

(19) **DANMARK**

(10) **DK/EP 2910314 T3**



Patent- og  
Varemærkestyrelsen

(12) **Oversættelse af  
europæisk patentskrift**

- 
- (51) Int.Cl.: **B 07 C 5/342 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2018-03-26**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2017-12-13**
- (86) Europæisk ansøgning nr.: **15158102.2**
- (86) Europæisk indleveringsdag: **2010-03-26**
- (87) Den europæiske ansøgnings publiceringsdag: **2015-08-26**
- (30) Prioritet: **2009-03-26 BE 200900192**
- (62) Stamansøgningsnr: **10734633.0**
- (84) Designerede stater: **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 SE SI SK SM TR**
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- (54) Benævnelse: **FREMGANGSMÅDE TIL SORTERING AF KARTOFFELPRODUKTER OG SORTERINGSAPPARAT TIL KARTOFFELPRODUKTER**
- (56) Fremdragne publikationer:  
**DE-A1- 4 127 903**



## DESCRIPTION

**[0001]** The invention concerns a method for sorting potato products which are being moved through a detection zone in a product flow, whereby unwanted products are detected in this product flow and are separated from the product flow.

**[0002]** According to the present state of the art, potato products are sorted by illuminating the potato products with one or several laser beams and by subsequently detecting the light which is scattered by the products or reflected directly. On the basis of this directly reflected or scattered light, the presence of any flaws in the products or of strange products is established. Such sorting systems are described for example in documents US 4723659 and US 4634881.

**[0003]** These known sorting systems for potato products are disadvantageous, however, in that laser beams with different wave lengths must be provided for the different flaws one wishes to find in the products or for the strange products one wishes to detect. Thus, the known sorting machines usually comprise several laser sources with different wave lengths, whereby for every wave length must be provided a corresponding detection system with detectors and accompanying diaphragms for directly reflected and scattered reflected light. Moreover, the use of several laser sources makes it necessary for the laser beams that are generated by the latter to be almost perfectly aligned.

**[0004]** Since, when sorting the potato products, the signals of all the detectors must be processed, the control unit of said sorting systems must process a huge amount of data.

**[0005]** Moreover, it was found that certain flaws in potato products cannot be detected, such as for example the presence of solanine in the products.

**[0006]** The invention aims to remedy these disadvantages by providing a method and a sorting machine which make it possible to detect the presence of flaws in the potato products or of strange objects in the product flow with a very small margin of error with a single beam of light. Said flaws may be for example the presence of eyes, offshoots or buds, rot, bruises, inner sugars, a brown coloured vascular bundle ring, etc. Moreover, the invention makes it possible to detect the presence of solanine in the potato products.

**[0007]** DE4127903 (A1) discloses a sorter which has a conveyor belt feed with the produce being discharged past a measuring chamber. The chamber has a glass cylinder that is illuminated from above and below by two lighting units. The ends of the cylinder have a number of photoelectric detectors that respond to the passage of the produce. The lighting units provide emissions with different wavelengths and the detector outputs are interpreted by an electronic unit to control a separator to deflect the product into different sections. The invention is defined by the method according to claim 1 and the apparatus according to claim 8. Particular embodiments of the invention are the subject of the respective dependent claims. As to the method, the presence of glycoalkaloid, in particular of solanine, in said potato

products is detected by detecting fluorescence, resulting from the incidence of said beam of light on the products in a red light spectrum. In particular, the intensity of the light which is emitted by the products is detected in a band of 600 nm to 700 or 750 nm. A product will thus be qualified as a product containing glycoalkaloid and it will be removed from the product flow if said intensity exceeds a preset value. Said fluorescence peak for detecting the presence of solanine is hereby preferably detected by a wave length of some 680 nm.

**[0008]** According to a preferred embodiment of the method according to the invention, said products are moved in the detection zone in front of a background element, whereby this background element extends over the entire width of the product flow, such that the beam of light will strike this background element whenever there is no product in the beam of light. The background element will hereby emit light having a wave length which corresponds to said detection band when said beam of light strikes the latter. Preferably, the background element will fluoresce in the wave length band wherever a good product has a fluorescence peak, whereas this background element will not fluoresce in the wave length band wherever the fluorescence peak for detecting the presence of solanine is situated.

