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CA 2718201 C 2014/04/22

(11)(21) 2 718 201

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 2009/02/20
(87) Date publication PCT/PCT Publication Date: 2009/09/17
(45) Date de délivrance/Issue Date: 2014/04/22
(85) Entrée phase nationale/National Entry: 2010/08/23
(86) N° demande PCT/PCT Application No.: EP 2009/001359
(87) N° publication PCT/PCT Publication No.: 2009/112158
(30) Priorité/Priority: 2008/03/08 (DE10 2008 013 525.9)

(51) Cl.Int./Int.Cl. *G01N 21/89* (2006.01),
G01N 33/12 (2006.01)

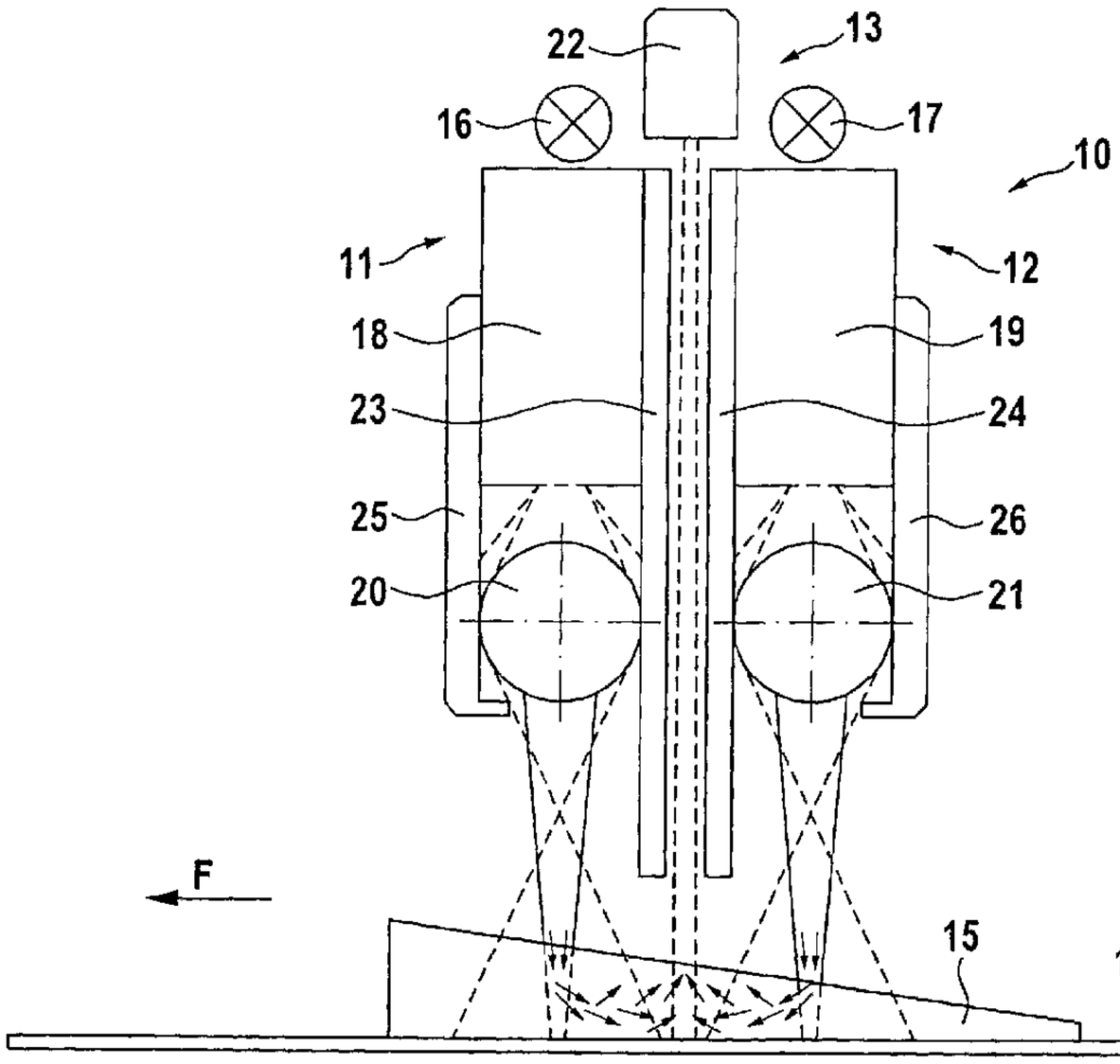
(72) Inventeurs/Inventors:
SIVERTSEN, AGNAR HOLTEN, NO;
HEIA, KARSTEN, NO;
NILSEN, HEIDI ANITA, NO

