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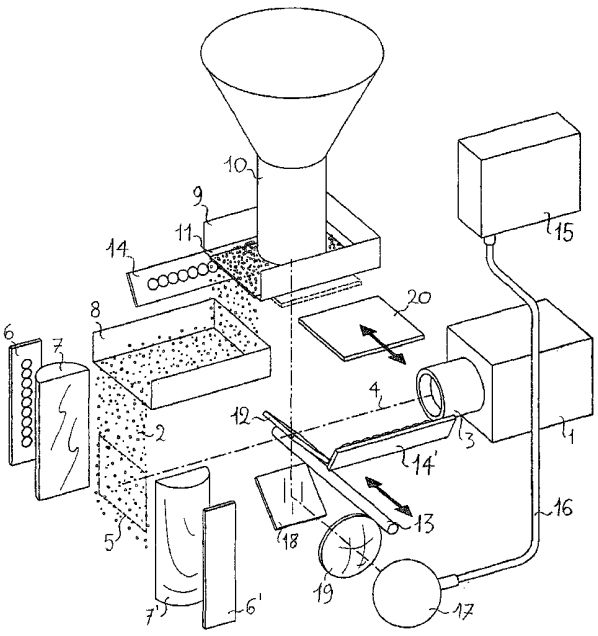
(54) Title: APPARATUS FOR ANALYZING THE CHARACTERISTICS OF GROUND PRODUCTS



(57) Abstract: Apparatus for analyzing the characteristics of ground products, which comprises at least one vibrating chute (9) suitable for transporting particles (2) of ground product, wherein the bottom (11) of said chute (9) is transparent and means (16, 17, 18, 19) suitable for supplying to at least one colorimeter (15) the images from the bottom of the particles (2) laying on this transparent bottom (11) are arranged under the latter. This apparatus can analyze the colorimetry of the particles of ground product and also their size and purity, if desired.

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APPARATUS FOR ANALYZING THE CHARACTERISTICS OF GROUND PRODUCTS

The present invention relates to an apparatus for analyzing the characteristics of ground products, and in particular an apparatus which can be used for carrying out the analysis of the colorimetry, as well as of the size and the purity, if desired, of particles of products coming from grinding plants, such as for instance flours and brans of different kinds.

Apparatuses for analyzing ground products are known to comprise a camera which shoots a portion of ground product dropped in front of its lens. Said camera is connected to a computer which analyzes the image sequence received from the camera and supplies, according to the content of these images, the particle colorimetry and size. During their fall, the particles of ground product are illuminated by one or more light sources arranged on the same side of the camera, so that the particles are illuminated frontally and appear as bright points on a background which must be black and opaque, in order to show up the particles and avoid light glares.

However, in this kind of known apparatuses the background becomes progressively light since some particles settle thereon during the time. Being light, the particles decrease the contrast of the background, thereby altering the values of the particle colorimetry and size measurement. These particles are very fine, so that they cannot be easily removed from the background with air jets and therefore brushes or other devices difficult to employ must be used.

Another drawback of these known apparatuses lies in the relatively low number of particles which are framed by the camera for analyzing the colorimetry. Furthermore, the area on which the color is analyzed is the sum of the apparent areas of the particles, so that the analysis is carried out on a less representative sample of all the particles.

Finally, the camera used for the colorimetric analysis is the same used for the particle size analysis, so that its color reproduction does not have a stability suitable for a precise analysis of the particle colorimetry.

It is therefore an object of the present invention to provide an apparatus for analyzing ground products, which is free from the above mentioned drawbacks. Said

object is achieved with an apparatus, the main features of which are described in the first claim and other features are described in the following claims.

Thanks to the vibrating chute with transparent bottom and to the colorimeter that analyzes from the bottom the particles of ground product transported by this chute, the apparatus according to the present invention allows to carry out precise colorimetric analysis on a uniform particle layer which constitutes a significant sample of all the particles to be analyzed. Said colorimeter preferably comprises a spectrophotometer, so as to improve the measurement precision and detect impurities which can be detected only with fluorescence analysis and not with colorimetric analysis, such as the impurities containing high ratios of ferulic acid.