**[0009]** Other particularities and advantages of the invention will become clear from the following description of some specific embodiments of the method and the apparatus according to the invention. This description is given as a mere example and does not limit the scope of the claimed protection in any way; the figures of reference used hereafter refer to the accompanying drawings.

Figure 1 represents the fluorescence spectrum of the flesh of a potato when excited by a laser with a wave length of 405 nm.

Figure 2 represents the fluorescence spectrum of a potato peel when excited by a laser with a wave length of 405 nm.

Figure 3 represents the fluorescence spectrum of peanut oil when excited by a laser with a wave length of 405 nm.

Figure 4 represents the fluorescence spectrum of potato slices baked in peanut oil, in particular chips, when excited by a laser with a wave length of 405 nm.

Figure 5 represents the fluorescence spectrum of sunflower oil with a high olein content (HOSO) when excited by a laser with a wave length of 405 nm.

Figure 6 represents the fluorescence spectrum of potato slices, in particular chips, baked in the oil of figure 5, when excited by a laser with a wave length of 405 nm.

Figure 7 represents the fluorescence spectrum of maize germ oil when excited by a laser with a wave length of 405 nm.

Figure 8 represents the fluorescence spectrum of frying oil composed of a mixture of sunflower oil, rapeseed oil and palm olein when excited by a laser with a wave length of 405 nm.

Figure 9 represents the fluorescence spectrum of colseed oil when excited by a laser with a wave length of 405 nm.

Figure 10 represents the fluorescence spectrum of sunflower oil when excited by a laser with a wave length of 405 nm.

Figure 11 is a schematic representation of a sorting machine, seen in perspective.

Figure 12 is a schematic representation of a detection device for a sorting machine according to the invention.

**[0010]** In the different drawings, the same reference figures refer to the same or analogous elements. In the method according to the invention, potato products are sorted on the basis of fluorescence. It was found that when UV light with a wave length of 350 to 450 nm strikes the potato products, potato products without any flaws will emit light as a result of the fluorescence having a wave length which is mainly situated in the wave length band of 460 nm to 600 nm. Flaws which are present in the potato products or strange products in the product flow do not have said fluorescence. The flaws can usually be visually observed and consist for example of the presence of eyes, offshoots or buds, rot, bruises, inner sugars, a brown coloured vascular bundle ring, etc.

**[0011]** According to one example, a product flow of potato products is moved through a detection zone where the products are illuminated with UV light. The intensity of the light which is emitted by the products as a result of the fluorescence is detected in a detection band of 460 nm to 600 nm. When the observed intensity in the detection zone is lower than a specific preset value for a product, it is assumed that there is no fluorescence peak, and the product concerned will be qualified as an undesirable product and if necessary it will be removed from the product flow. By an undesirable product is understood a strange component or a potato product with a flaw.

**[0012]** The fluorescence peak occurring as a result of the excitation by the light with a wave length between 350 and 450 nm is usually observed in a detection band of 480 to 580 nm, irrespective of the wave length of the exciting light beam.

**[0013]** For raw potato products, a detection band of 540 to 570 nm is preferably used. As is clear from figure 1, a fluorescence peak of some 560 nm will occur for raw peeled potato products when said beam of light is generated for example by a laser source with a wave length of 405 nm. In order to thus sort a product flow with said potato products, the presence of a fluorescence peak of some 560 nm is preferably detected.

**[0014]** Further, it was found that the potato peel has a fluorescence peak around practically the same wave length, such that the method according to the invention can also be used to detect for example flaws on the surfaces of unpeeled potato products. The fluorescence

spectrum of potato peels is represented in figure 2.

**[0015]** However, the method according to the invention is particularly interesting for sorting potato products baked in vegetable oil. Such products may for example consist of thin, baked potato slices, in particular chips, or of baked potato slivers such as fries.

**[0016]** The vegetable oil in which the potato products are baked may for example be peanut oil, sunflower oil with a high olein content (HOSO), maize germ oil, frying oil, colseed oil or sunflower oil. This vegetable oil preferably has a fluorescence peak of some 500 to 540 nm when being excited by UV light, in particular light having a wave length situated between 350 and 450 nm.

