

(19) **DANMARK**



Patent- og
Varemærkestyrelsen

(12)

Oversættelse af europæisk patentskrift

(10) **DK/EP 3482632 T3**

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- (51) Int.Cl.: **A 01 M 7/00 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2023-11-13**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2023-10-11**
- (86) Europæisk ansøgning nr.: **18401087.4**
- (86) Europæisk indleveringsdag: **2018-10-30**
- (87) Den europæiske ansøgnings publiceringsdag: **2019-05-15**
- (30) Prioritet: **2017-11-09 DE 102017126222**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
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- (54) Benævnelse: **FREM GANGSMÅDE TIL UDSPREDNING AF EN SPRØJTEVÆSKE**
- (56) Fremdragne publikationer:
EP-A1- 3 165 089
US-A1- 2002 024 665
US-B1- 6 199 000

METHOD FOR APPLICATION OF A LIQUID TO BE SPRAYED

Description

The invention relates to a method for applying a spray liquid by means of an agricultural sprayer according to the preamble of claim 1 and to an agricultural
5 sprayer, in particular a field sprayer, according to the preamble of claim 10.

During the growth of a useful plant stock in an agricultural area, harmful vegetation often also occurs; this harmful vegetation is controlled by the application of spray liquid by means of an agricultural sprayer in order to achieve an increase in yield and to prevent mixed vegetation in the agricultural area.

10 In order that spray liquid can be applied locally to the harmful vegetation, it is first necessary to detect the harmful vegetation and the position thereof. In DE 44 13 739 A1, a system is described for this purpose which determines differences between cultivated plants and wild plants by means of an optical detection device such that the application of spray liquid can be influenced accordingly.

15 However, in many applications the exclusively optical detection of harmful vegetation within a useful plant stock does not lead to satisfactory results and therefore, despite corresponding spray measures, a comparatively high proportion of harmful vegetation remains within the useful plant stock or the spray liquid is applied at incorrect positions. An incorrect application of the spray liquid can lead
20 to a considerable impairment of the useful plant stock.

Furthermore, it is known from US 6 199 000 B1 and US 2015/0245565 A1 that, when distinguishing between useful plants and wild plants, plant row information can be taken into account in order to increase the detection rate of the harmful vegetation within a useful plant stock.

25 However, sensor-based detection of corresponding plant rows is complex and cost-intensive, and for this reason is only conditionally suitable for practical use. Furthermore, sensor-based detection of plant rows is comparatively error-prone

and is dependent, for example, on the prevailing or changing light conditions when optical detection is used.

The object of the invention is thus to simplify and/or improve the detection and/or control of harmful vegetation within a useful plant stock.

- 5 The object is achieved by the characterizing features of claim 1.

The invention makes use of the knowledge that seed position information allows a conclusion to be drawn about the arrangement and formation of plant rows of a useful plant stock. Corresponding seed position information is stored by modern seed drills during sowing in any case and is available when the spray liquid is
10 applied. On the basis of the seed position information, it is possible to determine at which positions or in which regions useful plants are to be expected.

Vegetation identified at different positions or outside of appropriate regions can thus be identified as harmful vegetation in a simple way. Complex and cost-intensive sensor-based detection of plant rows is not absolutely necessary in this
15 case. In comparison with an exclusively optical detection of differences between cultivated plants and wild plants, the method according to the invention leads to a significantly increased detection rate and thus to higher yields and reduced mixed vegetation.

- Harmful vegetation can comprise, for example, one or more harmful plants, which
20 can be, for example, wild plants or other plants which do not correspond to the useful plant variety sown. The detection of the potential harmful vegetation and the position thereof is preferably accomplished using a satellite navigation module, in particular a GPS module. In addition, the detection of the potential harmful vegetation and the position thereof can comprise recording geographical position
25 data. Furthermore, the detection of the potential harmful vegetation and the position thereof can be accomplished using one or more optical detection devices and/or by camera.