According to an aspect of the invention, the images of the particles are transmitted to the colorimeter by optical gathering means preferably comprising a hollow sphere provided with a hole through which these images are projected from the outside, the interior of said hollow sphere being coated by a paint suitable for reflecting the entire light spectrum. With this arrangement, the precision of the colorimetric analysis is further improved, since the optical fiber can detect the color diffused by the inner walls of the hollow sphere thanks to the high number of reflections of the images coming from the outside.

Furthermore, before reaching the interior of the hollow sphere, said images are preferably concentrated into the hole of the hollow sphere by an achromatic doublet. With this arrangement the area of the particles on the transparent bottom which can be analyzed by the colorimeter can be enlarged.

According to another aspect of the invention, the particles of ground product transported by the vibrating chute with the transparent bottom can be dropped in front of the lens of a camera connected to a computer which analyzes the image sequence received from the camera and supplies, according to the content of these images, the particle size. With this arrangement, the apparatus according to the present invention can precisely analyze not only the particle colorimetry, but also their size, thereby exploiting for these purposes some common parts of the apparatus itself, so as to reduce the hindrance and the manufacturing costs with respect to two distinct apparatuses.

According to another aspect of the invention, means for deviate the shooting axis

of said camera toward the transparent bottom of the vibrating chute can be arranged along the shooting axis. With this arrangement, the apparatus according to the present invention, without relevant modifications of its structure, can precisely analyze not only the particle colorimetry and their size, if desired, but also their purity.

Further advantages and features of the apparatus according to the present invention will become evident to those skilled in the art from the following detailed and non-limiting description of one embodiment thereof, with reference to the attached drawings wherein the only figure 1 shows a perspective and schematic view of the apparatus according to this embodiment.

Referring to figure 1, it is seen that the apparatus according to the present embodiment of the invention comprises in a known way a camera 1 suitable for shooting a portion of particles 2 of ground product which are dropped in front of its lens 3. The latter is arranged with the shooting axis 4 oriented in a substantially perpendicular way with respect to the plane 5 (indicated with a hatched line) along which particles 2 fall. Camera 1 is further connected in a known way to a computer (not shown in the figure) which analyzes the sequence of images received and supplies, thanks to a suitable program which can be of a known kind, the size of particles 2 according to the content of these images.

According to the present embodiment of the invention, particles 2 are illuminated by one or more light sources 6, 6' which are arranged transversally, in particular laterally, with respect to the fall plane 5 of particles 2. The light sources 6, 6' preferably comprise two series of high efficiency LEDs, which are suitable for emitting flashes synchronized with the image sampling period of camera 1, in order to illuminate particles 2 only when these are effectively shot, for instance with a frequency of 10 images per second, so that the LEDs cannot overheat.

The light beams emitted by the light sources 6, 6' are preferably collimated along the fall plane 5 of particles 2 thanks to reflecting or refracting means 7, 7', such as for example mirrors, prisms and/or lenses. In particular, these reflecting or refracting means 7, 7' are made up of a pair of hemicylindrical lenses arranged with the longitudinal axis substantially parallel to the light sources 6, 6' and with the hemicylindrical surface turned toward the latter. The fall plane 5 of particles 2 is therefore comprised in a

substantially perpendicular manner between the rectangular surfaces of the hemicylindrical lenses 7, 7'.

Furthermore, the width of the light beams emitted by the light sources 6, 6' is preferably less than the depth of field of lens 3 of camera 1, so that particles 2, when they are illuminated by the light sources 6, 6', are always focused by lens 3. In particular, the light beams are collimated by the hemicylindrical lenses 7, 7' within a space comprised between two vertical planes which are 10 mm away from each other, while lens 3 has a greater depth of field. As a matter of fact, it has been verified that nearly all the particles 2 fall within said space 10 mm wide.

Particles 2 are transported toward the fall plane 5 by a chute 8 which vibrates with a high intensity. Another chute 9 which vibrates with a lower intensity with respect to chute 8 and leads above the latter, transports in the meantime a determinate quantity of particles 2 taken by a feeding duct 10 having the lower end arranged near to the bottom 11 of the vibrating chute 9.

