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(54) **REGULATION DRYING CONTROL SYSTEM FOR DRYING GRAIN OR OTHER POWDERY MATERIAL**

(57) Regulation drying control system for a grain dryer, where it comprises a humidity sensor (2) with a resolution of 0,01% or more, continuously measuring the humidity of the dry matter in the dryer connected to the control unit (3), which is intended to compare the measured humidity value with the desired humidity value, which is coupled to an actuator (4), which is intended for adjusting the drying time based on information from the control unit (3).

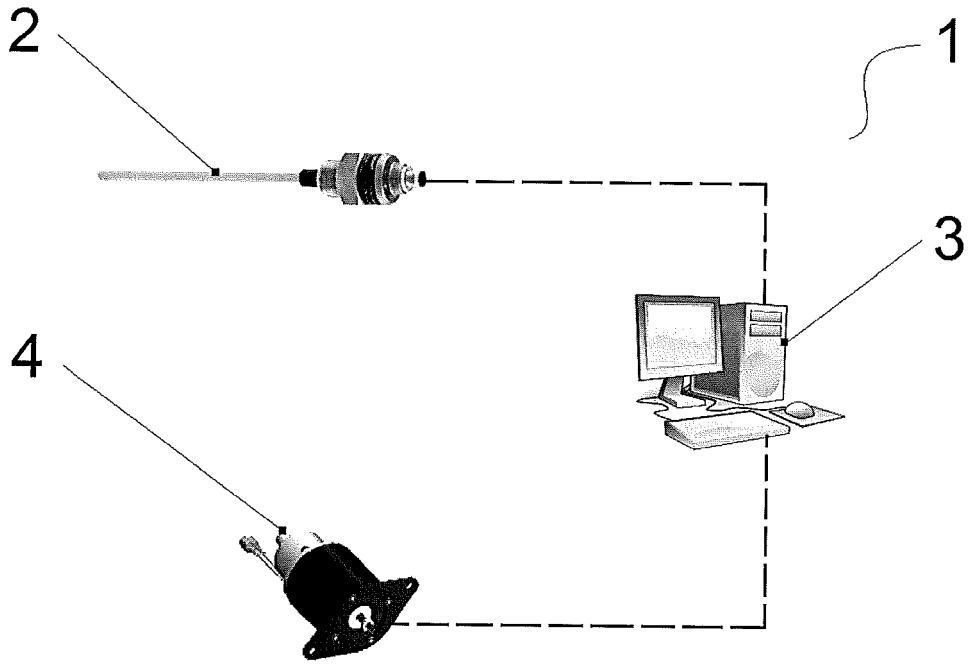

Fig. 4

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Description

Background of the invention

[0001] The invention refers to a regulation drying control system for dryer for drying grain or other powdery material.

State of the art

[0002] Specifically designed dryers are used for drying grains, corns and other powdery material, in general named as a dry matter, which are able to dry a crop to the predetermined humidity with highest possible accuracy. Precise drying is very important, because high content of humidity means that standards are not fulfilled, and low content of humidity means high cost of drying and loss of weigh of a dry matter.

[0003] Basically, two kinds of dryers are used, which are pouring dryers and belt dryers.

[0004] The pouring dryers are performed as hollow towers, into which grain is poured and later on dried by incoming hot air. Example of such dryer is presented in Fig. 1. The inner part of the dryer is divided to several zones. The higher zone is at least one drying zone A, A', where most of humidity is dried out. Under the higher zone a cooling zone B is presented, where the grain is cooled. Under the cooling zone B a collecting zone C is presented, into which predetermined amount of the dried grain is poured in periodical intervals, and which is intended to direct the gain to a transporter. Depending on measured humidity of the grain the temperature of drying air or movement of the grain in a dryer is configured Because of that, higher accuracy of drying of the grain is reached. The graph in the Fig. 2 presents sequences of single pourings, where is possible to see, that the pourings are performed periodically in the same period of drying, doesn't matter if the ideal value of humidity is reached.

[0005] The ideal value is presented by discontinuous line.

[0006] In the present time the measurements are performed once in 30 minutes. A sample is taken from the collecting zone C and estimated. Disadvantage of the method is, that the measurement is performed at the outlet of the dryer, so there is no possibility to maintain humidity of the measured grain by adapted temperature of drying air or by adapted speed of pouring of the grain. Further disadvantage is long response. The humidity is not measured continuously but in long term intervals, so there are many deviations between the measured values, see Fig. 5. In the example the measures are performed in intervals 30min.