**[0017]** Figure 3 shows the fluorescence spectrum for peanut oil. One can observe that a first fluorescence peak is present with a maximum between 510 nm and 525 nm, whereas a second fluorescence peak is observed around a wave length of 670 nm.

**[0018]** When the fluorescence spectrum of thin potato slices without any flaws, baked in the peanut oil of figure 3, in particular of chips, is determined, it is found that there is a fluorescence peak around a wave length of 520 nm, whereas the fluorescence around the wave length of some 670 nm has become negligible, as is shown in figure 4.

**[0019]** Moreover, it turns out that this fluorescence peak around 520 nm has a relatively large intensity, as a result of which it can be easily detected. It is assumed that there is a certain interaction between the oil and the potato products, which has for a result that, by baking the potato products in the vegetable oil, the fluorescence peaks of the oil itself and of the raw potato reinforce one another.

**[0020]** In the case of flaws in the products baked in peanut oil, said fluorescence peak around a wave length of 520 nm is not present, nor as with strange components which might be present in the product flow.

**[0021]** Thus, unwanted products in a product flow of potato products baked in peanut oil are detected by detecting the absence of said fluorescence peak in a band between 480 and 580 nm, and when such a fluorescence peak is not present, by qualifying the product concerned as an undesirable product. During the sorting of the potato products, these unwanted products are thus removed from the product flow.

**[0022]** Figure 7 shows the fluorescence spectrum of sunflower oil having a high olein content (HOSO), whereas figure 8 represents the fluorescence spectrum of thin potato slices baked in said oil, in particular chips, showing no flaws.

**[0023]** These spectra indicate that the sunflower oil with a high olein content has a fluorescence peak at about 515 nm and around 670 nm. The latter fluorescence peak cannot be observed in the baked potato products, whereas a fluorescence peak with a very high

intensity is observed for these baked products around 520 nm.

**[0024]** Flaws in the baked potato slices, which are baked in said sunflower oil with a high olein content, have no fluorescence peak in the band between 480 nm and 580 nm, such that in the absence of any fluorescence in this wave length band, a product will be qualified as an undesirable product and will preferably be removed from the product flow.

**[0025]** Thus, it is found that the fluorescence in a wave length band of 480 nm to 580 nm of potato products baked in sunflower oil with a high olein content is almost completely analogous to that of the potato products baked in peanut oil.

**[0026]** Figures 7 to 10 show the fluorescence spectra of maize germ oil, frying oil, colseed oil and sunflower oil respectively, whereby the frying oil is composed of sunflower oil, rapeseed oil and palm olein.

**[0027]** All these fluorescence spectra have peaks in the wave length band of 480 to 580 nm. Consequently, potato products which have been baked in one of these vegetable oils are also sorted by detecting the presence of fluorescence in the detection band of 480 to 580 nm. When no fluorescence whatsoever is observed in this detection band, the product concerned will be qualified as an undesirable product and will be preferably removed from the product flow.

**[0028]** Further, the presence of glycoalkaloid, in particular of solanine, in the potato products is preferably detected as well. This is done by detecting fluorescence in a red light spectrum.

**[0029]** The presence of solanine sometimes becomes evident from a green discoloration of the potato product, but solanine may also be present without this green discoloration occurring. The method according to the invention makes it possible to detect solanine irrespective of said discoloration.

**[0030]** In particular, the intensity of the light emitted by the potato products is detected in a band from 600 to 750 nm, in particular in a band from 600 to 700 nm, whereby a product will be qualified as a product containing solanine when a light intensity is detected in this band, resulting from the excitation by UV light, which exceeds a preset value. Such a product is then preferably removed from the product flow.

**[0031]** In an advantageous manner, the presence of a fluorescence peak having a wave length situated between 670 and 690 nm, in particular a wave length in the order of 680 nm, is thus detected. If such a fluorescence peak is present, a product will be qualified as a product containing glycoalkaloid, in particular solanine, and it will be removed from the product flow.