In a preferred embodiment of the method according to the invention, the seed position information comprises seed row position information and/or application

lane position information. Alternatively or additionally, the seed position information can comprise geographical position information relating to individual deposited seed grains. The configuration of the seed drill is generally known during sowing of seeds, and therefore the course and/or the position of the seed rows can be derived when the position of the application lane is known. For this reason, recording data by means of an individual satellite navigation module during sowing is already sufficient to allow position information to be derived for all seed rows.

During the detection of the potential harmful vegetation and/or during the identification of the actual harmful vegetation, the agricultural sprayer can move in parallel with or obliquely to the seed rows and/or plant rows. In this way, the detection of the potential harmful vegetation and/or the identification of the actual harmful vegetation in the headland or during a change in direction, for example, is considerably simplified.

The method according to the invention is also advantageously developed in that useful vegetation regions, in which useful plants are to be expected according to the seed position information, are determined. Alternatively or additionally, harmful vegetation regions, in which harmful plants are to be expected according to the seed position information, are determined. The useful vegetation regions preferably extend along the seed rows. The harmful vegetation regions relate to the areas between adjacent seed rows. Depending on the spacing between the seeds within individual seed rows, harmful vegetation regions can also form between the seeds of individual seed rows. By comparison of the position of the detected potential harmful vegetation with the determined useful vegetation regions and/or with the determined harmful vegetation regions, it can be determined in a simple manner whether the potential harmful vegetation is actual harmful vegetation to which spray liquid is to be locally applied.

Furthermore, a method according to the invention in which the seed position information is provided via wires to the agricultural sprayer is preferred. Alternatively or additionally, the seed position information can be provided wirelessly to the agricultural sprayer. The provision of the seed position

information can be done, for example, as a result of a data query from the agricultural sprayer or as a result of a corresponding transmission command which has been input via an administration application, in particular via a personal computer or a mobile terminal. The administration application can be, for example, 5 part of a farm management system, by means of which a farmer can manage their agricultural areas. For example, the administration application can be used to store, for later use, application maps relating to individual agricultural areas. Such application maps can comprise the seed position information. The provision of the seed position information for the agricultural sprayer is preferably done before 10 and/or during the application of the spray liquid. The seed position information can be provided, for example, locally by a user of the agricultural sprayer and/or by a third party, for example a service provider.

In another embodiment of the method according to the invention, the provision of the seed position information for the agricultural sprayer comprises the 15 transmission of the seed position information from a mobile data carrier to the agricultural sprayer. The mobile data carrier can be, for example, a memory stick, such as a USB stick. However, the mobile data carrier can also be part of a mobile terminal, for example a smartphone or a tablet. Furthermore, the provision of the seed position information for the agricultural sprayer can comprise the 20 transmission of the seed position information from a central computer, in particular via mobile telecommunications, to the agricultural sprayer. The central computer can be, for example, a server that is operated by an agricultural machine manufacturer or by a third-party supplier. The central computer can be associated with a farm management system so that a farmer can access the central computer 25 by means of a corresponding administration application. For example, application maps relating to individual agricultural areas can be stored on the central computer for later use. Such application maps can comprise the seed position information. In particular, the seed position information is transmitted from the central computer to the agricultural sprayer using the Internet. For example, an 30 agricultural machine manufacturer or a third-party supplier can provide database systems which a farmer can use for storing seed position information during or after sowing seed and/or for retrieving seed position information before and/or

during the application of spray liquid. The provision of the seed position information for the agricultural sprayer can also comprise the transmission of the seed position information from a seed drill to the agricultural sprayer. In this case, the seed position information can be directly sent from the seed drill to the
5 agricultural sprayer. Alternatively or additionally, the seed position information can be sent from the seed drill to the agricultural sprayer via one or more intermediate instances, for example via a farm management system.

Furthermore, a method according to the invention in which seed position information is recorded by a seed drill, in particular during the sowing of seed, is
10 preferred. Seed position information is preferably recorded using a satellite navigation module, in particular a GPS module, of the seed drill. Recording seed position information can also comprise calculating seed position information, for example on the basis of the machine configuration of the seed drill and geographical position data captured by the seed drill during sowing.

