

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
20 October 2005 (20.10.2005)

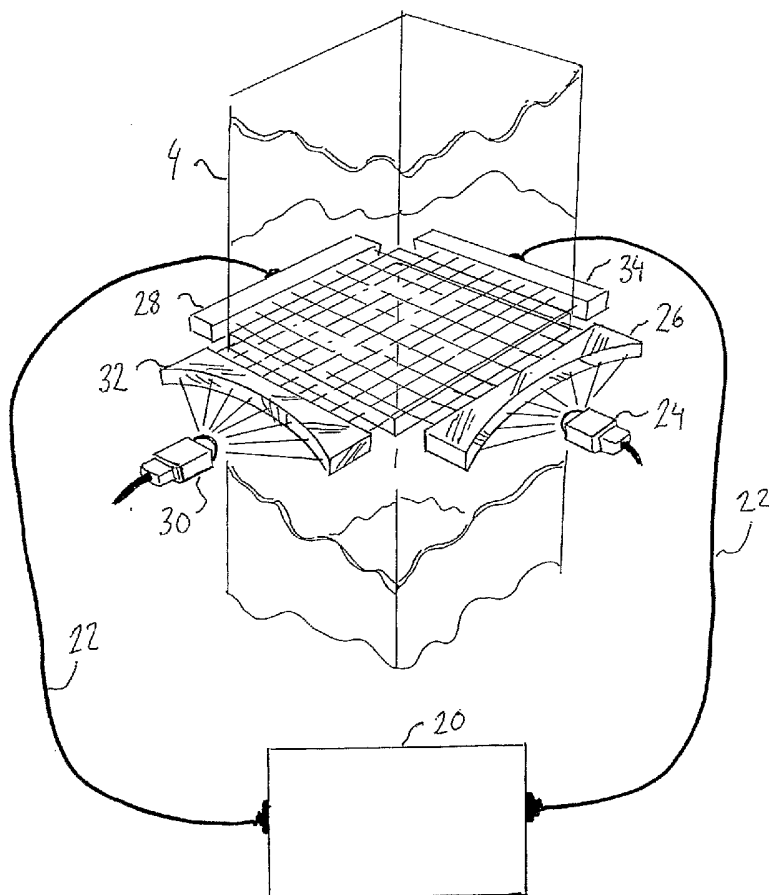
PCT

(10) International Publication Number
WO 2005/096799 A1

- (51) International Patent Classification⁷: **A01C 7/00**, [SE/SE]; Johannelundsvägen 6, S-587 24 LINKÖPING (SE).
G06M 7/00
- (21) International Application Number: PCT/SE2005/000479
- (22) International Filing Date: 1 April 2005 (01.04.2005)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 0400933-8 6 April 2004 (06.04.2004) SE
- (71) Applicant (for all designated States except US): **VÄDERSTAD-VERKEN AB** [SE/SE]; P.O. Box 85, S-590 21 VÄDERSTAD (SE).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **STARK, Fredrik**
- (74) Agent: **ALBIHNS STOCKHOLM AB**; P.O. Box 5581, S-114 85 STOCKHOLM (SE).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,

[Continued on next page]

(54) Title: DEVICE AND PROCEDURE FOR SEED COUNTING IN SEED DRILL



(57) Abstract: Abstract Device and procedure for seed counting in a seed drill comprising a seed container and a plurality of seed nozzles connected with connecting conduits (4, 5), and an air flow source adapted to create an air flow to conduct crop seed in the form of seeds from the seed container to the seed nozzles. A detection entity (18) is arranged at the connecting conduit (4, 5), and comprises two light sources (24, 30) adapted to send parallel light beams essentially perpendicular to the direction of flow in the connecting conduit (4, 5). Two line cameras (28, 34) are arranged at the opposite side of the connecting conduit (4, 5) having the aim of sensing the light level from the two light sources (24, 30). The line cameras (28, 34) are connected to a control entity (20) adapted to calculate the number of seeds that pass the line cameras (28, 34) by comparing the light level across the width of the line cameras (28, 34) over time. (Figure 2)

WO 2005/096799 A1



ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO,
SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN,
GQ, GW, ML, MR, NE, SN, TD, TG).

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.