(73) Propriétaire/Owner:
NORDISCHER MASCHINENBAU RUD. BAADER GMBH + CO. KG, DE

(74) Agent: ROBIC

(54) Titre : DISPOSITIF ET PROCEDE POUR DETECTER SANS CONTACT DES CARACTERISTIQUES DE PRODUITS TRANSLUCIDES TRANSPORTES EN CONTINU

(54) Title: DEVICE AND METHOD FOR THE CONTACTLESS DETECTION OF CHARACTERISTICS OF CONTINUOUSLY DELIVERED TRANSLUCENT PRODUCTS



(57) Abrégé/Abstract:
The invention relates to a device (10) for the detection of characteristics of continuously delivered translucent products (15), comprising a transmission unit (11, 12) having a light source (16, 17) for generating high-intensity light radiation, a light shaping

CA 2718201 C 2014/04/22

(11)(21) 2 718 201

(13) C

(57) Abrégé(suite)/Abstract(continued):
element (18, 19) for forming a planar light field from the light radiation, and a focusing element (20, 21) for forming a line of light from the planar light field extending transversely to the delivery direction F of the products (15), and a receiving unit (13) having a detection means (22) for accommodating light radiation transflected from the product (15), a shading element (23, 24) being disposed between the transmission unit (11, 12) and the receiving unit (13), characterized in that at least two transmission units (11, 12) are provided with a corresponding design such that at least two independent light sources (16, 17) are provided for illuminating the product (15), wherein a transmission unit (12) is disposed in the delivery direction F of the products (15) in front of the receiving unit (13), and the other transmission unit (11) is disposed in the delivery direction F behind the receiving unit (13). The invention further relates to a corresponding method.

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro

(43) Internationales Veröffentlichungsdatum
17. September 2009 (17.09.2009)

PCT

(10) Internationale Veröffentlichungsnummer
WO 2009/112158 A1

(51) Internationale Patentklassifikation:
G01N 21/89 (2006.01) *G01N 33/12* (2006.01)

(21) Internationales Aktenzeichen: PCT/EP2009/001359

(22) Internationales Anmeldedatum:
20. Februar 2009 (20.02.2009)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:
10 2008 013 525.9 8. März 2008 (08.03.2008) DE

(71) Anmelder *(für alle Bestimmungsstaaten mit Ausnahme von US)*: **NORDISCHER MASCHINENBAU RUD. BAADER GMBH + CO. KG** [DE/DE]; Geniner Strasse 249, 23560 Lübeck (DE).

(72) Erfinder; und

(75) Erfinder/Anmelder *(nur für US)*: **SIVERTSEN, Agnar Holten** [NO/NO]; Stakkevolvg. 14a, Leilighet 203, 9010 Tromsø (NO). **HEIA, Karsten** [NO/NO]; Ilevg. 3, 9017 Tromsø (NO). **NILSEN, Heidi Anita** [NO/NO]; Elvhusvn. 59, 9020 Tromsdalen (NO).

(74) Anwalt: **BAMBERGER, Stephan**; Wenzel & Kalkoff, Postfach 73 04 66, 22124 Hamburg (DE).