15 In another embodiment of the method according to the invention, the recorded seed position information is stored by the seed drill. Alternatively or additionally, the recorded and/or stored seed position information is provided by the seed drill. The seed drill can store the recorded seed position information either in a data memory internal to the seed drill or in a data memory external to the seed drill.

20 In a development of the method according to the invention, the provision of the recorded and/or stored seed position information by the seed drill comprises the transmission of the seed position information from the seed drill to a mobile data carrier, the transmission of the seed position information from the seed drill to a central computer, in particular via mobile telecommunications, and/or the
25 transmission of the seed position information from the seed drill to the agricultural sprayer.

Also advantageous is a method according to the invention in which the vegetation is examined by the agricultural sprayer using one or more spectral sensors. In particular, the vegetation is examined with regard to its radiation properties and/or
30 reflection properties and/or with regard to its color. For identifying actual harmful

vegetation, a useful vegetation spectral range is defined, to which substantially all the expected useful vegetation is assigned.

If the one or more spectral sensors detect vegetation which lies outside of the previously defined useful vegetation spectral range, the vegetation is classified
5 as harmful vegetation. Furthermore, for identifying actual harmful vegetation, a harmful vegetation spectral range can be defined, to which substantially all the expected harmful vegetation can be assigned. If the one or more spectral sensors detect vegetation which examined with regard to its radiation properties and/or reflection properties and/or with regard to its color. For identifying actual
10 harmful vegetation, a useful vegetation spectral range can be defined, to which substantially all the expected useful vegetation can be assigned. If the one or more spectral sensors detect vegetation which lies outside of the previously defined useful vegetation spectral range, the vegetation is classified as harmful vegetation. According to the invention, for identifying actual harmful vegetation, a
15 harmful vegetation spectral range is defined, to which substantially all the expected harmful vegetation can be assigned. If the one or more spectral sensors detect vegetation which lies within the previously defined harmful vegetation spectral range, the vegetation is classified as harmful vegetation. Moreover, for identifying actual harmful vegetation, a soil spectral range can be
20 defined, which defines the expected radiation properties, reflection properties and/or the expected color of the agricultural soil. If the one or more spectral sensors detect vegetation which lies outside of the previously defined soil spectral range, the vegetation is classified as harmful vegetation. Identifying harmful vegetation by taking into account a soil spectral range is advantageous
25 in particular if any useful vegetation is yet to be expected on the agricultural soil and therefore all vegetation present can be assessed as harmful vegetation. Also in accordance with the invention is a method in which the agricultural sprayer identifies the actual harmful vegetation also on the basis of the data from the one or more spectral sensors. According to the invention, a plurality of spectral
30 ranges are defined, and different harmful plant types or harmful plant varieties are detected using the plurality of different spectral ranges.

This allows different amounts of an active substance to be dispensed or different active substances or active substance mixtures to be dispensed onto the different harmful plant types or harmful plant varieties.

Furthermore, a method according to the invention is advantageous which

- 5 comprises detecting useful vegetation, in particular useful vegetation rows, and the position thereof by the agricultural sprayer, comparing the detected positions of the useful vegetation and the seed position information and/or correcting the seed position information on the basis of the detected positions of the useful vegetation. When recording seed position information is compared with the detected positions
10 of the useful vegetation, a correction of the seed position information which eliminates or at least considerably reduces any inaccuracies in the seed position information can be carried out.

- The object of the invention is also achieved by the characterizing features of claim 10. With regard to the advantages and modifications of the sprayer according to
15 the invention, reference is first made to the advantages and modifications of the method according to the invention.

- In a particularly preferred embodiment of the sprayer according to the invention, the detection device comprises one or more satellite navigation modules, in particular one or more GPS modules, by means of which the position of the potential harmful
20 vegetation can be detected. In this case, for example the position of potential harmful vegetation relative to a sensor, such as an optical sensor or a radar sensor, or relative to a camera can first be detected before the geographical position of the detected potential harmful vegetation is determined using the position of the sensor or the camera relative to one or more satellite navigation modules.