Published:

— *with international search report*

Device and procedure for seed counting in seed drill

The invention refers to a device for seed counting in seed drills according to the ingress of Claim 1, and a procedure for seed counting according to the ingress of Claim 7.

5

Background of the invention

There are today many tractor-drawn seed drills with pneumatic seed metering systems. Some of these seed drills are provided with some form of seed counting
10 device with the aim of ensuring metering of the desired number of seeds per area.

Such a seed counting device is shown in DE 101 34 991. Here a solution is shown where the flow of seed is diverted to a counting entity during a short time when the seed drill is disposed on the headland. The solution brings disadvantages in the
15 form of relatively slow feedback since seed counting can only occur on certain specific occasions.

Another device is shown in US 5 883 383. Here a light sensor is arranged in each feed pipe. This solution entails that if a seed passes close to the light source, there
20 is a risk of it 'shading' other seeds which are therefore not detected and represent a source of error in the result.

Objects of the invention

25 The object of the invention is to provide a device for seed counting in seed drills where the abovementioned disadvantages are avoided and which allows total flow measuring with relatively rapid feedback.

Furthermore the device should be able to be installed and used without extensive modifications of the rest of the seed drill. The device should also be easy to maintain, easy to adjust and in general be independent of seed type and metering rate.

5

The device also has the object of providing a procedure for seed counting in seed drills where the abovementioned disadvantages are avoided and which allows total flow measuring with relatively rapid feedback, and which is in general independent of seed type and metering rate.

10

Summary of the invention

The object of the invention is solved by a device according to Claim 1. Here a detection entity comprising two light sources is arranged with interacting line
15 cameras where both light sources emit essentially parallel beams but perpendicular to the beams of the other light source. The light beams are detected by the line cameras. The risk is hereby minimised of a seed being shaded by another seed near the light source, alternatively of the seed near the light source being interpreted as several smaller seeds further away. Having two essentially perpendicularly
20 arranged line cameras where one can compare their results allows one line camera to also identify seeds wholly or partly shielded from the other camera by other seeds, which gives an even better measurement result. The use of line cameras permits a comparatively time-specific and position specific device which can thereby be made practically independent of seed size and metering rate.

25

Claims 2 and 3 describe advantageous embodiments of details.

With a device according to Claim 4 with the detection entity in the connecting conduit before the distributor head, measurement of total flow is possible and

measurement comparatively close to the dosing device, and also the air flow source, which provides the potential for relatively rapid feedback.

Claims 5 and 6 describe alternative embodiments for partial flow measurement
5 for achieving as good measurements results as possible.

With a procedure according to Claim 7, good possibilities are obtained to identify every seed and to distinguish two or more seeds that pass the line cameras essentially simultaneously. By comparing the results from two line cameras
10 arranged perpendicular to each other, the possibility is also provided to identify seeds wholly or partly shaded by other seeds without any seeds being counted several times, which provides an even better measurement result.

Finally Claim 8 describes an advantageous procedure for seed counting where a
15 plurality of detection entities measure partial flows and where these partial flows are added and the total number of passed seeds is calculated based on a predicted relationship of the total seed flow expected to pass the detection entities included in the calculation.

20 The further characteristics and advantages of the invention are described more closely below with the help of an embodiment example and drawings related thereto.

Drawing summary

25

Figure 1 shows a schematic view of the seed metering system of a seed drill.

Figure 2 shows a schematic view of a detection entity.

Figure 3 shows schematic images detected by the detection entity.

Description of an embodiment example

Figure 1 shows a schematic view of the pneumatic metering system of a tractor-drawn seed drill. The seed is stored in a seed container 2 and conducted via a connecting conduit 4, 5 to a plurality of seed nozzles 12 (only one shown in fig. 2), here in the form of seed coulters. The distribution device 5 is comprised here in its turn of a distributor head 6 with a plurality of outlets 8 (only one shown in fig. 2) each connected to its individual seed coulters 12 via its individual second conduit (only one shown in fig.), here in the form of hoses 10.

10

A dosing device 14 of some type is arranged between the seed container 2 and the pipe part 4. An air flow source 16 in the form of a fan is adapted to generate an air flow that transports the seed from the seed container 2 to the seed nozzles 12 via the pipe part 4, the distributor head 6 and the hoses 10.

