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(54) Apparatus for detecting undesirable particles in textile fibre material

(57) Undesirable particles, especially bits of trash, neps, husk neps, burls and the like, in textile fibre material, for example cotton, synthetic fibres and the like, are detected using optical-electronic means, comprising an optical sensor 12 and an image-processing device 14. In order to be able to register the undesirable particles also inside the layer of fibres and to render possible the determination and differentiated evaluation of trash particles, neps, husk neps, burls and the like, a thin fibre web is formed, the sensor registers each individual undesirable particle in stages, and specific characteristics, for example half-tones, are determined for each individual particle by means of an evaluation device, the individual particles are classified on the basis of the characteristics, for example according to type, shape, size, by way of a comparison, and the individual particles are counted. Light reflected from and transmitted through the fibre web is detected.

Fig.1

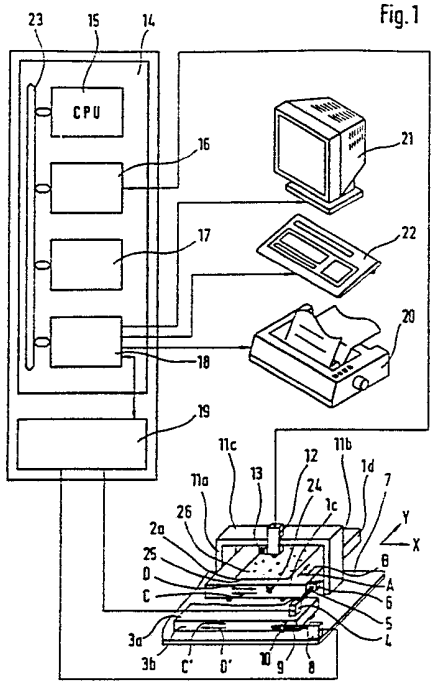

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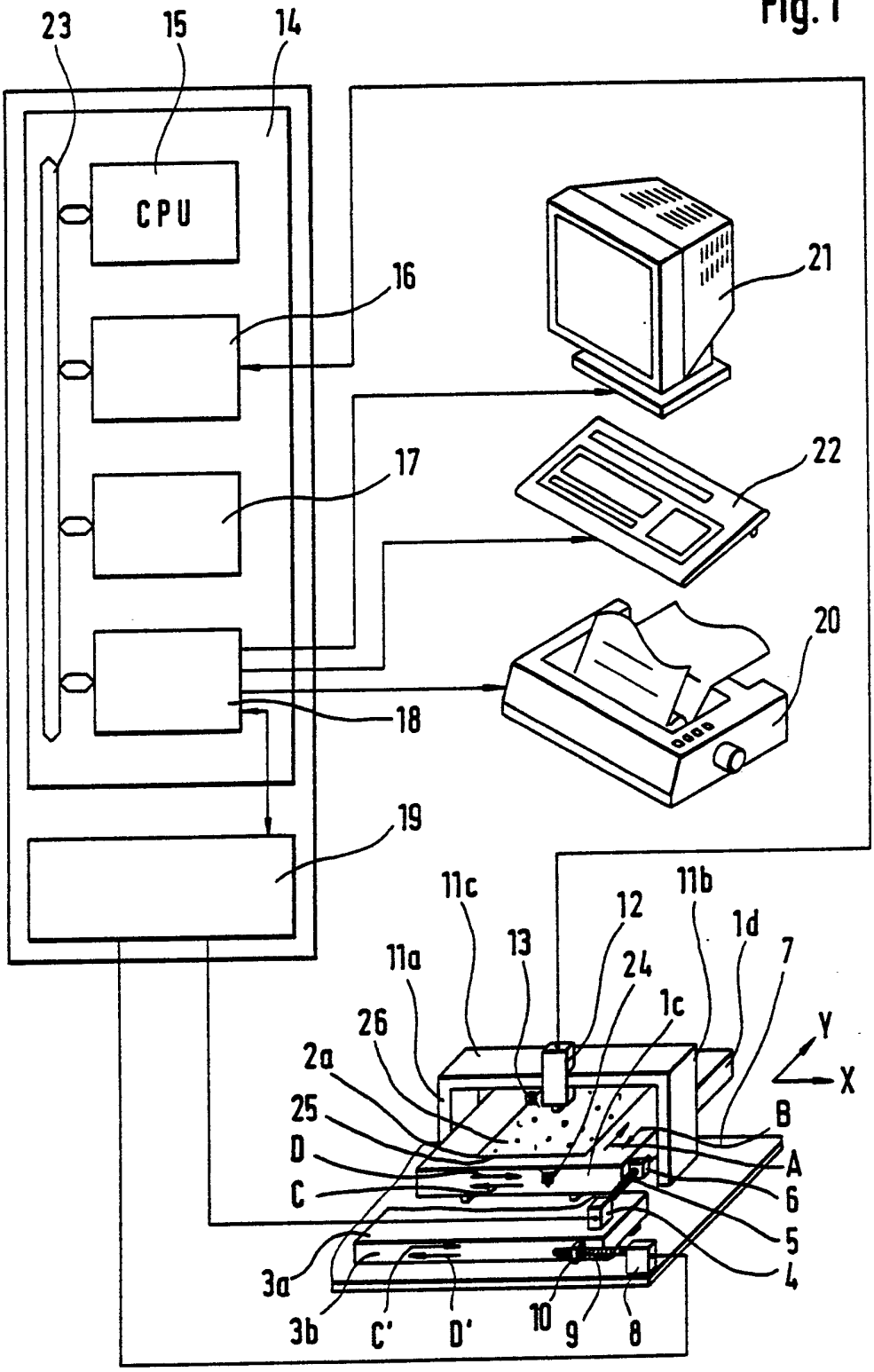
Fig. 1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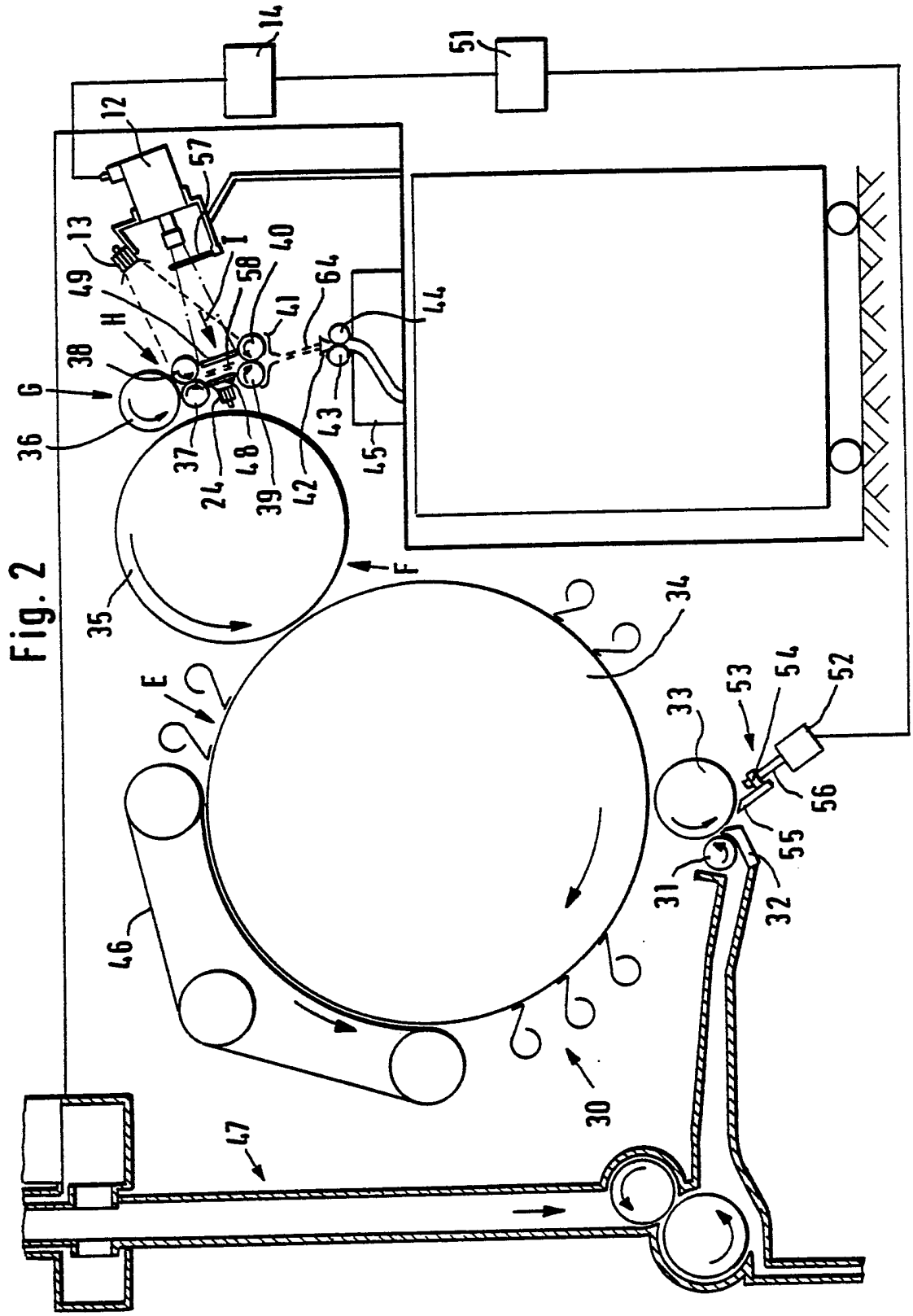
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Fig. 2