- 25 In a development of the sprayer according to the invention, the detection device comprises one or more spectral sensors, by means of which a spectral examination of the vegetation can be carried out. Preferably, the one or more spectral sensors are in the form of color sensors, infrared sensors or radar sensors and/or are part of a camera, whereby different sensor types and/or camera types can also be used in
30 combination. In particular, the one or more spectral sensors are configured to detect

colors, radiation states and/or reflection states and/or allow radiation signatures, in particular infrared signatures, to be created.

In another embodiment of the sprayer according to the invention, the sprayer is designed to carry out the method for applying a spray liquid according to one of
5 the embodiments described above.

Further details of the invention can be found in the description of the figures and in the drawings. The following are shown:

Fig. 1 an embodiment of the agricultural sprayer according to the invention during the execution of the method according to the invention; and

10 Fig. 2 a useful plant stock, to which spray liquid is to be applied by means of the method according to the invention.

Fig. 1 shows an application combination consisting of an agricultural vehicle 100, which is in the form of a tractor, and an agricultural sprayer 10, which is pulled by the vehicle 100 and is in the form of a field sprayer.

15 The agricultural sprayer 10 comprises a storage container 12, which stores a spray liquid to be applied or a carrier liquid that is yet to be mixed with an active substance in order to form a spray liquid to be applied. The storage container 12 is fluidically connected to a plurality of application elements, which are in the form of spray nozzles and are arranged on a multi-part spray boom 14a, 14b.

20 The application elements are connected to a control device which makes it possible to control the application of the spray liquid in such a way that the spray liquid is applied only locally and not over the entire working width of the sprayer 10. Furthermore, the sprayer can also be configured to locally apply different spray liquids, for example having different active substance concentrations and/or
25 different active substances.

The spray liquid is applied to an agricultural area which, in addition to useful vegetation N, also has harmful vegetation S. The useful vegetation N is arranged in useful vegetation rows 20a-20q. The useful vegetation rows 20a-20q result since

the seed is likewise sown in corresponding rows. The aim of the application of spray liquid is to locally dispense the spray liquid onto the harmful vegetation S. The application combination consisting of the agricultural vehicle 100 and the agricultural sprayer 10 travels along a travel lane 16, which has two tracks 18a, 18b, wherein a
5 useful vegetation row 20i is also arranged between the tracks 18a, 18b.

The agricultural sprayer 10 has a detection device, which is designed to detect potential harmful vegetation P and the position thereof. Potential harmful vegetation P can be, for example, vegetation whose radiation properties, reflection properties or color deviates from the usual and/or expected radiation properties,
10 reflection properties or the usual and/or expected color of the useful plants which were sown. Potential harmful vegetation P can also be, for example, vegetation whose position lies within a region in which harmful vegetation and/or no useful vegetation is to be expected. The control device is configured to identify the actual harmful vegetation S on the basis of seed position information and the position of
15 the detected potential harmful vegetation P in order to be able to apply spray liquid locally to the actual harmful vegetation S.

The detection device comprises a satellite navigation module, which is in the form of a GPS module, and a plurality of optical sensors. The optical sensors are arranged on the distributor boom 14a, 14b and allow for the optical detection of the
20 potential harmful vegetation P. For example, the optical sensors are in the form of spectral sensors, by means of which a spectral examination of the vegetation can be carried out. The position of the potential harmful vegetation P can be determined using the sensor data from the optical sensors, the geographical position data from the satellite navigation module and the relative position between
25 the optical sensors and the satellite navigation module.

The seed position information is seed row position information from which the control device can derive the expected positions of the useful vegetation rows 20a-20q. By comparing the seed position information, or information derived from the seed position information, and the position of the potential harmful vegetation P, it
30 is thus possible to identify, reliably and comparatively cost-effectively, actual

harmful vegetation S by means of the agricultural sprayer 10 so that a corresponding local application of spray liquid can be carried out.

