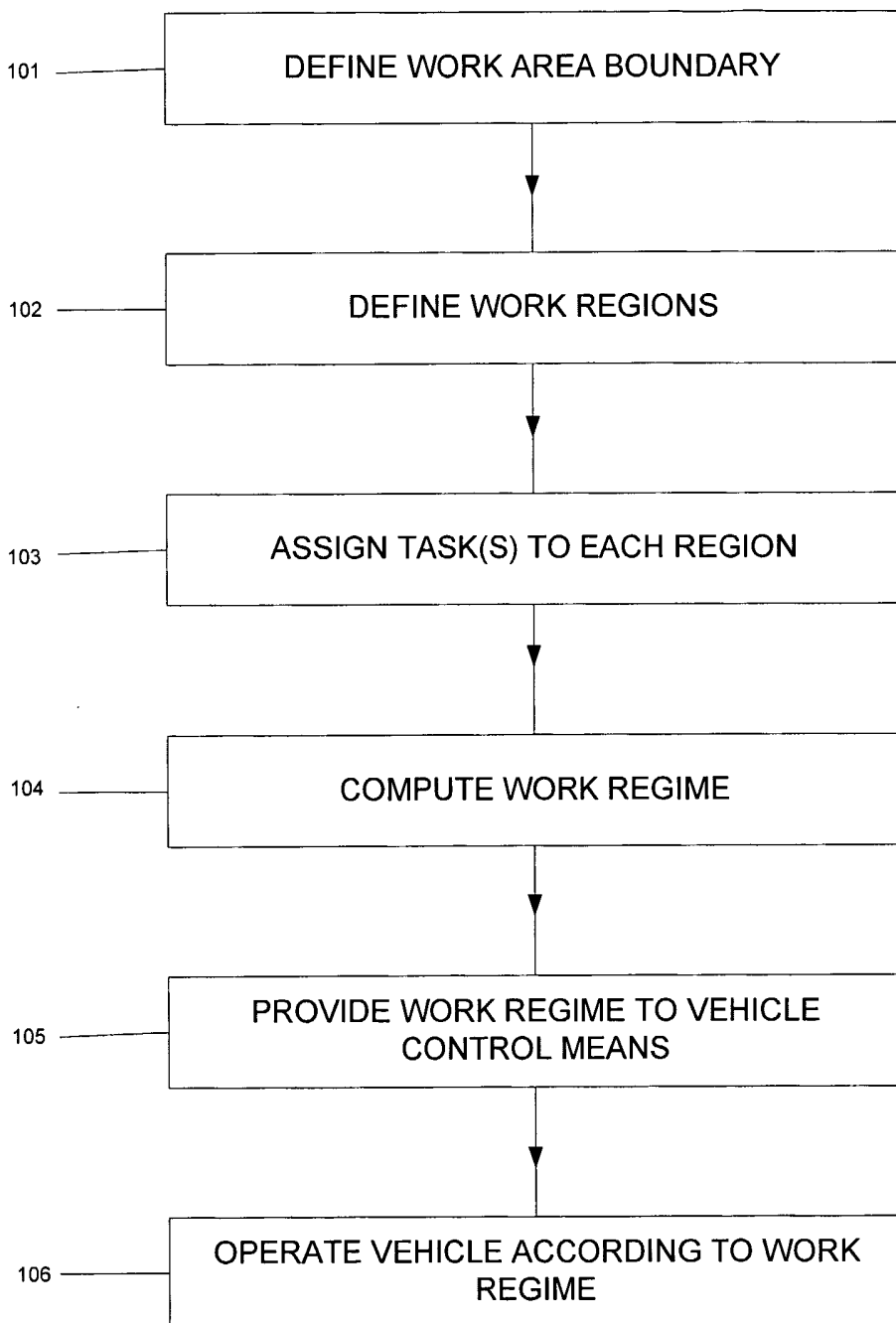


Figure 12

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 03/00351

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A01B79/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 128 574 A (DIEKHANS NORBERT) 3 October 2000 (2000-10-03) abstract; figures column 3, line 49 - line 65 column 4, line 8 - line 14 column 4, line 33 - line 45 column 6, line 57 - line 63 ---	1-20
X	US 5 606 850 A (NAKAMURA TETSUYA) 4 March 1997 (1997-03-04) abstract; figures column 1, line 23 - line 27 column 3, line 46 - column 4, line 4 column 7, line 52 - column 8, line 17 --- -/--	1,15

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

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Date of the actual completion of the international search

27 May 2003

Date of mailing of the international search report

04/06/2003

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 03/00351

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98 46065 A (UNIV CARNEGIE MELLON) 22 October 1998 (1998-10-22) abstract; figures page 14, line 21 -page 15, line 8 page 18, line 20 - line 30 ---	1,15
X	US 5 528 888 A (MIYAMOTO YASUHIKO ET AL) 25 June 1996 (1996-06-25) abstract; figures column 8, line 15 - line 24 ---	1,15
X	US 4 769 700 A (PRYOR TIMOTHY R) 6 September 1988 (1988-09-06) abstract; figures column 13, line 30 - line 38 -----	1,15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 03/00351

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6128574	A	03-10-2000	DE 19629618 A1	29-01-1998
			DE 59708415 D1	14-11-2002
			DK 821296 T3	10-02-2003
			EP 0821296 A2	28-01-1998
US 5606850	A	04-03-1997	JP 6113607 A	26-04-1994
			AU 675454 B2	06-02-1997
			AU 4876693 A	21-04-1994
			CA 2107821 A1	10-04-1994
			US 5438817 A	08-08-1995
WO 9846065	A	22-10-1998	AU 7110698 A	11-11-1998
			EP 0975209 A1	02-02-2000
			WO 9846065 A1	22-10-1998
			US 6336051 B1	01-01-2002
US 5528888	A	25-06-1996	JP 7184414 A	25-07-1995
			JP 7184415 A	25-07-1995
			DE 4446867 A1	29-06-1995
			GB 2285905 A , B	02-08-1995
			GB 2290212 A , B	20-12-1995
US 4769700	A	06-09-1988	US 4482960 A	13-11-1984
			US 6314631 B1	13-11-2001
			US 6163946 A	26-12-2000
			US 6301763 B1	16-10-2001
			US 5602967 A	11-02-1997
			US 5148591 A	22-09-1992
			US 6167607 B1	02-01-2001
			US 6317953 B1	20-11-2001
			US 5608847 A	04-03-1997