[0007] Another option is to use more sensors, which are arranged for example in the upper part of the drying zone A and lower part of the cooling zone B. On the bases of measured values, the adaptation of the drying process is performed. However, higher amount of sensors means higher expenses. However, even this solution doesn't present good result.

[0008] The aim of the invention is to present a precise and economical regulation drying control system for dryers intended for drying grain or other powdery material, which eliminates the above mentioned disadvantages of the state of the art.

Feature of the invention

[0009] The above mentioned drawbacks are eliminated by the regulation drying control system for a grain dryer, where it comprises a humidity sensor (2) with a resolution of 0,01% or more, continuously measuring the humidity of the dry matter in the dryer connected to the control unit (3), which is intended to compare the measured humidity value with the desired humidity value, which is coupled to an actuator (4), which is intended for adjusting the drying time based on information from the control unit (3).

[0010] In advantages embodiment the humidity sensor (2) is located at the interface between the drying zone (A) and the cooling zone (B).

[0011] In other advantages embodiment the humidity sensor (2) is capacitive sensor.

[0012] The above mentioned drawbacks are eliminated also by the dryer comprises a regulation drying control system according to any one of the preceding claims.

[0013] The above mentioned drawbacks are eliminated also by the regulation drying method using the regulation drying control system according to one of claims 1 to 3, **where** the humidity content of the dry matter is measured by the sensor (2), then the measured value is sent to the control unit (3), than the measured value is compared by the control unit (3) with the desired humidity value, than the control unit (3) informs the actuator (4) how to adjust the drying time, and then the actuator (4) adjusts the drying time.

[0014] In advantages embodiment the individual steps of the regulation drying method are automated.

Description of the drawings

[0015] The invention will be further clarified by use of figures, where Fig. 1 represents schematic view of a dryer according to the state of the art, Fig. 2 presents a graph of sequences of single pourings if drying system according to the state of the art is used, Fig. 3 presents progress of pourings if a drying system according to the invention is used, where substantial shortening of the periods of pourings is apparent, Fig. 4 presents the regulation drying control system according to the invention, Fig. 5 presents a graph of deviations between measured values of humidity, if a drying system according to the state of the art is used, Fig. 6 presents a graph of humidity progress, if the regulation drying control system according to the invention is used, and Fig. 7 presents a rapidity of response, if the regulation drying control system ac-

cording to the invention is used.

Preferred embodiments of the invention

[0016] Construction of a dryer according to the invention is similar to the dryer according to the state of the art presented in Fig. 1, whereas it further comprises the regulation drying control system 1 according to the invention presented in Fig. 4, comprises a humidity sensor 2 with a resolution of 0,01% or more, which is connected with a control unit 3, which is connected with an actuator 4.

[0017] The control unit 3 is intended to estimate measured values of humidity, to compare it with desired value, and to transfer an order to the actuator 4.

[0018] The actuator 4 can be both an attendant and an automatization unit, which performs pouring of s dry matter if desired humidity is reached. The moment can be different for each dose, see Fig. 3, where the dashed line represents desired value of humidity. It is obvious from the Fig. 3, that, if the regulation system according to the invention is used, the period of drying is shortened, because pouring is performed, when the desired humidity is reached.

[0019] Advantageously, the humidity sensor 2 is placed on the boundary between the drying zone A and the cooling zone B, most preferably at the place, where the drying zone A is ending.

[0020] The humidity sensor 2 is a capacity sensor, arranged in the inner space of the dryer, which is still buried during a whole drying process. Totally covering of the humidity sensor 2 is a strict requirement for the continuous measurement. The requirement is obvious and not necessary have to be presented in the claims. Thanks to the requirement the continuous measurement ensures fast adaptation of the drying process. The term "continual" means a constant measuring, where a single measuring takes approximately 1 second.

[0021] The length of the humidity sensor 2 lie in the range from 60cm to 2m, which ensures to perform a measuring for higher amount of samples.

[0022] The method of measuring by the regulation drying control system according to the invention as follows:

[0023] When humidity of a dry matter is measured, the value of it is forwarded to the control unit 3, where it is compared with desired value of humidity for the dry matter. If the humidity is still too high, the drying continuous. If the humidity is equal to the desired humidity, the control unit 3 transmits the information to the actuator 4, by which pouring is performed. The process is repeated continuously. The delay between two pourings is equal to the time, which is necessary to reach the desired humidity.