**[0032]** A possible embodiment of a sorting machine for applying the method according to the invention is represented in figure 1. This sorting machine is provided with a vibrating table 1 onto which the potato products 2 to be sorted are supplied. As a result of the vibrations of this

vibrating table 1, the products 2 are led to a drop plate 3. Next, through the action of the gravitational force, the products 2 move over the surface of the drop plate 3 in a wide product flow with a thickness of about one product over practically its entire width, whereby they leave the drop plate 3 at its bottom edge. Subsequently, the products 2 move in free fall in a product flow through a detection zone 4 where they are scanned by a beam of light 5 moving crosswise over the product flow.

**[0033]** In the detection zone, the product flow with the potato products is moved over a background element 6 extending over the entire width of the product flow. The background element 6 has further been positioned in such a way that said light beam 5 scanning the product flow will strike said background element 6 when there is no product 2 in the path of the light beam 5.

**[0034]** Downstream the detection zone 4, the products 2 from the product flow move along a removal device 7 which makes it possible to remove unwanted products from the product flow. The removal device 7 is formed of a row of compressed air valves 8 extending parallel to the product flow and crosswise to the moving device 9 of the latter. When a product is thus qualified as an undesirable product, a compressed air valve 8 will be opened in a position which corresponds to that of the undesirable product, such that the latter, under the influence of the thus generated compressed air jet, will be blown out of the product flow. Thus is generated a product flow 10 which contains practically no unwanted products, as well as a flow separated from the latter containing practically only unwanted products 11.

**[0035]** Further, the sorting machine comprises a detection device 12 which makes it possible to generate said beam of light 5 and to detect the light emitted by the products 2 in said detection zone 4.

**[0036]** As is schematically represented in figure 4, said detection device comprises a light source 13 to generate the beam of light 5 with a wave length of 350 to 450 nm. This light source 13 is preferably formed of a laser source and thus generates a laser beam. The laser beam has for example a wave length of 378 nm or of 405 nm.

**[0037]** The beam of light 5 is reflected as of the light source 13 via a mirror 14 to a polygon mirror 15 rotating around a central axis thereof. This polygon mirror 15 has successive mirror faces 17 on its perimeter. The beam of light 5 strikes the polygon mirror 15 and is directed, via one of its mirror faces 17, to the product flow and to said background element 6. As a result of the rotation of the polygon mirror, the beam of light 5 moves over the entire width of the product flow as indicated by arrow 18 and thus scans the products 2 to be sorted.

**[0038]** When the beam of light 5 strikes a product 2 to be sorted, this product will be excited by the beam of light 5 and it will fluoresce. The light 19 which is emitted as a result of this fluorescence is sent, via the polygon mirror 15 and a beam separator 20, to detectors 21 and 22 via respective semi-transparent mirrors 23 and 24.

**[0039]** A first detector 21 of these detectors is sensitive to green light having a wave length of for example 460 to 600 nm and generates a detection signal as a function of the observed light intensity which is emitted by a product 2 situated in the path of the light beam 5. This detector 21 co-operates with a control system to control the aforesaid removal device 7 when the light intensity observed by the detector 21 is lower than a preset value to thus remove the product concerned from the product flow. When said light intensity is lower than the preset value, no fluorescence peak will be observed in the detection band of 460 to 600 nm, and a product will consequently be qualified as an undesirable product.

**[0040]** A second detector 22 is sensitive to red light, in particular to light having a wave length of for example 600 to 700 nm, and preferably detects light having a wave length in the order of 680 nm. As a function of the observed light intensity, a detection signal is generated by this detector 22 in order to control said removal device 7. In particular, a product will be removed from the product flow by means of the removal device 7 when said intensity of the red light detected by the detector 22 exceeds a preset value. For, in this case, fluorescence is detected indicating the presence of solanine in the product situated in the path of the light beam.

**[0041]** Further, the background element 6 will emit light having a wave length which corresponds practically to said detection band when said beam of light strikes the background element 6. Thus is made sure that the compressed air valves 8 of the removal device 7 are only activated when an undesirable product is situated in the path of the light beam 5, and they will not be activated when there is no product 2 in the path of the light beam 5. In particular, the background element 6 will fluoresce when said beam of light strikes it, and it will preferably emit light having a wave length of 500 to 560 nm.