According to the invention, this bottom is transparent and its upper and lower surfaces are smooth, so that particles 2 can homogeneously spread above it and can be shot from the bottom without distortions. Mobile reflecting or refracting means 12 suitable for deviating the shooting axis 4 toward the transparent bottom 11 of vibrating chute 9, preferably in the direction of feeding duct 10, are arranged along the shooting axis 4 of camera 1.

In particular, the mobile reflecting or refracting means 12 comprise a mirror, for example inclined about 45°, which is arranged under the vibrating chute 9 and is fixed to a rod 13 which can translate along a substantially horizontal axis perpendicular to the shooting axis 4. Furthermore, one or more light sources 14, 14' are arranged under the vibrating chute 9 for illuminating the lower surface of its bottom 11. Also the light sources 14, 14' preferably comprise two series of high efficiency LEDs, if necessary of a different kind with respect to the light sources 6, 6', which can emit flashes synchronized with the image sampling period of camera 1. When mirror 12 deviates the shooting axis 4 toward the vibrating chute 9, the computer connected to camera 1 analyzes the sequence of received images, detects the particles 2 having a dark color and provides, thanks to a suitable program also of a known kind, data relating to the

purity of particles 2 according to the number of dark particles detected. Since the particle size measurement needs long times, camera 1 can shoot the transparent bottom 11 of the vibrating chute 9 for a period shorter than the period in which it shoots the particles 2 falling from the vibrating chute 8. For example, these shooting periods of camera 1 can last 1 and 20 seconds, respectively.

The apparatus according to the present invention suitably comprises a colorimeter 15, preferably a spectrophotometer, which is connected through an optical fiber 16 to optical gathering means 17 comprising a hollow sphere, the interior of which is coated by a white paint suitable for reflecting the entire light spectrum, so as to uniformly spread it by means of its numerous reflections. The hollow sphere 17 is provided with a hole through which the images of the particles 2 laying on the transparent bottom 11 of the vibrating chute 9 are projected from the outside. Before reaching the interior of the hollow sphere 17, these images are in fact reflected by a mirror 18, which is arranged under the transparent bottom 11 correspondingly to duct 10 and is inclined about 45°, after which they are concentrated into the hole of the hollow sphere 17 by an achromatic doublet 19.

A mobile plate 20, the lower surface of which, visible from the hollow sphere 17, has a reference color for colorimeter 15, is preferably arranged under the transparent bottom 11. Colorimeter 15 can be automatically calibrated during the use by horizontally moving for short periods the mobile plate under the transparent bottom 11.

For carrying out fluorescence analysis with the spectrophotometer, the light sources 14, 14' also comprise blue and ultraviolet lamps, while the transparent bottom 11 is made of quartz, so as to allow the passage of the exciting radiation.

Variations and/or additions of the present described and illustrated embodiment can be made by those skilled in the art remaining within the scope of the invention itself.

CLAIMS

1. Apparatus for analyzing the characteristics of ground products, which comprises at least one vibrating chute (9) suitable for transporting particles (2) of ground product, characterized in that the bottom (11) of said chute (9) is transparent and means (16, 17, 18, 19) suitable for supplying to at least one colorimeter (15) the images from the bottom of the particles (2) laying on this transparent bottom (11) are arranged under the latter.

2. Apparatus according to the previous claim, characterized in that said colorimeter (15) comprises a spectrophotometer.

3. Apparatus according to one of the previous claims, characterized in that the upper and lower surfaces of said transparent bottom (11) are smooth.

4. Apparatus according to one of the previous claims, characterized in that said means (16, 17, 18, 19) suitable for supplying to the colorimeter (15) the images of the particles (2) on the transparent bottom (11) comprise optical gathering means (17) connected to the colorimeter (15) through an optical fiber (16).

5. Apparatus according to the previous claim, characterized in that said optical gathering means (17) comprise a hollow sphere which is provided with a hole through which the images of the particles (2) on the transparent bottom (11) are projected from the outside, the interior of said hollow sphere (17) being coated by a paint suitable for reflecting the entire light spectrum.

6. Apparatus according to the previous claim, characterized in that before reaching the interior of the hollow sphere (17), said images are concentrated into the hole of the hollow sphere (17) by an achromatic doublet (19).