[0024] The core of the invention is the combination of the exact sensor, continual measuring, and advantageously suitable arrangement of the sensor. Each single part of the combination was speculated in past, but never realized, because if only single one is not used, the advantages doesn't compensate expenses for the modification. Only the mutual combination gives the desired effect. This was found out by performed tests.

[0025] A dryer with a humidity sensor with resolution at least 0,01% is according to the state of the art a revolution. Nowadays only sensors with resolution not more than 0,1% are used. More precise sensors were considered useless and much more expensive. Another reason is, that because of small quantity of measured sample of dry matter, higher accuracy have small benefit. Another reason is, that the whole process of measuring and adjustment of drying temperature was performed by workers, which are not able to sufficiently use such resolution.

[0026] Continuality of the measurement relates with use of a precise sensor. The continual measurement, where sensors with low resolution are used, is useless complication, because a worker is not able to response fast enough.

[0027] Advantage of the arrangement of the sensor on the boundary between the drying zone and the cooling zone, compared to the state of the art, is a possibility to affect drying of the dry matter in the whole inner space of the dryer, i.e. not even in the collecting zone.

[0028] Fig. 6 presents a graph of humidity progress of a dry grain, a middle-dry grain and a wet grain. It is apparent from the figure that by the regulation system according to the invention, a grain with any starting humidity is dried before it reached the cooling zone.

[0029] Speed of response of the system according to the invention is presented in Fig. 7, where the curve presents measured humidity and discontinuous line presents desired humidity. It is apparent from the figure, that when demand for adaptation of the temperature is raised, the response is almost instant. That was not possible in the previous systems according to the state of the art.

[0030] Although, advantage of use of only one sensor is obvious reduction of purchase cost and maintenance cost, until now such solution was believed insufficient. Because of high volume of the drying tower, because of high amount of a dry matter, and because of necessity of exact measuring, such solution according to the invention was considered not applicable. Only the variant with a precise continuous measuring sensor arranged for example on the boundary of the drying zone and the cooling zone ensured such configuration. Simple adjustment only of arrangement or accuracy will be not enough.

[0031] Another advantage is possible automatization of the whole drying process. The automatization is also inventive, when the regulation drying control system according to the invention is used. When sensors with lower accuracy is used, or when the system is operated by human, the automatization is useless.

[0032] Use of the regulation drying control system according to the invention should be used for all kind of dryer, e.g. a pouring dryer, a belt dryer, and for all sort of crop or other material.

Claims

1. Regulation drying control system for a grain dryer **characterized in, that** it comprises a humidity sensor (2) with a resolution of 0,01% or more, continuously measuring the humidity of the dry matter in the dryer connected to the control unit (3), which is intended to compare the measured humidity value with the desired humidity value, which is coupled to an actuator (4), which is intended for adjusting the drying time based on information from the control unit (3).

2. Regulation drying control system according to claim 1, **characterized in that** the humidity sensor (2) is located at the interface between the drying zone (A) and the cooling zone (B).

3. Regulation drying control system according to claim 1, **characterized in that** the humidity sensor (2) is capacitive sensor.

4. Dryer comprises a regulation drying control system according to any one of the preceding claims.

5. Regulation drying method using the regulation drying control system according to one of claims 1 to 3, **characterized in, that** the humidity content of the dry matter is measured by the sensor (2), then the measured value is sent to the control unit (3), than the measured value is compared by the control unit (3) with the desired humidity value, than the control unit (3) informs the actuator (4) how to adjust the drying time, and then the actuator (4) adjusts the drying time.

6. Regulation drying method according to claim 5, **characterized in, that** the individual steps of the regulation drying method are automated.