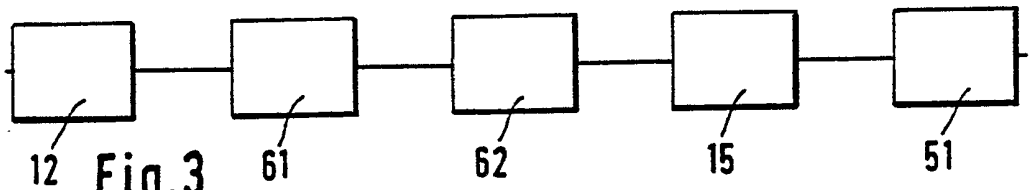


Fig.3

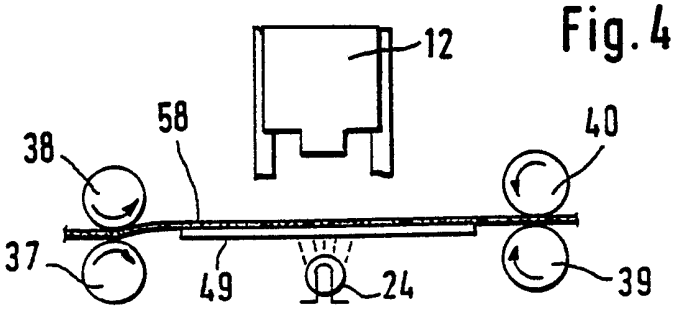


Fig.4

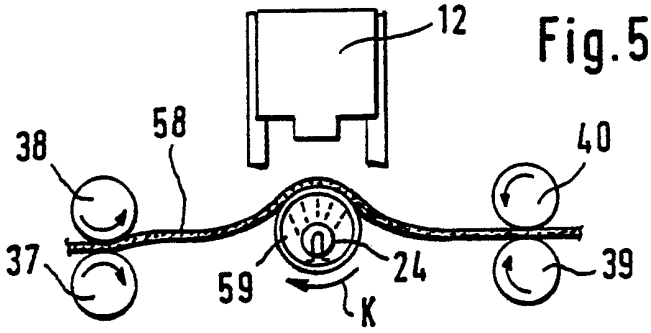


Fig.5

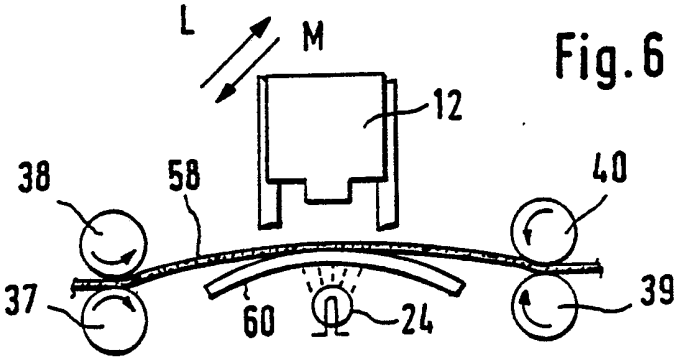


Fig.6

Fig.7

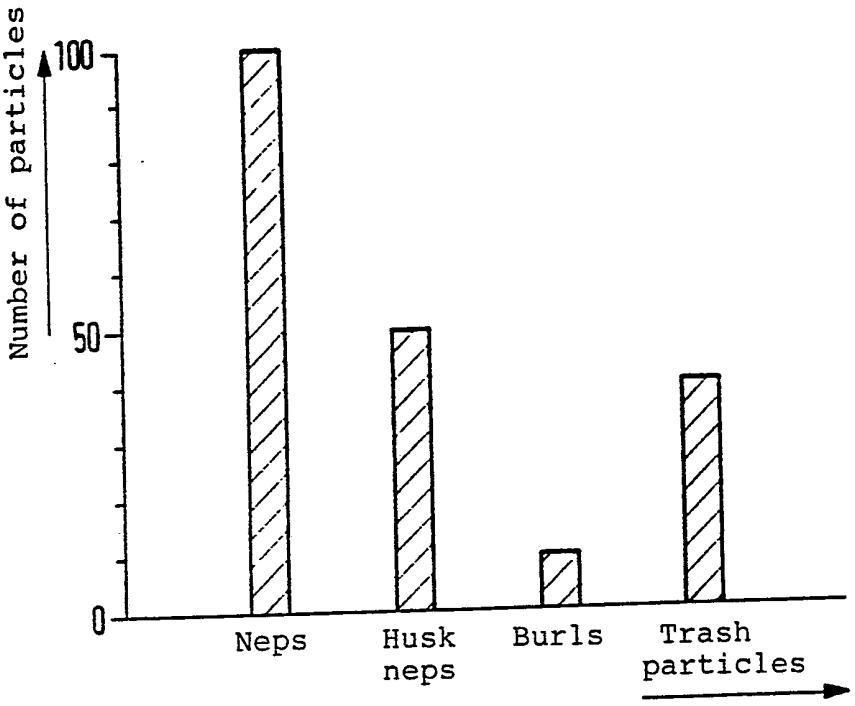


Fig.8

	I	II	III
half-tone	black to grey	grey	grey to black
web element	trash particle core fragment husk nep	nep fibre whiskers husk nep	web without undesirable particles