Previously, during sowing of the seed, a seed drill recorded and stored the seed position information and provided it to a central computer for later retrieval. The
5 central computer is a server which is associated with a farm management system in this case. The seed position information was stored in the form of an application map which comprises deposit positions for the sown seed. Before the application of the spray liquid, the transmission of the seed position information from the central computer of the farm management system to the agricultural sprayer 10
10 was initiated by means of a transmission command which was input via an administration application on a mobile terminal. The central computer thus provides a database for storing and retrieving agricultural data.

Fig. 2 schematically shows how the plant stock is classified into useful vegetation regions NB and harmful vegetation regions SB during the execution of one
15 embodiment of the method. The useful vegetation regions NB and harmful vegetation regions SB are determined by the agricultural sprayer 10 on the basis of the seed position information provided to the agricultural sprayer 10. Useful vegetation regions NB are regions in which useful plants are to be expected according to the seed position information. Harmful vegetation regions SB are
20 regions in which harmful plants are to be expected according to the seed position information. Depending on whether the position of detected potential harmful vegetation P lies in a useful vegetation region NB or in a harmful vegetation region SB, the potential harmful vegetation P is assessed as actual harmful vegetation S or as useful vegetation N.

25 Furthermore, it is also possible by means of the method to detect the useful vegetation rows 20a-20q and the positions thereof and to compare them with the seed position information. In this way, inaccuracies in the seed position information attributable to the recording sensor system can be corrected. By correcting the seed position information on the basis of the detected positions of
30 the useful vegetation rows 20a-20q, at least some recording inaccuracies in the satellite-based position detection are compensated for.

List of reference signs

	10	Spraying apparatus
	12	Storage container
5	14a, 14b	Distributor boom
	16	Travel lane
	18a, 18b	Tracks
	20a-20q	Useful vegetation rows
	100	Vehicle
10	P	Potential harmful vegetation
	S	Actual harmful vegetation
	N	Useful vegetation
	SB	Harmful vegetation regions
	NB	Useful vegetation regions

PATENTKRAV

1. Fremgangsmåde til udspredning af en sprøjtevæske ved hjælp af en landbrugssprøjte (10), hvilken fremgangsmåde omfatter følgende trin:

- detektering af potentiel skadelig plantevækst (P) og dens position ved
5 hjælp af landbrugssprøjten (10); og
- styring af udspreddingen af sprøjtevæsken med landbrugssprøjten (10), således at sprøjtevæsken udspreddes lokalt på faktisk skadelig plantevækst (S);
- identificering af den faktiske skadelige plantevækst (S) ved hjælp af
landbrugssprøjten (10) på basis af informationer om såsædsposition og positionen
10 af den detekterede potentielle skadelige plantevækst (P),

kendetegnet ved følgende trin:

- undersøgelse af plantevæksten ved hjælp af én eller flere
spektralsensorer med landbrugssprøjten (10), idet landbrugssprøjten (10) også
identificerer den faktiske skadelige plantevækst (S) på basis af dataene fra den
15 ene eller flere spektralsensorer, idet der til identificering af faktisk skadelig
plantevækst (S) defineres et spektralområde for skadelig plantevækst, til hvilket i
det væsentlige al den skadelige plantevækst (S), der kan forventes, kan henføres,
eller idet der defineres en flerhed af forskellige spektralområder, ved hjælp af
hvilke forskellige skadelige plantetyper eller skadelige plantesorter kan detekteres.

20 2. Fremgangsmåde ifølge krav 1,

kendetegnet ved, at informationerne om såsædsposition omfatter
positionsinformationer om såsædsrække og/eller positionsinformationer om
udspreddingsbane.