15

A detection entity 18 according to the invention is arranged at the pipe part 4. The detection entity 18 is connected to a control entity 20 for signal transfer via one or several connections 22. The control entity 20 is also connected to the dosing device 14 and in this case also the fan 16 via connections 23, 25.

20

The detection entity 18 comprises a first light source 24, here in the form of a laser, arranged at the pipe part 4 for sending parallel light beams via a first lens 26 essentially perpendicular to the direction of flow in the pipe part 4 across its entire cross-section. A first line camera 28 (sometimes called photodiode array) is arranged at the opposite side of the pipe part 4 with the aim of sensing the light level from the laser 24 across the entire width of the line camera 28. The line camera 28 is connected to the control entity 20.

25

The detection entity 18 also comprises a second light source 30, here in the form

of a laser, arranged at essentially the same axial position on the pipe part 4 as the first laser 24. The second laser 30 is adapted to send parallel light beams via a second lens 32 in essentially the same plane as the light beams of the first laser 24 but essentially perpendicular to those beams across the entire cross-section of the pipe part 4. A second line camera 34 is arranged at the opposite side of the pipe part 4 with the aim of sensing the light level from the second laser 30 across the entire width of the line camera 34. The line camera 34 is also connected to the control entity 20.

10 The pipe part 4 is suitably comprised of a metal pipe with essentially circular cross-section except in the area of the detection entity 18 where the cross-section is rectangular, preferably essentially quadratic with the aim that the light beams and the line cameras are able to detect the entire cross-section. This is achieved by mechanical reshaping of the pipe in this area.

15 It is advantageous to arrange the detection entity 18 in a straight part of the pipe part 4 since the risk of turbulence is lowest there. Otherwise one risks whirling seeds which risk passing the line cameras 28, 34 on several occasions causing erroneous measurement results.

20 The procedure for seed counting is described now with the help of Figure 3. There is shown an example of a picture that is detected by the first line camera 28 across its entire width B_1 and a picture that is detected by the second line camera 34 across its entire width B_2 as a function of time t .

25 The line cameras 28, 34 sense the light level at the respective width position and time and send data about this to the control entity 20 which is adapted to calculate the number of passed seeds from these data.

The control entity 20 compares the light level with a reference level and interprets levels below the reference level as being a seed passing the line camera, these shown by dark portions 40, 42, 44, 46, 48 in Figure 3. The control entity counts continuous width positions and continuous time-points with a light level below the
5 reference level as the same seed.

According to the example in Figure 3 the control entity accordingly counts that during the time window t_0-t_5 the first line camera 28 (cf. B₁) has detected two seeds 40, 42, one with start time t_1 and finish time t_3 , and one with start time t_2 and
10 finish time t_4 .

Furthermore the control entity counts that during the time window t_0-t_5 the second line camera 34 (cf. B₂) has however detected three seeds 44, 46, 48, one with start time t_1 and finish time t_2 , one with start time t_1 and finish time t_3 and one with start
15 time t_2 and finish time t_4 .

The control entity thereafter compares the results from both line cameras. The control entity is adapted to count seeds detected with the same start time and finish time by both cameras as the same seed. In this comparison, it emerges that the
20 detected seeds 40 and 48 both have start time t_2 and finish time t_4 , wherein the control entity thus counts these as the same seed. It also emerges that the detected seeds 42 and 46 both have start time t_1 and finish time t_3 wherein the control entity thus counts these as the same seed.

25 It hereby follows thus that the control entity according to the example in Figure 3 has identified in total three separate seeds detected by both line cameras during the time window t_0-t_5 . By in this way using two line cameras and comparing the results, one accordingly succeeds in detecting seed 44 which lay hidden behind seed 42, at least partly, for the first line camera (cf. B₁) and was therefore not

identified as a separate seed by it.

The control entity is also provided with indata representing the desired number of seeds per area, the driving speed of the seed drill across the field, the setting of the dosing device, perhaps also the speed of the fan.

The control entity is adapted to calculate the desired number of seeds per unit time based on these indata. By comparing this set point with the detected and counted seeds the control entity can give signals to an influencing member not shown here for the dosing device and perhaps also the fan to influence its setting so that the actual metered amount of seeds per area agrees with the desired set point.