Fig.9

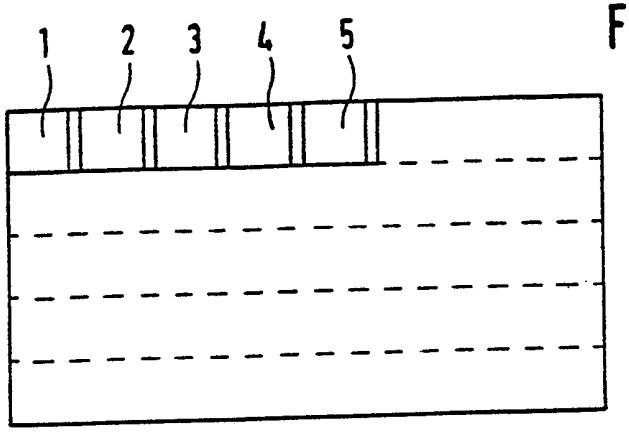
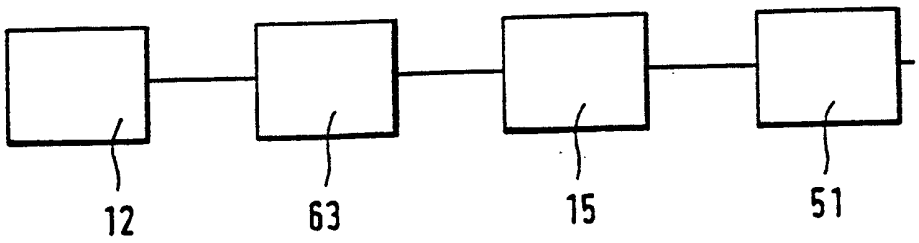


Fig.10

Burls	Knots of fibre > c. 1mm	
Neps	Knots of fibre < c. 1mm	
Trash particles	leaf and husk remains	
Husk neps	Seed husk fragments	

Fig.11



Method and apparatus for detecting undesirable particles in textile fibre material.

The invention relates to a method and apparatus for detecting undesirable particles, especially bits of trash, neps, husk neps, burls (which may also be referred to as "knops" or "knots) and the like, in textile fibre material, for example cotton, synthetic fibres and the like.

In a known method of cleaning and opening fibre material that is in flock form, the fibre material passes through a feeding device and is then subjected to a cleaning process. The contamination level of the fibre material is ascertained as the material is conveyed to the cleaning process. To carry out the known method, a measurement section for the fibre material is provided between a feeding device and an opening and cleaning device. The measurement section is a channel-like guide comprising a transparent disc and a conveyor belt which serves to press the layer of fibres in the channel against the disc. The distance of the disc from the conveyor belt is from 2 to 4 cm. Arranged in the measurement section is a camera and connected in series after the camera is a half-tone comparator, a counter and a computer. The transparent disc is irradiated by a lamp. The process of cleaning the fibre material fed to the cleaning device is said to be improved with this apparatus. The fibre material leaving the cleaning device

is then conveyed to a carding machine. A disadvantage of the known method is that the flock fed to the cleaner is approximately 2 to 4 cm thick, so that only the unwanted material waste on the surface, but not inside the flock layer, can be ascertained. A further disadvantage is that of the unwanted material waste detected on the surface in direct light, only a percentage proportion summed up in comparison with the fibres can be ascertained. Finally, other particularly undesirable particles for the spinning process, such as neps, husk neps and burls, cannot be detected.

The problem underlying the invention is therefore to provide a method of the kind described at the beginning that avoids or mitigates the disadvantages mentioned, that is able to register the undesirable particles also on the inside of the layer of fibres, and that renders possible the determination and differentiated evaluation of bits of trash, neps, husk neps, burls and the like.

According to the invention there is provided a method of detecting undesirable particles, especially bits of trash, neps, husk neps, burls and the like, in textile fibre material, for example cotton, synthetic fibres and the like, wherein the contamination level (trash content) of the fibre material is determined by optical-electronic means, the fibre material being registered by a sensor and the measurements fed to an image-processing device, characterised in that

a) a thin fibre web is formed,

b) the sensor registers each individual undesirable particle in stages,

c) specific characteristics, for example half-tones, are determined for each individual particle by means of an evaluation device,

d) the individual particles are classified on the basis of the characteristics, for example according to type, shape, size, by way of a comparison, and

e) the individual particles are counted.

The present invention also provides a method of detecting undesirable particles in textile fibre material in which the fibre material is formed into a thin fibre web and examined by an optical sensor connected to an evaluation device including an image processing device, wherein the resolution of the sensor is such that undesirable particles can be examined on a portion-by-portion basis, a graded output signal is available for each portion, from an examination of the output signals the particles are classified, and individual undesirable particles are counted.

By using a thin fibre web (for example 5 g/m^2) that light can penetrate, the undesirable particles both on the surface and on the inside of the fibre structure are ascertained. The sensor registers in stages every individual undesirable particle (for example with a resolution down to approximately 0.1 mm). A sensor, for example a camera registers a certain measurement range of the fibre web and forms electrical pulses corresponding to the image which are fed to an electronic evaluation device. In the evaluation device specific characteristics are ascertained for each individual particle, for example based on a half-tone analysis (identification as undesirable particles). On the basis of these characteristics, each individual particle is classified, especially according to type, shape and size, by way of comparison, for example, with predetermined stored characteristics. The individual particles are then counted so that, for example, a type classification (number of particles per type) or size classification (number of particles of a particular size) is rendered possible. With the method according to the invention, advantageously the undesirable particles also inside the layer of fibres, and thus in the entire layer of fibres, are registered, and in addition to trash particles also undesirable neps, husk neps and burls are registered, and finally all undesirable particles are classified according to particular criteria, such as, for example, type,

shape and size.