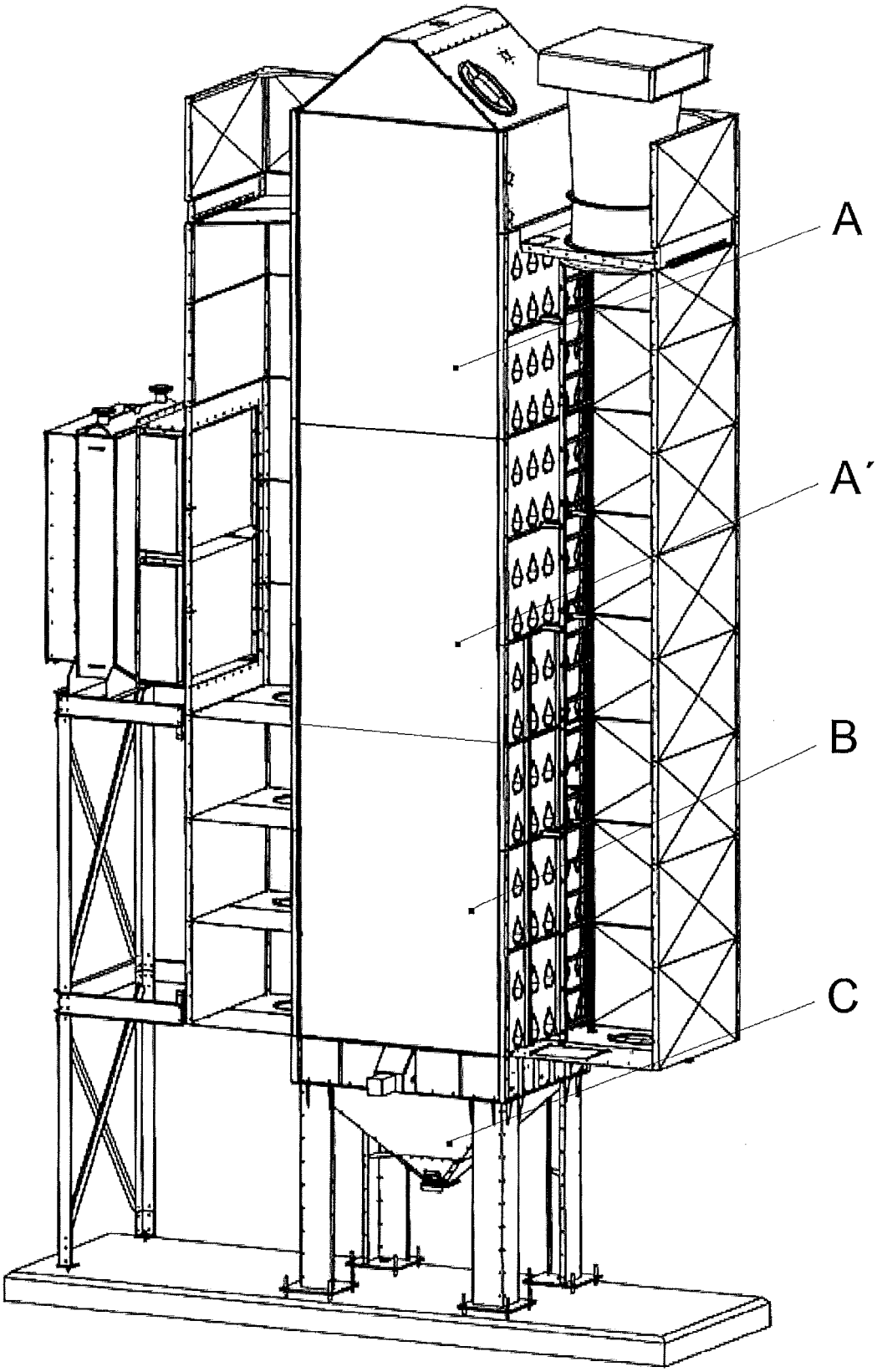

Fig. 1

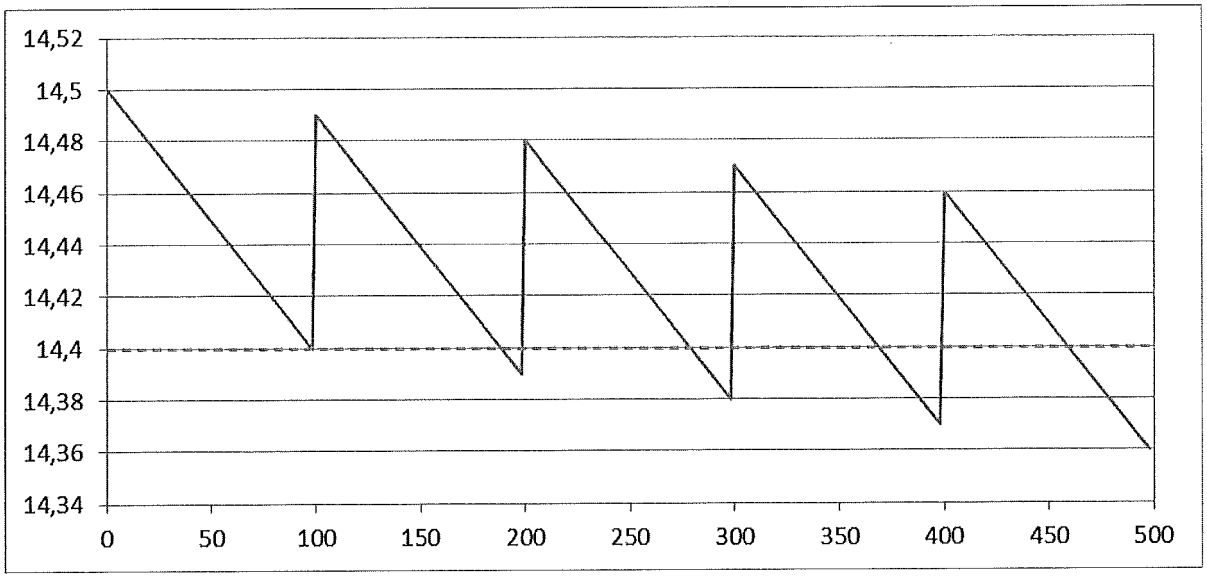
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