7. Apparatus according to one of the previous claims, characterized in that a mobile plate (20), the lower surface of which has a reference color for the colorimeter (15), is arranged under the transparent bottom (11).

8. Apparatus according to one of the previous claims, characterized in that it comprises a feeding duct (10) for the particles (2), which has the lower end arranged close to the transparent bottom (11).

9. Apparatus according to one of the previous claims, characterized in that one

or more light sources (14, 14') are arranged under the transparent bottom (11).

10. Apparatus according to the previous claim, characterized in that the light sources (14, 14') comprise blue and ultraviolet lamps, and that the transparent bottom (11) is made of quartz.

11. Apparatus according to one of the previous claims, characterized in that it comprises a camera (1) suitable for shooting a portion of particles (2) of ground product which are dropped in front of its lens (3) and are transported by said vibrating chute (9), said camera (1) being connected to a computer which analyzes the received image sequence and supplies, according to the content of these images, the size of the particles (2), which are illuminated by one or more light sources (6, 6') arranged transversely with respect to the plane (5) along which the particles (2) fall.

12. Apparatus according to the previous claim, characterized in that the light sources (6, 6') are arranged laterally with respect to the fall plane (5) of the particles (2).

13. Apparatus according to claim 11 or 12, characterized in that the light sources (6, 6') comprise one or more series of high efficiency LED, which are suitable for emitting flashes synchronized with the image sampling period of the camera (1).

14. Apparatus according to one of claims 11 to 13, characterized in that the light beams emitted by the light sources (6, 6') are collimated along the fall plane (5) of the particles (2) by reflecting or refracting means (7, 7').

15. Apparatus according to the previous claim, characterized in that said reflecting or refracting means (7, 7') comprise one or more hemicylindrical lenses arranged with the longitudinal axis substantially parallel to the light sources (6, 6') and with the hemicylindrical surface turned toward the latter, so that the fall plane (5) of the particles (2) is comprised in a substantially perpendicular manner between the rectangular surfaces of the hemicylindrical lenses (7, 7').

16. Apparatus according to the previous claim, characterized in that the width of the light beams emitted by the light sources (6, 6') is less than the depth of field of the lens (3) of the camera (1).

17. Apparatus according to the previous claim, characterized in that the light beams emitted by the light sources (6, 6') are collimated within a space comprised between two vertical planes which are 10 mm away from each other, while the lens (3)

of the camera (1) has a greater depth of field.

18. Apparatus according to one of claims 11 to 17, characterized in that mobile reflecting or refracting means (12) suitable for deviating the shooting axis (4) of the camera (1) toward the transparent bottom (11) of said vibrating chute (9) are arranged along the shooting axis (4).

19. Apparatus according to the previous claim, characterized in that said mobile reflecting or refracting means (12) comprise a mirror which is arranged under the transparent bottom (11) and is fixed to a rod (13) which can translate along a substantially horizontal axis perpendicular to the shooting axis (4).

20. Apparatus according to the claim 18 or 19, characterized in that the light sources (14, 14') arranged under the transparent bottom (11) comprise one or more series of high efficiency LED, which are suitable for emitting flashes synchronized with the image sampling period of the camera (1), which is connected to a computer suitable for analyzing the image sequence transmitted by the camera (1), detecting the particles (2) having a dark color and providing data relating to their purity according to the number of dark particles detected.

21. Apparatus according to one of claims 11 to 20, characterized in that said vibrating chute (9) leads above a second vibrating chute (8) which transports the particles (2) of ground product toward the fall plane (5) and vibrates with a higher intensity with respect to the first chute (9).

22. Apparatus according to the previous claim, characterized in that the camera (1) shoots the transparent bottom (11) for a period shorter than the period in which it shoots the particles (2) falling from the second chute (8).