Advantageously, the thin fibre web and the sensor are moved relative to one another. Preferably, the sensor is moved in stages through a programmable measurement range. Preferably, the sensor registers some of the undesirable particles in transmitted light. Advantageously the sensor registers some of the undesirable particles in direct light. Advantageously the husk neps are registered in the transmitted light, at least two different half-tones being evaluated for the ascertaining operation. Preferably, the husk neps are ascertained by comparing the measurement results obtained in transmitted light with those in direct light.

The invention also includes an advantageous apparatus for detecting undesirable particles, especially bits of trash, neps, husk neps, burls and the like in textile fibre material, for example cotton, synthetic fibres and the like, for carrying out the method, in which apparatus a measurement section is provided for the fibre material, there being arranged in the measurement section a sensor for ascertaining the contamination level, which apparatus has a camera, for example a diode line camera or planar camera (a camera having a two dimensional array of light sensitive elements which may be continuous or discrete), an electronic evaluation device (image-processing unit), a classification device, a counter and a computer. Advantageously, the sensor and a lighting means are

arranged on the same side of the fibre web. Preferably, the sensor and a lighting means are arranged on different sides of the fibre web. Preferably, a switching means is provided for switching over between two or more lighting means. Advantageously, the evaluation device comprises a comparison means for the electrical pulses in transmitted light and direct light determination. Advantageously, the evaluation device comprises an analogue/digital converter. Preferably, the evaluation device comprises a half-tone filter. The evaluation device preferably ascertains the form (shape) of the individual particles. The evaluation device advantageously ascertains the size of the individual particles. The evaluation device advantageously ascertains the brightness of the individual particles. The classification means preferably includes a store. The apparatus preferably comprises a monitor. Advantageously, a biaxial control means is associated with the support for the fibre web. The support is advantageously transparent, for example consists of glass or the like. The support preferably has a convex surface. Preferably, the support is a roller with a transparent or translucent covering surface. Advantageously, the sensor with the lighting means is arranged at the inlet and/or at the outlet of a a fibre web-forming device, for example a carding machine. Advantageously, the sensor is able to register the fibre web disposed on a roller. Preferably, the

number and/or amount of undesirable particles can be determined over the width of the roller. As a result the undesirable particles can be assigned to, for example, a defective section of clothing. Preferably, a plurality of sensors is connected to the evaluation device. Advantageously, the computer is connected by way of a control unit and control wires, for controlling the degree of cleaning, to the drive for an adjusting element, for example a guide element or stripper blade associated with a clothed roller on a carding machine or the like. Adjusting elements may also be drive elements for delivery rollers and/or feed rollers and/or clothed rollers. Advantageously, the computer is connected to a quality-registering device, for example a card information system (CIT). Preferably, the computer is connected to the control means of the fibre web-forming machine, for example carding machine, and if predetermined threshold values for the undesirable particles, stored for example in a store, are exceeded, a warning device and/or means for switching off the machine can be actuated.

"Burls" are fibre knots greater than approximately 1 mm, "neps" are fibre knots smaller than approximately 1 mm. "Trash particles" are, for example, leaf and husk remains. "Husk neps" are seed husk fragments on which there are fibres. A separate class (sub-class) is formed by long bits of trash (bark, grass) that have a large

ratio of length to breadth, for example stem remains.

By way of example certain embodiments of the invention will now be described with reference to the accompanying schematic drawings, of which

Fig. 1 shows a first form of apparatus for detecting undesirable particles,

Fig. 2 is a side view of a second form of apparatus for detecting undesirable particles, the apparatus being installed in a carding machine,

Fig. 3 is a block circuit diagram of part of the apparatus of Fig. 2,

Fig. 4 is a side view of a support and illuminating arrangement for use in the invention in which the support is flat,

Fig. 5 is a side view of a support and illumination arrangement similar to that of Fig. 4 but in which the support comprises a roller,

Fig. 6 is a side view of a support and illumination arrangement similar to that of Fig. 4

but in which the support comprises an arched plate,

Fig. 7 is a graph classifying undesirable particles according to type,

Fig. 8 is a table representation of the half-tone ranges of a web image,

Fig. 9 is a schematic representation of the putting together of the total image from the individual images taken in stages,

Fig. 10 is a schematic representation of undesirable particles, comprising bits of trash, neps, husk neps and burls, and

Fig. 11 is a block circuit diagram similar to Fig. 3 but showing a modified arrangement.

Referring first to Fig. 1, a variable-position table 1 (the position of which is variable in the direction of the coordinates x and y) is provided that on its upper surface 1a has a glass plate 2a and on its lower surface 1b (not shown) has a glass plate (2b) (not shown). Beneath the glass plate 2 is a lighting means 24. A fibre web 25 (specimen) incorporating undesirable

particles 26 lies on the glass plate 2a. External to the table 1 is a variable-position support plate 3 on which a stepper motor 4 is fastened. The rotatable motor shaft is in the form of a screw shaft 5 which engages with a screw block 6 secured to a lateral face 1d of the table 1. On rotation of the screw shaft 5 the table 1 is displaced in the direction of the arrows A, B. Provided externally to the table 1 and the support plate 3 is a fixed-position support plate 7 on which a stepper motor 8 is fastened. The rotatable motor shaft is in the form of a screw shaft 9 which engages with a screw block 10 secured to a lateral face 3b of the support plate 3. On rotation of the screw shaft 9 the support plate 3 is moved in the direction of the arrows C', D' and, as a result of the mechanical connection, at the same time the table 1 is moved in the direction of the arrows C, D. Arched over the table 1 is a U-shaped support 11 the lateral pillars 11a, 11b of which are secured to the plate 7 and on the crosshead 11c of which a camera 12, for example a diode line camera, and a lighting means 13, are arranged.