Fig. 2

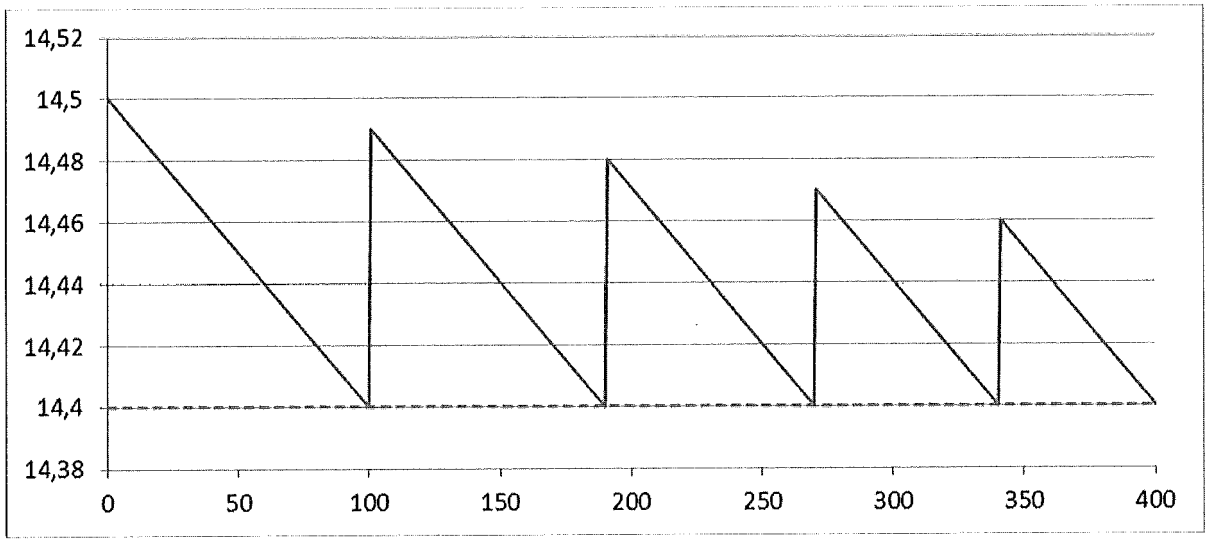
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Fig. 3