3. Fremgangsmåde ifølge krav 1 eller 2,

25 **kendetegnet ved** mindst ét af følgende trin:

- bestemmelse af områder med nyttevækst (NB), i hvilke der ifølge
informationerne om såsædsposition skal forventes nyttevækst;

- bestemmelse af områder med skadelig plantevækst (SB), i hvilke der ifølge informationerne om såsædsposition skal forventes skadelig plantevækst.

4. Fremgangsmåde ifølge et hvilket som helst af de foregående krav,

kendetegnet ved mindst ét af følgende trin:

- 5 - kabelforbundet tilvejebringelse af informationerne om såsædsposition for landbrugssprøjten (10);

- trådløs tilvejebringelse af informationerne om såsædsposition for landbrugssprøjten (10).

5. Fremgangsmåde ifølge krav 4,

10 **kendetegnet ved, at** tilvejebringelse af informationerne om såsædsposition for landbrugssprøjten (10) omfatter mindst ét af følgende trin:

- overførsel af informationerne om såsædsposition fra en mobil databærer til landbrugssprøjten (10);

- overførsel af informationerne om såsædsposition fra en centralcomputer, 15 især via mobil telekommunikation, til landbrugssprøjten (10);

- overførsel af informationerne om såsædsposition fra en såmaskine til landbrugssprøjten (10).

6. Fremgangsmåde ifølge et hvilket som helst af de foregående krav,

kendetegnet ved følgende trin:

- 20 - registrering af informationer om såsædsposition ved hjælp af en såmaskine, især under udspredningen af såsæd.

7. Fremgangsmåde ifølge krav 6,

kendetegnet ved mindst ét af følgende trin:

- lagring af de registrerede informationer om såsædsposition ved hjælp af 25 såmaskinen;

- tilvejebringelse af de registrerede og/eller lagrede informationer om såsædsposition ved hjælp af såmaskinen.

8. Fremgangsmåde ifølge krav 7,

kendetegnet ved, at tilvejebringelse af de registrerede og/eller lagrede informationer om såsædsposition ved hjælp af såmaskinen omfatter mindst ét af følgende trin:

- overførsel af informationerne om såsædsposition fra såmaskinen til en mobil databærer;
- overførsel af informationerne om såsædsposition fra såmaskinen til en centralcomputer, især via mobil telekommunikation;
- overførsel af informationerne om såsædsposition fra såmaskinen til landbrugssprøjten (10).

9. Fremgangsmåde ifølge et hvilket som helst af de foregående krav,

kendetegnet ved mindst ét af følgende trin:

- detektering af nyttevækst (N), især rækker med nyttevækst (20a-20q), og dens position ved hjælp af landbrugssprøjten (10);
- sammenligning af de detekterede positioner af nyttevæksten (N) og informationerne om såsædsposition;
- korrigerende af informationerne om såsædsposition på basis af de detekterede positioner af nyttevæksten (N).

10. Landbrugssprøjte (10), især en marksprøjte, der omfatter

- en flerhed af udspredelementer til udsprede af en sprøjtevæske;
- en detekteringsindretning, der er udformet til at detektere potentiel skadelig plantevækst (P) og dens position;

- en styreindretning, der er udformet til at styre udspredningen af sprøjtevæsken ved hjælp af udspretningsselementerne på en sådan måde, at sprøjtevæsken udsprede lokalt på faktisk skadelig plantevækst (S);

idet styreindretningen er udformet til at identificere den faktiske skadelige plantevækst (S) på basis af informationer om såsædsposition og positionen af den detekterede potentielle skadelige plantevækst (P),

kendetegnet ved, at styreindretningen er udformet til at undersøge plantevæksten ved hjælp af én eller flere spektralsensorer med landbrugssprøjten (10), idet landbrugssprøjten (10) også identificerer den faktiske skadelige plantevækst (S) på basis af dataene fra den ene eller flere spektralsensorer, idet der til identificering af faktisk skadelig plantevækst (S) defineres et spektralområde for skadelig plantevækst, til hvilket i det væsentlige al den skadelige plantevækst (S), der kan forventes, kan henføres, eller idet der defineres en flerhed af forskellige spektralområder, ved hjælp af hvilke forskellige skadelige plantetyper eller skadelige plantesorter kan detekteres.