Especially suitable for the invention is digital image-processing in which the image is resolved into individual points (so-called pixels). Apart from the stepper motors 4, 8 there are also limit switches (not shown), so that it is possible to drive the table to or from a defined position.

The apparatus also includes an image-processing device 14 that has a central processing unit (CPU) 15, for example a microprocessor, an image-processing system 16, an auxiliary store 17 and an interface unit 18, which are electrically connected to each other by a data bus 23. Connected to the interface unit 18 is a biaxial control means 19 which is connected to the stepper motors 4 and 8. In addition, the image-processing system 16 is connected to the camera 12. The interface unit 18 is connected to a printer 20, to a terminal 21 and to a service keyboard 22.

The apparatus according to Fig. 1 can be used, for example, as laboratory apparatus, and comprises the image-processing device 14 with auxiliary store 17 and interface unit 18, a light source 24 below the table for transmitting light through the table (which at least in the required region is transparent or has an opening), a terminal 21 and a direct lighting means 13 above the table. The fibre web 25 to be examined can also be disposed between a pair of thin transparent plates like the plates 2a, 2b on top of the table. The camera 12 secured to the crosshead 11c scans in stages a programmable measurement range. The trash particles 26 and neps detected during the course of this are classified. The measurement results and size distributions (histogram) can be presented on the connected terminal 21 and the printer 20. In the light transmitted through the table,

all light-impermeable objects, for example trash particles 26 or husk neps, are registered and classified according to size. When measurements are made using direct light (that is light from the means 13 shining directly onto the fibre web), the neps and burls stand out as locally defined light regions and are identified with the image-processing system 14. The identified neps and burls are also classified according to size. The duration of the test for registering trash particles 26 and husk neps is, for example, from 3 to 20 minutes. Parts that are visible in transmitted light are detected to a minimum size of approximately 0.1 mm (diameter). The maximum size can be up to 60 mm. In the case of particles evaluated in direct light, neps with a minimum diameter of about 0.1 mm are detected. The maximum particle size of the burls is approximately 2 mm.

Fig. 2 shows a carding machine 30 with a feed roller 31, feed table 32, licker-in 33, cylinder 34, doffer 35, stripper roller 36, squeezing rollers 37, 38, transport rollers 39, 40, web guide element 41, sliver funnel 42, from which a sliver 64 emerges, delivery rollers 43, 44, coiler 45 and moving card top 46. A flock feed device 47 is provided in the carding machine 30. Between the squeezing rollers 37, 38, which deliver a thin fibre web 58 (not shown), and the transport rollers 39, 40, which receive the fibre web 58 and transport it further, there

are two transparent fixed-position plates 48, 49, which form a channel defining a monitoring section 50, and which are spaced from each other by approximately 2 to 10 cm and between which the fibre web 58 travels. The plates 48, 49 at the same time prevent interfering air currents which might tear the thin fibre web 58 especially at high running speed.

The apparatus for detecting undesirable particles in the fibre web 58 passing through the measurement section 50 has a camera 12 and an image-processing device 14 (which is similar to that described with reference to Fig. 1) which, inter alia, comprises a half-tone comparator, a counter and a processing computer. Connected in series after the image-processing device 14 is a control means 51, for example a machine control means for the carding machine 30, which is connected to a regulable drive motor 52 that varies the distance of a separator blade 55 from the licker-in 33 by means of a screw threaded shaft 56 which is driven by the motor 52 and which engages in a screw block 54 on which the blade 55 is mounted.

In this manner an on-line detection and registration of the undesirable particles with regulation of the removal of the undesirable particles is effected. If predetermined threshold values stored in the store 17 are exceeded, then a warning may be given and/or the carding machine 30 may be switched off by way of the control

means 51 (by means of an output that is not shown). An optical filter 57 may extend in front of the camera 12. Furthermore, a lamp 13 is arranged on the side of the camera 12 for providing direct light and a lamp 24 is arranged on the side of the plate 48 opposite the camera 12 for transmitted light, the lamps serving to light up the subject of which an image is to be produced.

Examples of positions on the carding machine 30 at which fibre monitoring of the kind described above may be carried out are as follows:
fibre web or charge on the cylinder 34 (for example at the position shown by arrow E), fibre web or charge on the doffer 35 (for example at the position shown by arrow F), fibre web or charge on the stripper roller 36 (for example at the position shown by arrow G), fibre web between stripper roller 36 and squeezing rollers 37, 38 (at the position shown by arrow H) and fibre web between the squeezing rollers 37, 38 and the transport rollers 39, 40 (the position shown by arrow I and illustrated in Fig. 2). The undesirable particles, for example neps in the case of synthetic fibres, can be detected in the fibre web on the cylinder 34, on the doffer 35 and on the stripper roller 36 only in direct light, whereas the undesirable particles between stripper roller 36 and squeezing rollers 37, 38 and between squeezing rollers 37, 38 and transport rollers 39, 40 can be detected in transmitted light and direct light since in the latter

environments it is possible to provide a light source behind the fibre.