The control entity can advantageously be adapted to receive insignals from the line cameras during a predetermined time window, preferably 1-3 seconds, and thereafter calculate the number of passed seeds. Thereupon a new cycle of reception of new insignals during a new time window can be initiated.

One can also if so desired use a solution where calculation occurs continuously and simultaneously with the signal reception, but this then requires greater processor capacity.

The above-described embodiment is not limiting for the invention which can be varied in a plurality of ways within the frame of the patent claims. According to the embodiment described, the seed drill comprises for example a distributor head arranged inside the seed container. It is also possible to place the distributor head outside the seed container and/or to provide the seed drill with several distributor heads where each head is connected to the seed container via its individual connecting conduit and dosing device.

According to further variants one can arrange the detection entity on one of the hoses 10, alternatively on several of the hoses. With such an arrangement the control entity is adapted to add the calculated seeds from all calculation entities and thereafter calculate the total number of passed seeds based on a set
5 relationship of the total seed flow that is expected to pass the detection entities included in the calculation. If one for example arranges detection entities in two hoses out of a total 20 this set point is set to 1/10. The control entity thereby calculates the total amount of seed metered out during the actual time window to 10 times the calculated amount from the detection entities.

10

A further advantage with several detection entities is that the results can be compared and that one thereby can more easily indicate and notice any faults and damage to the device. One can perhaps allow a part amount of the calculation entities to be used for seed counting and the rest for function control and error
15 indication.

20

A device according to the embodiment example with a detection entity in the pipe part is however preferred since it allows cost-effective whole flow measurement. Since the detection entity is arranged near the dosing device rapid feedback is also permitted.

25

According to the preferred refinements the seed counting entity can be encapsulated around the pipe part or hoses to protect against dirt, moisture and other mechanical effect, in those cases where this can be expected to occur.

A further refinement comprises replaceable and/or cleanable protective glass or plastic or similar adapted to protect the light source and/or the camera against dirt from the flow in the pipe.

Claims

1. A device for seed counting in a seed drill comprising a seed container (2), plurality of seed nozzles (12), connecting conduits (4, 5) between the seed container (2) and the seed nozzles (12), an air flow source (16) adapted to create an air flow to conduct crop seed in the form of seeds from the seed container (2) to the seed nozzles (12), *characterised in that* at least one detection entity (18) is arranged at the connecting conduit (4, 5), which detection entity (18) comprises a first light source (24) arranged at one side of the connecting conduit (4, 5) to send parallel light beams essentially perpendicular to the direction of flow in the connecting conduit (4, 5) across the entire cross-section of the connecting conduit (4, 5), a second light source (30) arranged at the connecting conduit (4, 5) at essentially the same axial position on the conduit (4, 5) as the first light source (24) to send parallel light beams in essentially the same plane as the light beams of the first light source (24) essentially perpendicular to these beams across the entire cross-section of the connecting conduit (4, 5), a first line camera (28) arranged at the opposite side of the connecting conduit (4, 5) relative to the first light source (24) with the aim of sensing the light level from the first light source (24) across the entire width (B_1) of the first line camera (28), a second line camera (34) arranged at the opposite side of the connecting conduit (4, 5) relative to the second light source (30) with the aim of sensing the light level from the second light source (30) across the entire width (B_2) of the second line camera (34), that the line cameras (28, 34) are connected to a control entity (20), and that the control entity (20) is adapted to calculate the number of seeds that pass the line cameras (28, 34) by comparing the light level across the entire width of the line cameras (28, 34) over time (t).

25

2. A device according to claim 1, wherein the connecting conduit (4, 5) at the axial position of the line camera (28, 34) has an essentially rectangular, preferably

quadratic cross-section.

3. A device according to any one of the preceding claims, wherein the light sources (24, 30) are comprised of a respective laser.

5

4. A device according to any one of the preceding claims, wherein the line cameras (28, 34) are arranged at a pipe part (4) of the connecting conduit (4, 5), that the pipe part (4) connects a dosing device (14) with a distribution device (5) and that the distribution device (5) is comprised of a distributor head (6) with a plurality of outlets (8), where each outlet (8) is connected to a seed nozzle (12), preferably in the form of a seed couler.