11. Sprøjte (10) ifølge krav 10,

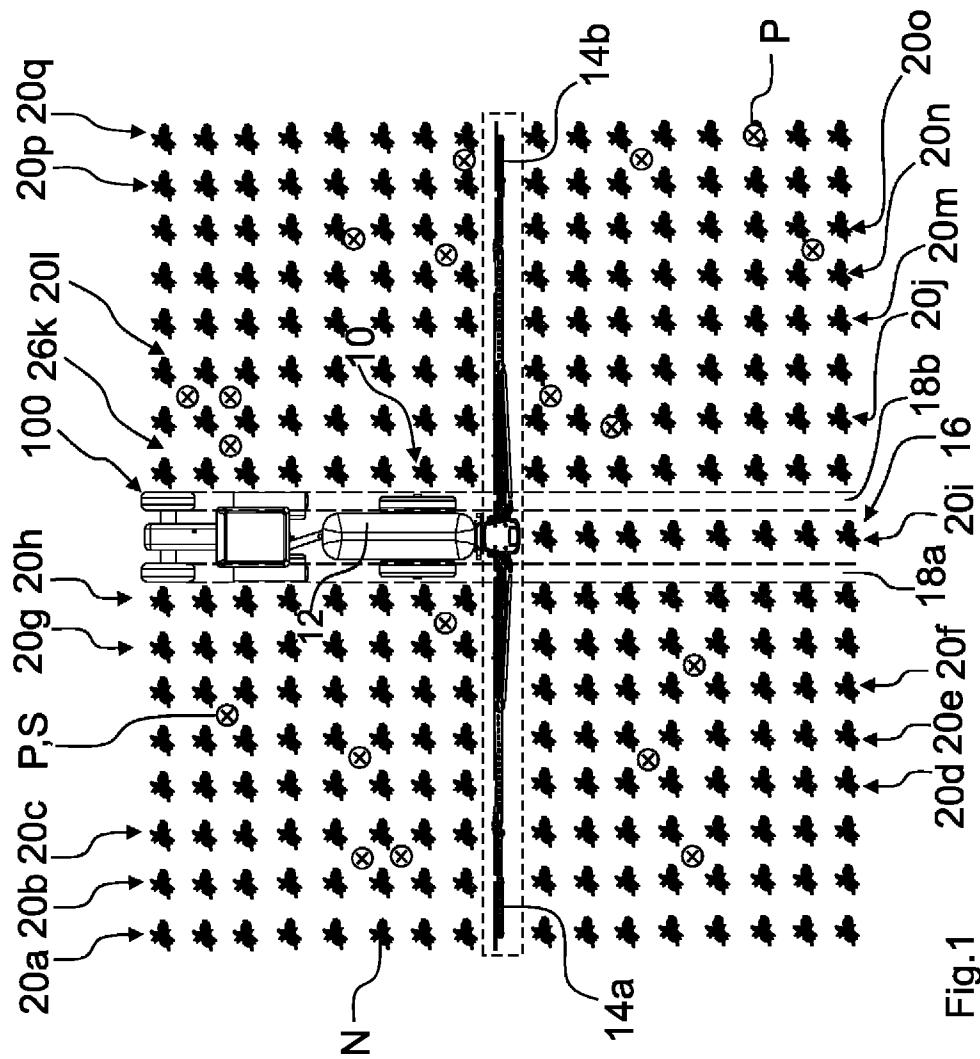
kendetegnet ved, at detekteringsindretningen omfatter ét eller flere satellitnavigationsmoduler, især ét eller flere GPS-moduler, ved hjælp af hvilke positionen af den potentielle skadelige plantevækst (P) kan detekteres.

12. Sprøjte (10) ifølge krav 10 eller 11,

kendetegnet ved, at detekteringsindretningen omfatter én eller flere spektralsensorer, ved hjælp af hvilke der kan udføres en spektral undersøgelse af plantevæksten.