**[0042]** If the presence of solanine in the potato products is being detected as well according to the method of the invention, the background element 6 will be selected such that it will further not emit any light in a band of 600nm to 700 nm, and preferably up to 750 nm, in particular in a band situated around 680 nm when it is hit by said beam of light 5.

**[0043]** Naturally, the invention is not restricted to the above-described embodiments of the method and the sorting machine for sorting potato products.

**[0044]** Thus, for example in the sorting machine, the vibrating table 1 and/or the drop plate 3 can be replaced by a conveyor belt for moving the products to be sorted to the detection zone.

**[0045]** Further, the wave length of the fluorescence peak for detecting flaws or strange components in the product flow may shift somewhat as a function of the wave length of the light beam which hits the products and excites them. Thus, the fluorescence peak for detecting the presence of solanine may shift as well as a function of the wave length of the exciting light beam.

**[0046]** Apart from that, it is clear that the detection of flaws or strange components in the product flow can be carried out completely independent from the detection of the presence of

solanine.

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description

- [US4723659A \[0002\]](#)
- [US4634881A \[0002\]](#)
- [DE4127903A1 \[0007\]](#)

**Patentkrav**

- 1.** Fremgangsmåde til detektering af produkter indeholdende glycoalkaloid, især solanin, i en produktstrøm af kartoffelprodukter (2), ved at lade en lysstråle (5) med en bølgelængde beliggende i et bånd på 350 til 450 nm ramme disse  
5 produkter og ved detektering af tilstedeværelsen af fluorescens i et rødt lysspektrum, især ved detektering af intensiteten af lyset der udsendes af produkterne i et bånd på 600 til 750 nm, og fortrinsvis i et bånd mellem 600 og 700 nm, hvorved et produkt vil blive kvalificeret som et produkt indeholdende glycoalkaloid når intensiteten er højere end en forindstillet værdi.  
10
- 2.** Fremgangsmåde ifølge krav 1, hvor tilstedeværelsen af en fluorescensstop med en bølgelængde beliggende mellem 670 og 690 nm, især en bølgelængde i størrelsesordenen 680 nm, detekteres og hvorved et produkt vil blive kvalificeret som et produkt indeholdende glycoalkaloid, især solanin, når sådan en  
15 fluorescensstop er til stede.
- 3.** Fremgangsmåde ifølge et hvilket som helst af de foregående krav hvor lysstrålen (5) er dannet af en laserstråle der bevæges på tværs over bredden af produktstrømmen.  
20
- 4.** Fremgangsmåde ifølge et hvilket som helst af de foregående krav hvor produktstrømmen af kartoffelprodukterne bevæges i en detektionszone over et baggrundselement (6) der strækker sig over hele bredden af produktstrømmen.
- 25 **5.** Fremgangsmåde ifølge krav 4 hvor baggrundselementet (6) vil fluorescere når en lysstråle rammer det og udsende lys med en bølgelængde på 500 til 560 nm.
- 6.** Fremgangsmåde ifølge krav 4 eller krav 5, hvor baggrundselementet (6) ikke vil fluorescere i bølgelængdebåndet uanset hvor fluorescensstoppen til detektering  
30 af tilstedeværelsen af solanin er beliggende.

**7.** Fremgangsmåde ifølge et hvilket som helst af de foregående krav yderligere omfattende fjernelse af produkter indeholdende glycoalkaloid fra produktstrømmen.

- 5 **8.** Apparat til detektering af produkter indeholdende glycoalkaloid, især solanin, i en produktstrøm af kartoffelprodukter, hvilket apparat omfatter:

organ (12) til at lade en lysstråle (5) med en bølgelængde beliggende i et bånd på 350 til 450 nm ramme disse produkter;

- 10 organ (22) til detektering af tilstedeværelsen af fluorescens i et rødt lysspektrum, omfattende organ til detektering af intensiteten af lyset der udsendes af produkterne i et bånd på 600 til 750 nm, og fortrinsvis i et bånd mellem 600 og 700 nm; og

organ til at kvalificere et produkt som et produkt indeholdende glycoalkaloid når intensiteten er højere end en forindstillet værdi.