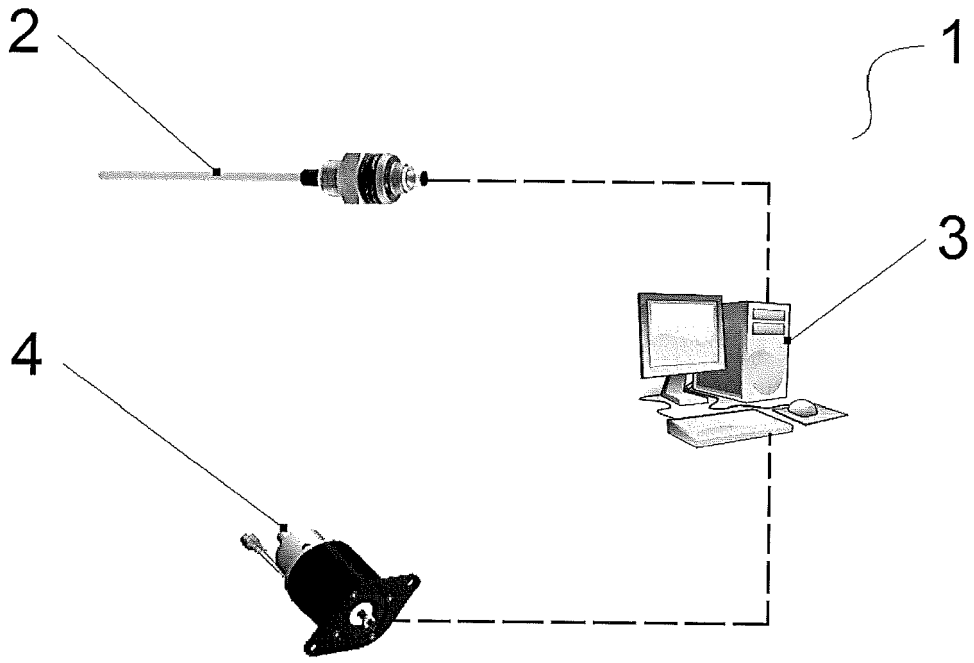
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Fig. 4

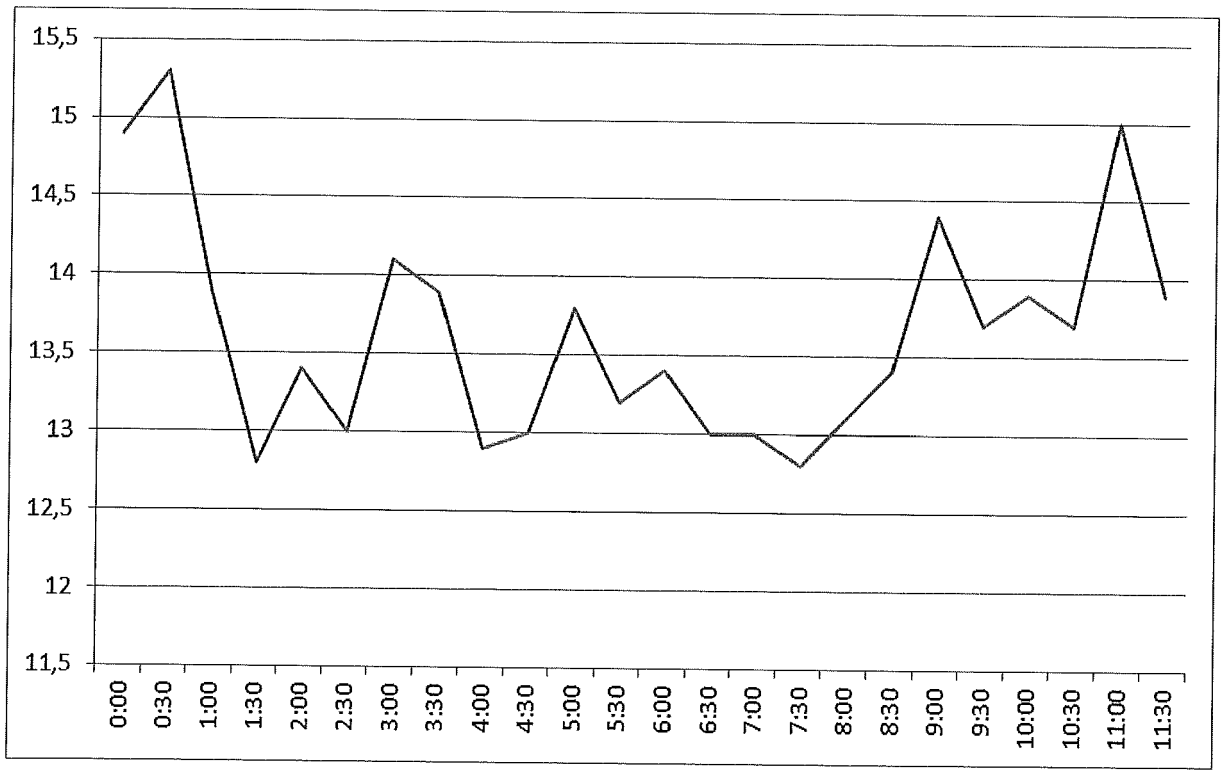
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Fig. 5