10

5. A device according to any one of Claims 1-4, wherein the connecting conduit (4, 5) comprises a distribution device (5) connected to a seed container (2), that the distribution device (5) is comprised of a distributor head (6) with a plurality of outlets (8), where each outlet (8) is connected to a seed nozzle (12), preferably in the form of a seed couler, with a respective other conduit (10), and that a detection entity (18) is arranged at at least one other conduit (10).

15

20

6. A device according to Claim 5, wherein a detection entity (18) is arranged at a plurality of other conduits (10).

7. Procedure for seed counting with a device according to any one of Claims 1-6, *characterised in that* the line cameras (28, 34) send signals to the control entity (20) corresponding to the light level at a number of different width positions (B_1 , B_2) at a number of specified time-points (t), that the control entity (20) compares the light status with a reference level, that the control entity (20) interprets continuous width positions (B_1 , B_2) and continuous time-points (t) with

25

a light level below a predetermined reference level as one seed detected by the actual camera (28, 34), that the control entity (20) compares the results from both cameras (28, 34), and that seeds detected with the same start time (t) and finish time (t) by both cameras (28, 34) are counted as the same seed.

5

8. Procedure for seed counting according to Claim 7 with a device according to any one of Claims 2-5, wherein the line cameras (28, 34) in each detection entity (18) send signals to the control entity (20) corresponding to the light level at a number of different width positions (B_1 , B_2) at a number of specified time-points (t), that the control entity (20) compares the light level with a reference level, that the control entity (20) interprets continuous width positions (B_1 , B_2) and continuous time-points (t) with a light level below a predetermined reference level as one seed detected by the relevant camera (28, 34), that the control entity (20) compares the results from both cameras (28, 34), and that seeds detected with the same start time (t) and finish time (t) by both cameras (28, 34) are counted as the same seed, that the control entity (20) adds the calculated seeds from the detection entities (18), and that the control entity (20) calculates the total number of passed seeds based on a set relationship of the total seed flow predicted to pass the detection entities (18) included in the calculation.