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- 9.** Apparat ifølge krav 8, yderligere omfattende organ til detektering af tilstedeværelsen af en fluorescensstop med en bølgelængde beliggende mellem 670 og 690 nm, især en bølgelængde i størrelsesordenen 680 nm, og organ til at kvalificere et produkt som et produkt indeholdende glycoalkaloid, især solanin,  
20 når sådan en fluorescensstop er til stede.

**10.** Apparat ifølge de foregående krav 8 eller krav 9, hvor lysstrålen (5) er dannet af en laserstråle, hvilket apparat yderligere omfatter organ til at bevæge laserstrålen på tværs over bredden af produktstrømmen.

25

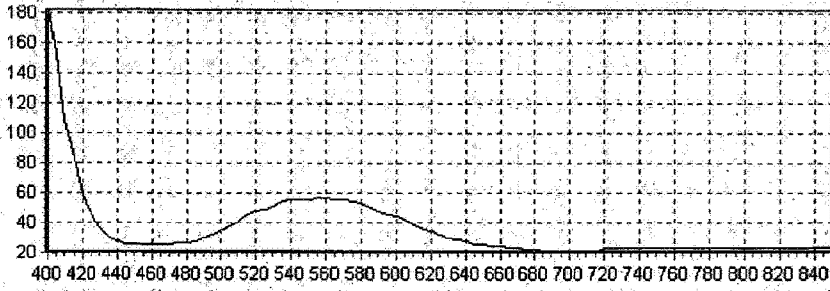
**11.** Apparat ifølge et hvilket som helst af kravene 8 til 10 yderligere omfattende et baggrundselement (6), der strækker sig over hele bredden af produktstrømmen, over hvilket produktstrømmen af kartoffelprodukterne bevæges i en detektionszone.

30

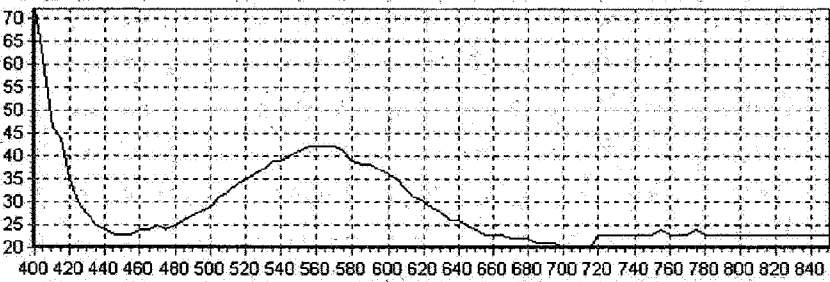
**12.** Apparat ifølge krav 11 hvor baggrundselementet (6) er indrettet til at fluorescere når en lysstråle rammer det, og udsende lys med en bølglængde på 500 til 560 nm.

5 **13.** Apparat ifølge et hvilket som helst af kravene 8 til 12 yderligere omfattende organ (8) til at fjerne produkter indeholdende glycoalkaloid fra produktstrømmen.