As shown in Fig. 3 there may be arranged in series after the camera 12 a half-tone comparator 61, a counter 62 and the computer 15, which are connected to the control means 51. The classification and counting are effected by means of appropriate computer programmes (software).

The following criteria are taken into consideration in order to classify the particles:

1) Type:

a) Nep:
Detection in direct light by half-tone filtering

b) Trash particles:
Detection in transmitted light by half-tone filtering

c) Long bits of trash (bark, grass):
This class represents a separate class of trash particles.

d) Husk neps:
Either comparison of transmitted light (the core is visible) and direct light (the fibres of the husk neps are visible)

or only direct light:

Dark core (high half-tone), lighter fibre surround, as in the case of a nep (lower half-tone).

In addition to the described identification methods a) to d) it is possible to use half-tone operations, edge detections or others for improved differentiation of the particles.

2) Size:

The area of the particle is registered in square millimeters (minimum size 0.1 mm diameter).

Fig. 4 shows a glass plate 49 which is arranged along the fibre path between squeezing rollers 37, 38 and transport rollers 39, 40 and over which the fibre web 58 runs. The camera 12 is arranged above the glass plate 49 and the lamp 24 for transmitted light exposure is arranged below the glass plate 49. The direction of rotation of the squeezing rollers 37, 38 and of the transport rollers 39, 40 is indicated by curved arrows.

In the arrangement shown in Fig. 5 there is arranged between the squeezing rollers 37, 38 and the transport rollers 39, 40, with its axis parallel thereto, a roller 59 (the direction of rotation of which is shown by the arrow K) with glazed covering surface over which the

fibre web 58 runs. The peripheral speed of the roller 59 is advantageously identical to the running speed of the fibre web 58, so that there is no relative movement causing abrasion. The lamp 24 is arranged inside the roller 59.

Fig. 6 shows a form of construction similar to Fig. 5 in which the support is a convex glass plate 60 over which the fibre web 58 slides and which with sliding contact renders possible improved guidance. The fibre web 58 is in contact only with a part of the glass plate 60. The uppermost point of the roller 59 and the glass plate 60 is advantageously in each case above the connecting straight lines between the roller nip of the squeezing rollers 37, 38 and of the transport rollers 39, 40. The arrows L and M indicate the direction in which the camera 12 can be moved across the width of the machine.

Fig. 7 is a graph of a classification of the undesirable particles according to type. The proportion of particles is given as a percentage by number against the type of particle.

Fig. 8 shows in table form the half-tone ranges of a web image, in which particular elements of the fibre web (undesired particles and material fibres) are each allotted particular half-tones. In Fig. 8 a total of three half-tones are shown.

Fig. 9 shows an arrangement in which each image

provided by an individual picture is smaller than the complete specimen, so that the total result is obtained by placing several images next to each other with overlap.

In the arrangement shown in Fig. 11, an analogue/digital converter 63 and computer 15 are arranged in series after the camera 12. The counting is effected by software in the computer 15. The analogue/digital converter 63 converts the sensor signal into a plurality of half-tones, for example 200 to 300 half-tones. Advantageously the apparatus according to Fig. 2 has as the camera 12 a CCD planar camera ("planar" in the sense that the light sensitive elements are disposed in a two dimensional array). Preferably the planar camera 12 has a device for short-time exposure. In the carding machine (Fig. 2) a possible lack of definition owing to movement is avoided by using a short-time exposure. The taken image is quasi "frozen" by the short-time exposure.

Throughout the specification reference has been made to "trash particles", "neps", "husk neps" and "burls". Fig. 10 shows an illustration of each of these particles, thereby showing the kind of particles to which reference is being made.

Where in the description above reference is made to light it should be understood that the light may be in the invisible (for example, infra red) part of the spectrum.

Claims

1. A method of detecting undesirable particles in textile fibre material in which the fibre material is formed into a thin fibre web and examined by an optical sensor connected to an evaluation device including an image processing device, wherein the resolution of the sensor is such that undesirable particles can be examined on a portion-by-portion basis, a graded output signal is available for each portion, from an examination of the output signals the particles are classified, and individual undesirable particles are counted.

2. A method according to claim 1, in which the thin fibre web and the sensor are moved relative to one another.

3. A method according to claim 2, in which the sensor is moved in stages through a programmable measurement range.

4. A method according to any preceding claim, in which the sensor senses an image of light that has been directed onto the fibre web from a source on the same side of the web as the sensor.

5. A method according to any preceding claim, in which the sensor senses an image of light that has been

transmitted through the fibre web from a source on the opposite side of the web from the sensor.

6. A method according to claim 5, in which the husk neps are detected at least partly by sensing of transmitted light and at least two different half-tones of the transmitted light are distinguished by the sensor.

7. A method according to claim 4 and claim 5 or 6, in which the husk neps are detected by comparing the measurement results of the transmitted light with those of the direct light.