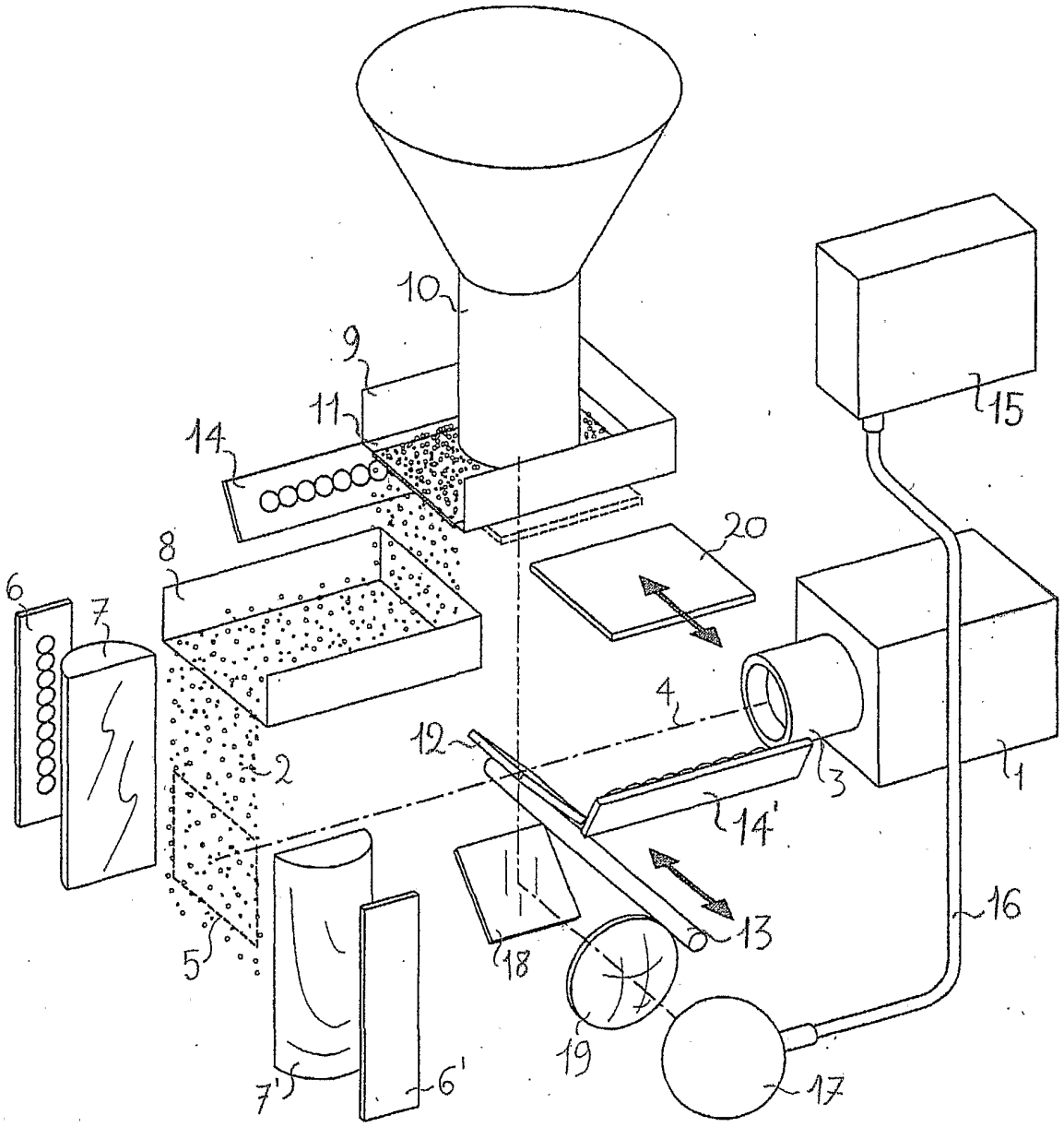

Fig.1

INTERNATIONAL SEARCH REPORT

Int ıl Application No
PCT/IT 00/00481

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01N15/02

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01N

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

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

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 90 11 680 U (HAJIME INDUSTRIES) 25 October 1990 (1990-10-25) page 1, line 5-11 page 3, line 23-31 page 5, line 5 -page 6, line 5 page 6, line 18 -page 7, line 11 page 8, line 14 -page 9, line 7 page 11, line 16-20 page 12, line 6-9 page 12, line 25-34 page 19, line 27-34	1
A	GB 2 237 381 A (PRISECTER SAMPLING PLC) 1 May 1991 (1991-05-01) abstract; figure 2	1

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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