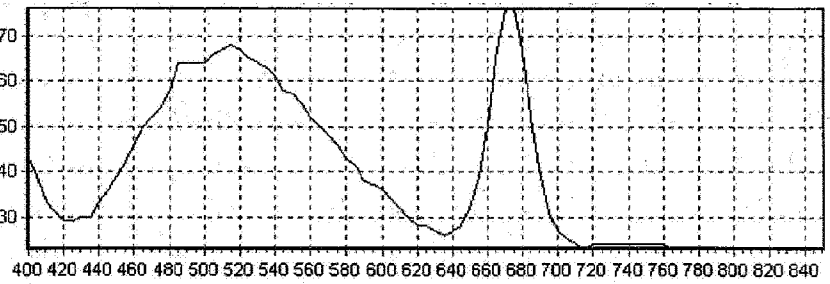
**DRAWINGS**



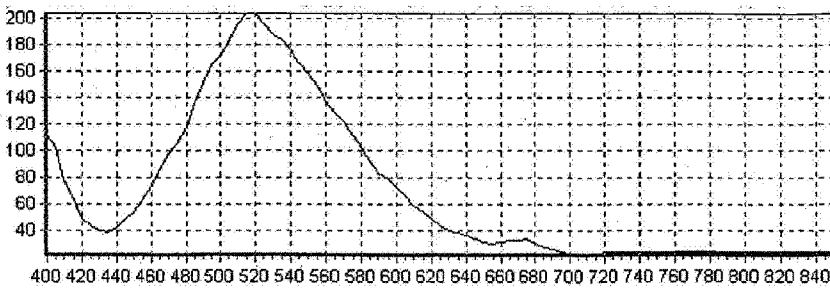
*Fig. 1*



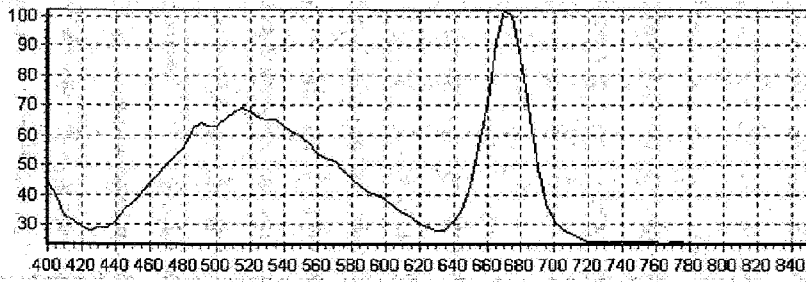
*Fig. 2*



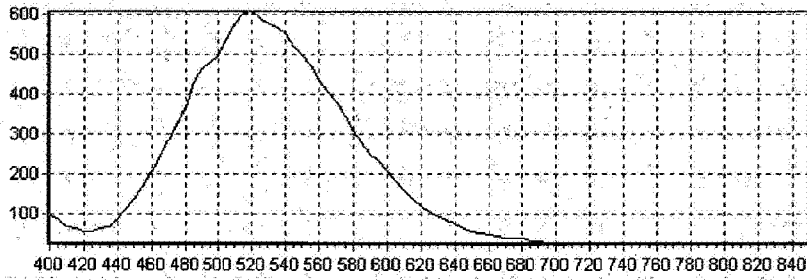
*Fig. 3*



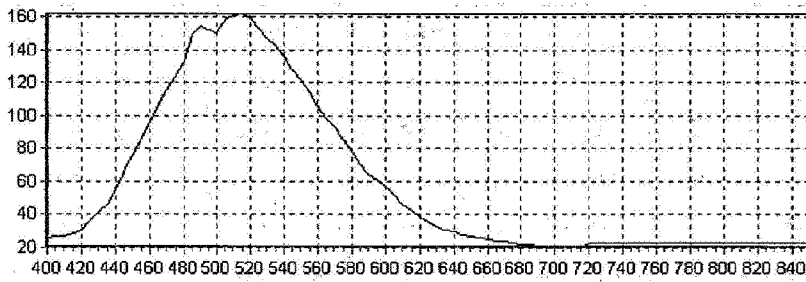
*Fig. 4*



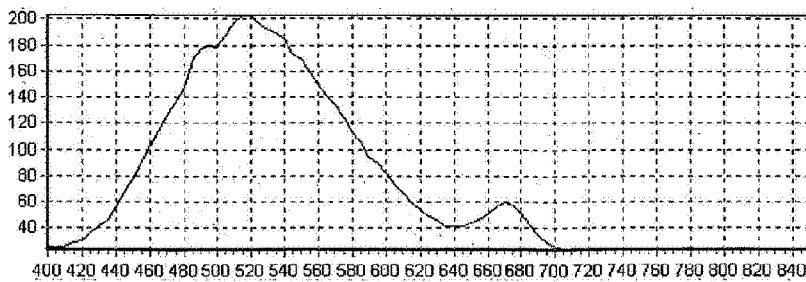