10
15
20

Fig. 1

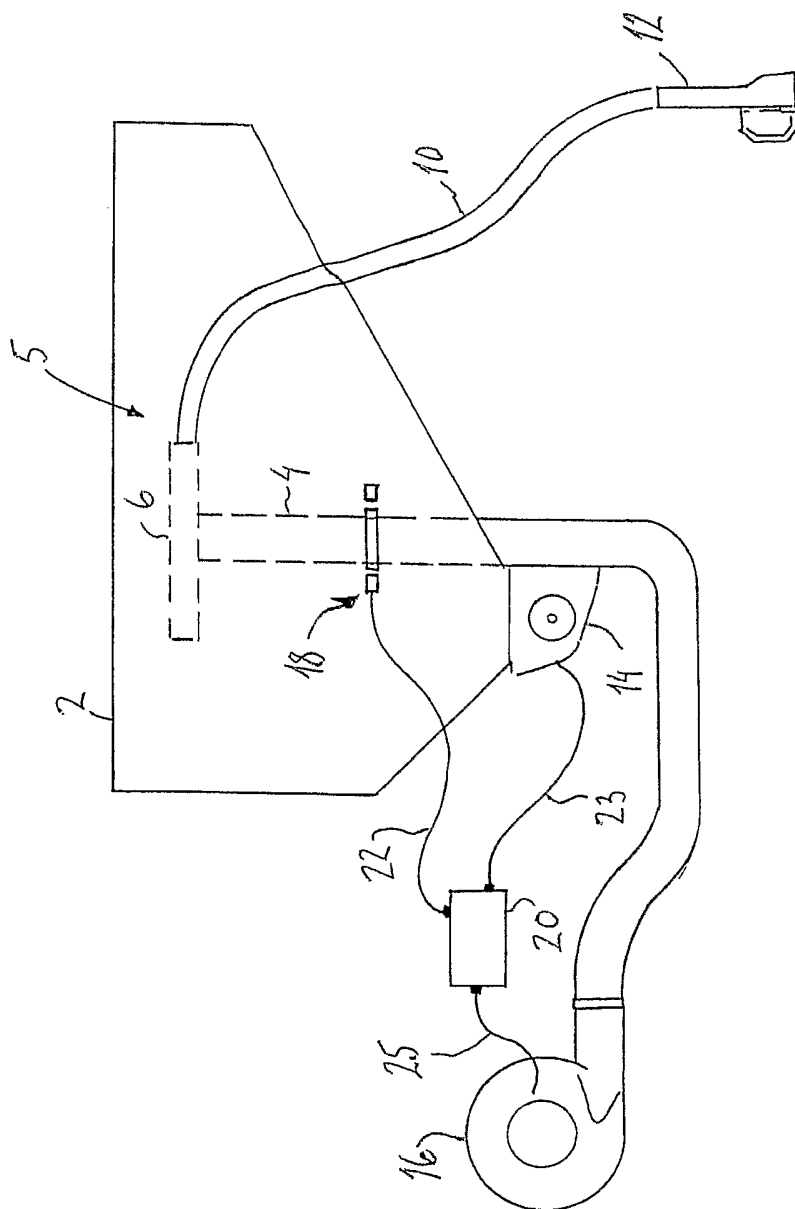


Fig. 2