8. An apparatus for detecting undesirable particles in textile fibre material, the apparatus including:

means for forming the fibre material into a thin web,

an optical sensor for examining the fibre web,

an evaluation device, including an image processing device, connected to the optical sensor,

a classification device for classifying the particles detected by the sensor and the evaluation device, and

a counter for counting the number of particles detected.

9. An apparatus according to claim 8 in which the optical sensor is a camera.

10. An apparatus according to claim 9 in which the camera has a line of light sensitive elements.

11. An apparatus according to claim 9 in which the

camera has a two dimensional array of light sensitive elements.

12. An apparatus according to any one of claims 8 to 11, in which the optical sensor and a light source are arranged on the same side of the fibre web path.

13. An apparatus according to any one of claims 8 to 12, in which the optical sensor and a light source are arranged on opposite sides of the fibre web path.

14. An apparatus according to claim 12 and 13, in which a switching means for switching over between the light source on the same side and the light source on the opposite side is provided.

15. An apparatus according to claim 12 and 13 or claim 14, in which the evaluation device comprises a comparison means for comparing electric pulses from the optical sensor resulting from transmitted light and direct light.

16. An apparatus according to any one of claims 8 to 15, in which the evaluation device includes an analogue/digital converter.

17. An apparatus according to any one of claims 8 to 16, in which the evaluation device includes a half-tone filter.

18. An apparatus according to any one of claims 8 to 17, in which the evaluation device includes means for ascertaining the shape of individual particles detected.

19. An apparatus according to any one of claims 8 to 18, in which the evaluation device includes means for

ascertaining the size of the individual particles.

20. An apparatus according to any one of claims 8 to 19, in which the evaluation device includes means for ascertaining the lightness of the individual particles.

21. An apparatus according to any one of claims 8 to 20, in which the classification device includes a store.

22. An apparatus according to any one of claims 8 to 21, further including a display for displaying results of the particle detection.

23. An apparatus according to any one of claims 8 to 22, in which means for adjusting the relative positions of the optical sensor and the fibre web path are provided.

24. An apparatus according to claim 23 in which the adjusting means is arranged to provide a biaxial adjustment.

25. An apparatus according to any one of claims 8 to 24, in which at least partially transparent or translucent support for the fibre web in the vicinity of the optical sensor is provided.

26. An apparatus according to claim 25, in which the support has a convex surface.

27. An apparatus according to claim 25 or 26, in which the support is a roller with a transparent or translucent periphery.

28. An apparatus according to any one of claims 8 to 27, in which the sensor is arranged at the outlet of the fibre web-forming means.

29. An apparatus according to any one of claims 8 to 28 in which the fibre web-forming means comprises a carding machine.

30. An apparatus according to any one of claims 8 to 29, in which the sensor is able to examine the fibre web while it is disposed on a clothed roller.

31. An apparatus according to claim 30, in which the detection of undesirable particles can take place over the width of the roller.

32. An apparatus according to any one of claims 8 to 31, in which a plurality of sensors are connected to the evaluation device.

33. An apparatus according to any one of claims 8 to 32, in which a control means is provided, the control means being connected to receive an input related to the results of particle detection and to provide an output for adjusting the operation of a machine upstream of the optical sensor.

34. An apparatus according to claim 33, in which the control means is connected to provide an output to adjust the position of part of a cleaning device associated with a clothed roller.

35. An apparatus according to any one of claims 8 to 34, in which the control means is connected to a control unit of the fibre web-forming means, and when predetermined threshold values for the undesirable particles are exceeded a warning means and/or means for switching off

the machine are actuated.

36. An apparatus according to any one of claims 8 to 35, further including a quality-registering means connected to receive an input related to the results of particle detection.

37. An apparatus according to claim 36 in which the quality-registering means comprises a card information system.

38. An apparatus according to any one of claims 8 to 37, in which the optical sensor is a CCD camera.

39. An apparatus according to any one of claims 8 to 38, in which the optical sensor is a camera arranged to operate with a short-time exposure.

40. A method of detecting undesirable particles in textile fibre material in which the fibre material is formed into a thin fibre web and examined by an optical sensor connected to an evaluation device including an image processing device, wherein the web is illuminated from both sides and the optical sensor detects both light that has been directed onto the web from the same side as the sensor and light that has passed through the web from the opposite side to the sensor.

41. A method of detecting undesirable particles in textile fibre material in which the fibre material is formed into a thin fibre web and examined by an optical sensor connected to an evaluation device including an image processing device, wherein the resolution of the

sensor is such that undesirable particles can be examined on a portion-by-portion basis, a graded output signal is available for each portion, and from an examination of the output signals the particles are classified.

42. An apparatus for detecting undesirable particles in textile fibre material, the apparatus including:

means for forming the fibre material into a thin web,

an optical sensor for examining the fibre web,

an evaluation device, including an image processing device, connected to the optical sensor,

a light source on the same side of the fibre web path as the optical sensor, and,

a further light source on the opposite side of the fibre web path to the sensor.

43. A method of detecting undesirable particles in textile fibre material, the method being substantially as herein described with reference to and as illustrated by Fig. 1 or by Fig. 2 of the accompanying drawings.

44. An apparatus for detecting undesirable particles in textile fibre material, the apparatus being substantially as herein described with reference to and as illustrated by Fig. 1 or by Fig. 2 of the accompanying drawings.

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