13. Sprøjte (10) ifølge et hvilket som helst af kravene 10 til 12,

kendetegnet ved, at sprøjten (10) er udformet til at udføre fremgangsmåden til udspretning af en sprøjtevæske ifølge et hvilket som helst af kravene 1 til 9.



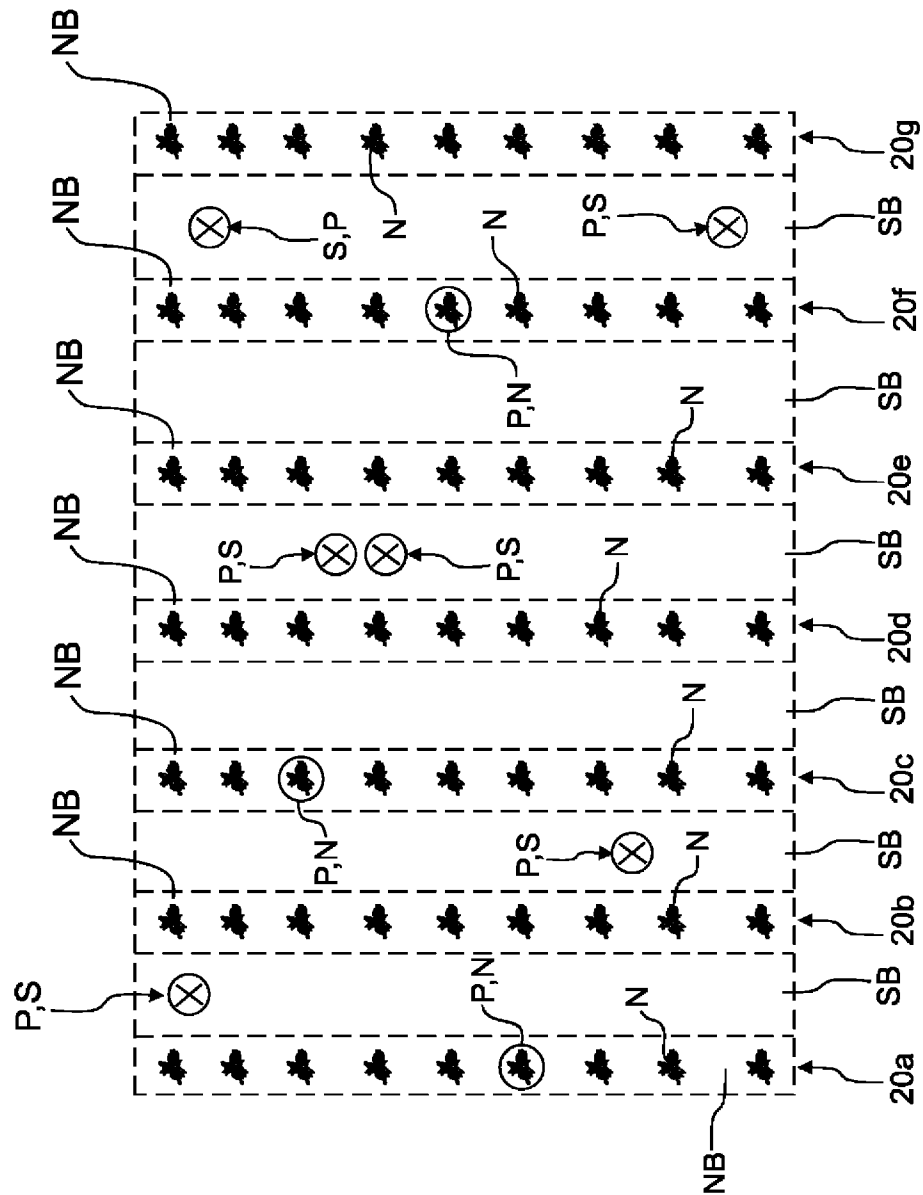


Fig.2