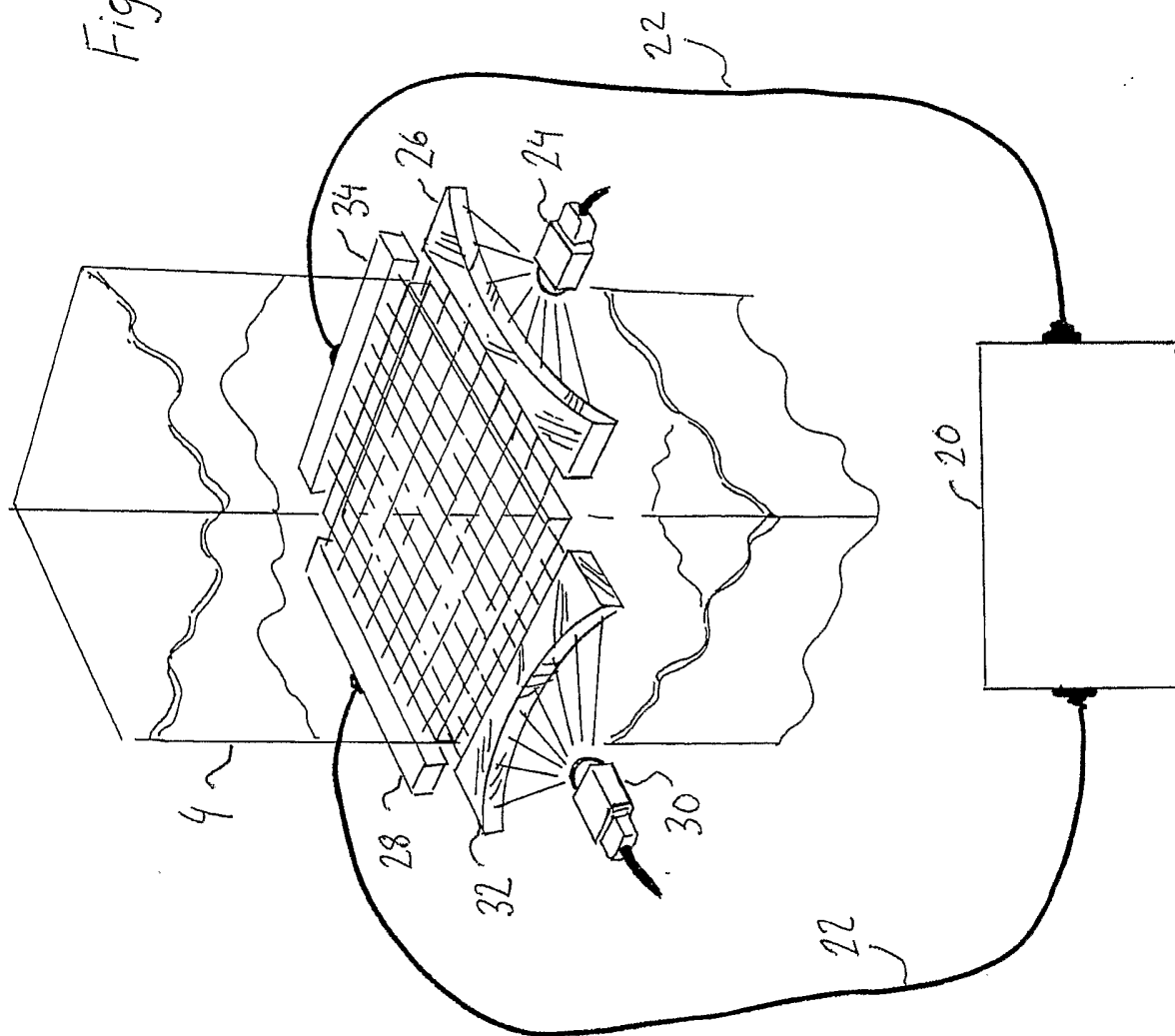
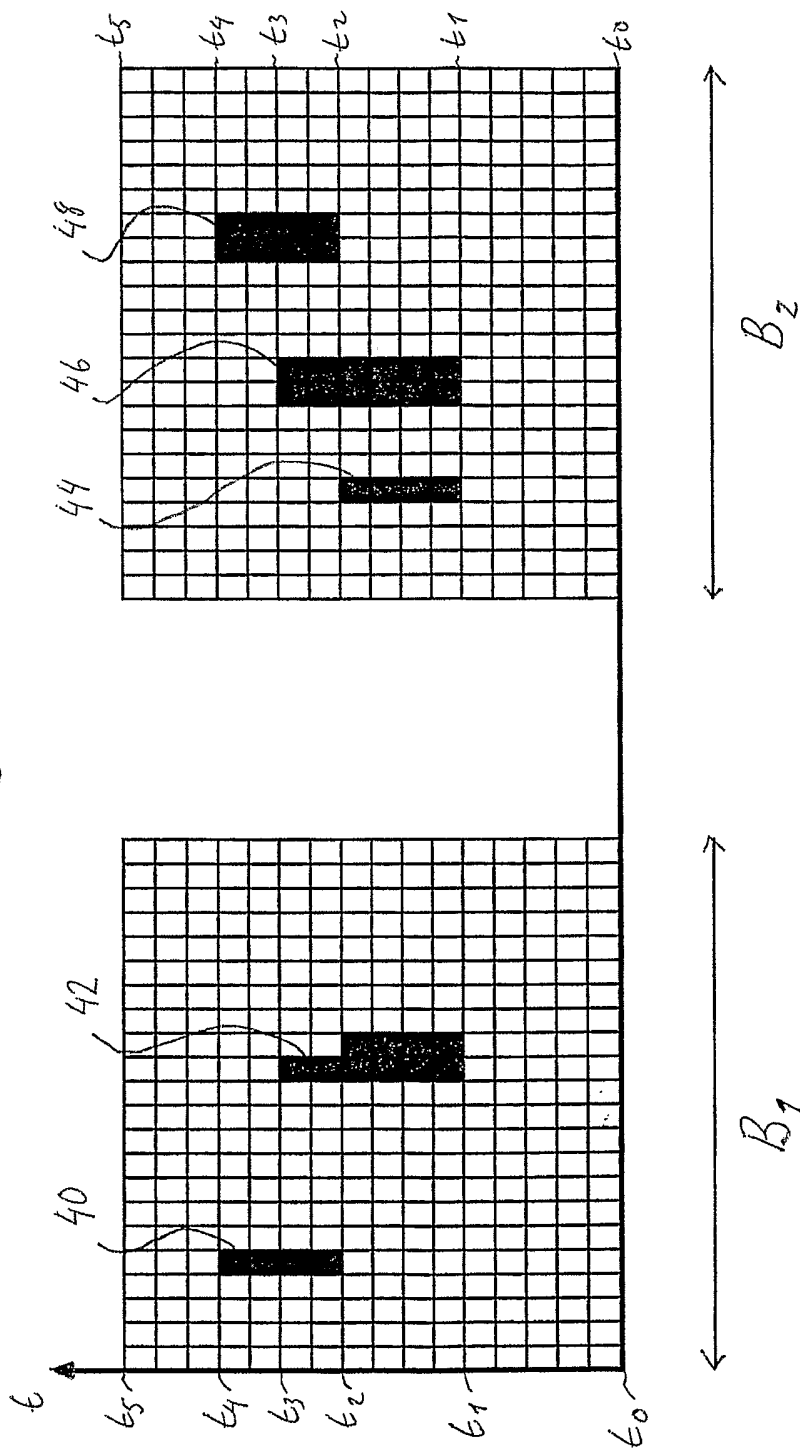