**Fig. 5**



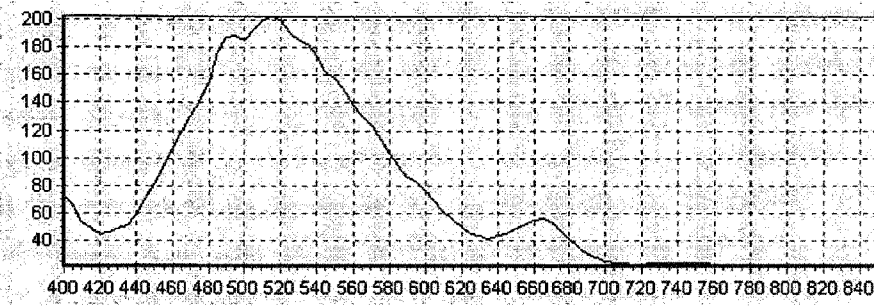
**Fig. 6**



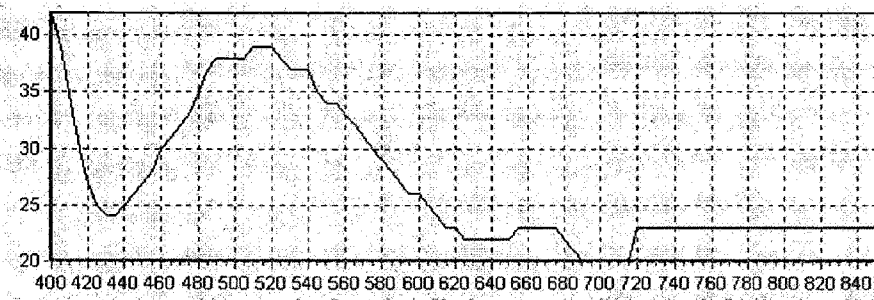
**Fig. 7**



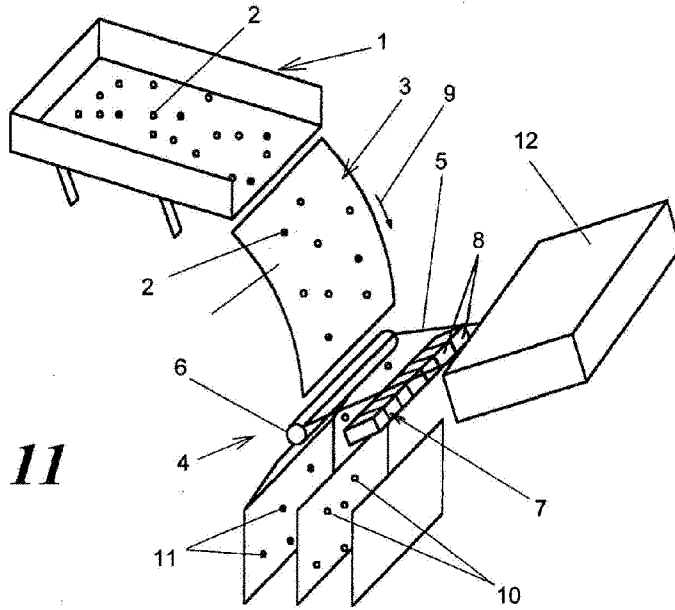
**Fig. 8**



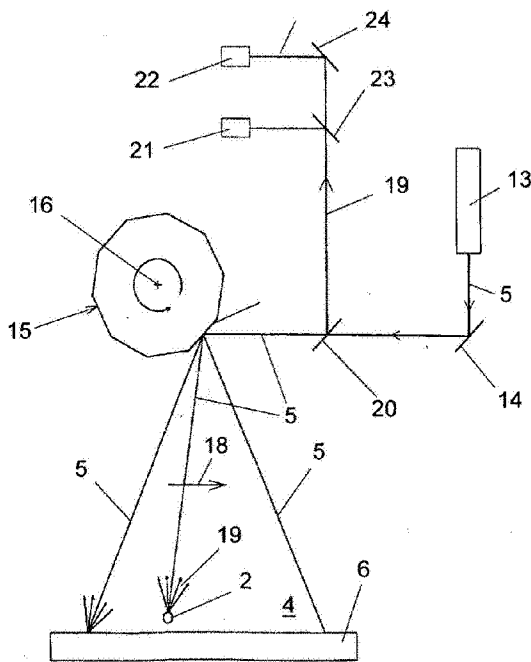
*Fig. 9*



*Fig. 10*



**Fig. 11**



**Fig. 12**