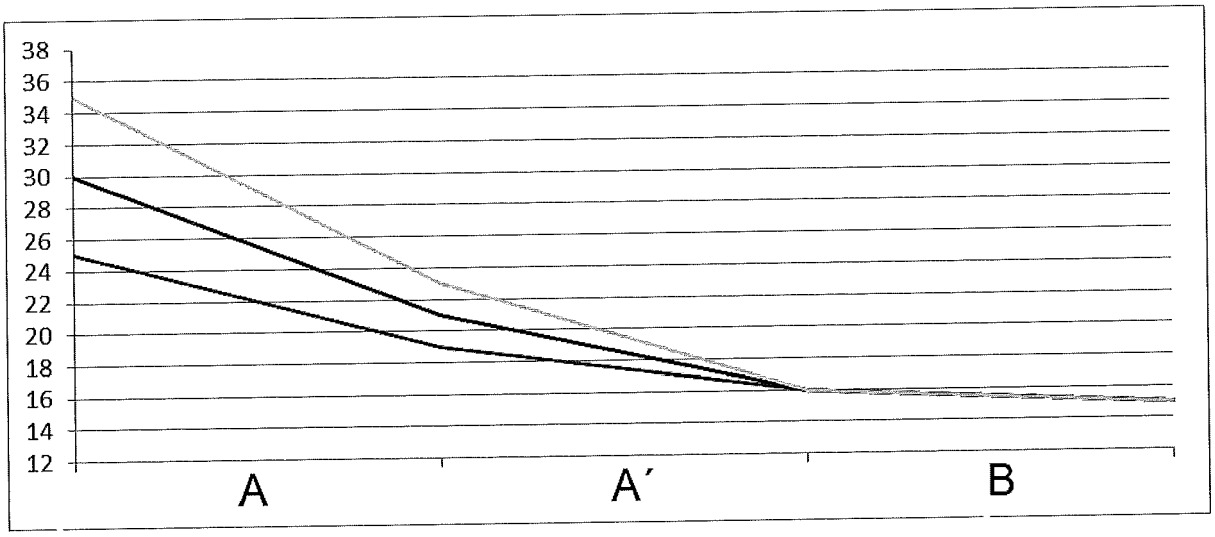
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Fig. 6

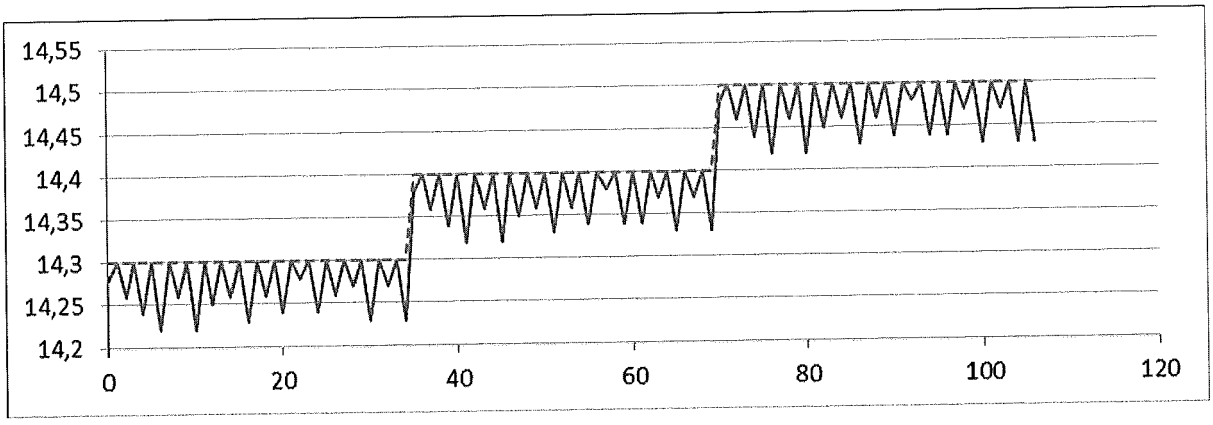
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Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 18 16 4874

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			TECHNICAL FIELDS SEARCHED (IPC)
			F26B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11 July 2018	Makúch, Milan

CATEGORY OF CITED DOCUMENTS

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