Fig. 3



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 2005/000479

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: A01C 7/00, G06M 7/00
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)

IPC7: A01C, G06M

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4675520 A (JAN HARRSEN ET AL), 23 June 1987 (23.06.1987), column 2, line 3 - line 17; column 2, line 59 - line 63; column 3, line 5 - line 8, column 3, line 18 - line 21; figures 1,4; abstract --	1,7
A	US 6093926 A (KARL-HEINZ O. MERTINS ET AL), 25 July 2000 (25.07.2000), column 6, line 30 - line 38; column 10, line 53 - line 67, figure 2, abstract --	1,4,5,6
A	US 5847389 A (KARL-HEINZ O. MERTINS ET AL), 8 December 1998 (08.12.1998), figures 9a-c, 15, abstract --	1,4,5,6

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 23 June 2005	Date of mailing of the international search report 28-06-2005
--	---

Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Magnus Thorén/MP Telephone No. +46 8 782 25 00
--	--

INTERNATIONAL SEARCH REPORT

Inter application No.
PCT/SE 2005/000479

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5426501 A (JON V. HOKANSON ET AL), 20 June 1995 (20.06.1995), abstract --	1-3
A	US 6296425 B1 (RUSSEL J. MEMORY ET AL), 2 October 2001 (02.10.2001), abstract --	1
A	US 4634855 A (KENNETH D. FRIEND ET AL), 6 January 1987 (06.01.1987), figure 1, claim 1, abstract --	1
A	US 4163507 A (DENNIS M. BELL), 7 August 1979 (07.08.1979), column 1, line 12 - line 35, abstract --	1
A	US 5092675 A (HOLGER T. SOMMER), 3 March 1992 (03.03.1992), abstract -- -----	2-3

INTERNATIONAL SEARCH REPORT

 Inter application No.
 PCT/SE 2005/000479

 US 4675520 A 23/06/1987 DE 3419883 A 28/11/1985
 EP 0166136 A 02/01/1986

 US 6093926 A 25/07/2000 US 5847389 A 08/12/1998
 AU 709264 B 26/08/1999
 AU 6695296 A 29/11/1996
 BR 9608782 A 29/06/1999
 CA 2221165 A,C 21/11/1996
 EP 0827614 A 11/03/1998
 US 5650609 A 22/07/1997
 US 5834764 A 10/11/1998
 US 5936234 A 10/08/1999
 WO 9636889 A 21/11/1996

 US 5847389 A 08/12/1998 US 6093926 A 25/07/2000
 AU 709264 B 26/08/1999
 AU 6695296 A 29/11/1996
 BR 9608782 A 29/06/1999
 CA 2221165 A,C 21/11/1996
 EP 0827614 A 11/03/1998
 US 5650609 A 22/07/1997
 US 5834764 A 10/11/1998
 US 5936234 A 10/08/1999
 WO 9636889 A 21/11/1996

US 5426501 A 20/06/1995 NONE

 US 6296425 B1 02/10/2001 US 6192813 B 27/02/2001
 US 5996516 A 07/12/1999
 US 6158363 A 12/12/2000

 US 4634855 A 06/01/1987 AT 58796 T 15/12/1990
 AU 574503 B 07/07/1988
 AU 4733385 A 20/03/1986
 CA 1242015 A 13/09/1988
 DE 3580733 D 00/00/0000
 EP 0175530 A,B 26/03/1986
 SE 0175530 T3
 IE 56894 B 15/01/1992
 IE 852218 L 10/03/1986
 JP 1603700 C 22/04/1991
 JP 2027711 B 19/06/1990
 JP 61070682 A 11/04/1986
 KR 9303129 B 19/04/1993
 MX 159097 A 14/04/1989
 ZA 8506922 A 27/05/1987

US 4163507 A 07/08/1979 NONE

US 5092675 A 03/03/1992 NONE