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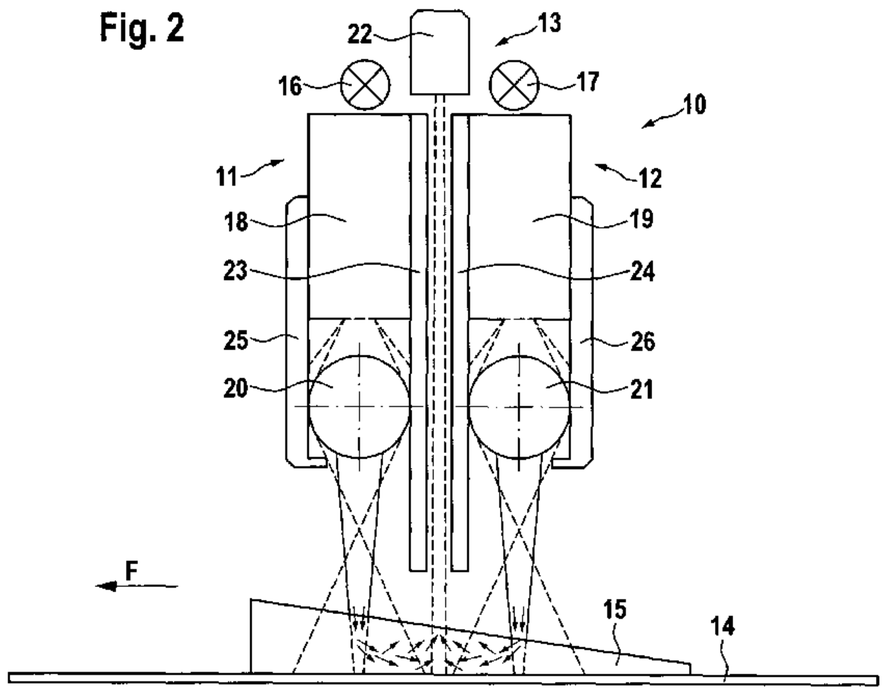
(84) Bestimmungsstaaten *(soweit nicht anders angegeben, für jede verfügbare regionale Schutzrechtsart)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), eurasisches (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), europäisches (AT, BE, BG, CH, CY, CZ, DE,

[Fortsetzung auf der nächsten Seite]

(54) **Title**: DEVICE AND METHOD FOR THE CONTACTLESS DETECTION OF CHARACTERISTICS OF CONTINUOUSLY DELIVERED TRANSLUCENT PRODUCTS

(54) **Bezeichnung**: VORRICHTUNG UND VERFAHREN ZUM KONTAKTLOSEN ERKENNEN VON CHARAKTERISTIKA VON KONTINUIERLICH GEFÖRDERTEN, TRANSLUZENTEN PRODUKTEN

Fig. 2



(57) **Abstract**: The invention relates to a device (10) for the detection of characteristics of continuously delivered translucent products (15), comprising a transmission unit (11, 12) having a light source (16, 17) for generating high-intensity light radiation, a light shaping element (18, 19) for forming a planar light field from the light radiation, and a focusing element (20, 21) for forming a line of light from the planar light field extending transversely to the delivery direction F of the products (15), and a receiving unit (13) having a detection means (22) for accommodating light radiation transflected from the product (15), a shading element (23, 24) being disposed between the transmission unit (11, 12) and the receiving unit (13), characterized in that at least two transmission units (11, 12) are provided with a corresponding design such that at least two independent light sources (16, 17) are provided for illuminating the product (15), wherein a transmission unit (12) is disposed in the delivery direction F of the products (15) in front of the receiving unit (13), and the other transmission unit (11) is disposed in the delivery direction F behind the receiving unit (13). The invention further relates to a corresponding method.

(57) **Zusammenfassung**:

[Fortsetzung auf der nächsten Seite]

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DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Erklärungen gemäß Regel 4.17:

— *Erfindererklärung (Regel 4.17 Ziffer iv)*

Veröffentlicht:

— *mit internationalem Recherchenbericht (Artikel 21 Absatz 3)*

Die Erfindung betrifft eine Vorrichtung (10) zur Erkennung von Charakteristika von kontinuierlich geförderten, transluzenten Produkten (15), umfassend zum einen eine Sendeeinheit (11, 12) mit einer Lichtquelle (16, 17) zum Erzeugen hochintensiver Lichtstrahlung, einem Lichtumformelement (18, 19) zur Bildung eines flächigen Lichtfelds aus der Lichtstrahlung und einem Fokussierelement (20, 21) zum Bilden einer quer zur Förderrichtung F der Produkte (15) verlaufenden Lichtlinie aus dem flächigen Lichtfeld, und zum anderen eine Empfangseinheit (13) mit einem Detektionsmittel (22) zum Aufnehmen der vom Produkt (15) transflektierten Lichtstrahlung, wobei zwischen der Sendeeinheit (11, 12) und der Empfangseinheit (13) ein Abschattungselement (23, 24) angeordnet ist, die sich dadurch auszeichnet, dass mindestens zwei Sendeeinheiten (11, 12) mit entsprechendem Aufbau vorgesehen sind, derart, dass mindestens zwei unabhängige Lichtquellen (16, 17) zum Beleuchten des Produktes (15) vorgesehen sind, wobei eine Sendeeinheit (12) in Förderrichtung F der Produkte (15) vor der Empfangseinheit (13) und die andere Sendeeinheit (11) in Förderrichtung F hinter der Empfangseinheit (13) angeordnet ist. Des Weiteren betrifft die Erfindung ein entsprechendes Verfahren.

Device and method for the contactless detection of characteristics of continuously delivered translucent products

The invention concerns an apparatus for the contactless detection of characteristics of continuously conveyed, translucent products, comprising firstly a transmitting unit having a light source for generating high-intensity light radiation, a light-converting element for forming a planar light field from the light radiation and a focusing element for forming a line of light running transversely to the direction of conveying F of the products from the planar light field, and secondly a receiving unit having a detection means for picking up the light radiation transflected by the product, wherein a shading element is arranged between the transmitting unit and the receiving unit.

Furthermore the invention concerns a method for the contactless detection of characteristics of continuously conveyed, translucent products, comprising the steps of: continuously conveying the products through an inspection region of a receiving unit, exposing the products to light radiation by means of a transmitting unit, and picking up the light radiation transflected by the products by means of the receiving unit.

Such apparatuses and methods are used in different industrial fields in which products are tested for certain characteristics. Possible characteristics are different product-specific properties, but also anomalies or foreign bodies and the like. In the fish-processing industry e.g. the detection of parasites inside fish fillets is of particular importance. This means that each fish fillet is tested for parasites, which are usually very small objects compared with the fish fillet. In this case the fish fillets are conveyed continuously at a very high speed of e.g. 40 cm/s or more on a transport element through an inspection region of a detection means.

It is known that the products, hence the fish fillets in the case of this example, can be exposed to light radiation. The light radiation which is scattered and/or reflected inside the translucent product is detected via the detection means and evaluated. To put it another way, the light radiation penetrates the products, wherein the light radiation is scattered without direction or reflected directionally inside the product, e.g. on foreign bodies. In addition further processes such as e.g. absorption and fluorescence may alter

the spectral characteristic of the light as well. This light radiation obtained as a result of transflection (transflectance/interactance) (scattered and/or directed) is hereinafter also referred to as transflected light. The transflected light is then detected by the detection means. Known apparatuses are constructed in such a way that they have a transmitting unit with a light source, wherein the light source beams high-intensity light radiation to a light-converting element. Within the light-converting element, in which e.g. glass fibre bundles can be arranged, the light radiation is shaped and conducted from the light input opening to the light output opening. The light-converting element has a planar opening in the output region for the light radiation. For physical reasons the light radiation scatters on leaving the light-converting element. This scattered light then encounters the focusing element which is arranged beneath the light-converting element and which focuses the planar light field to a line of light which runs transversely to the direction of conveying F of the products. In the known apparatuses, the transmitting unit is arranged either in front of the receiving unit or behind the receiving unit in the direction of conveying F of the products.

The problem with the existing apparatuses lies in that the single transmitting unit and hence the single light source on the one hand has too low a light intensity to illuminate/transilluminate the products sufficiently at high speeds of conveying, and on the other hand illuminates only a limited region of the fish fillet. This leads in particular to parts of the fish fillet, namely either in the leading region or in the trailing region, not being illuminated, as a result of which a full inspection is impossible.

It is therefore the object of the present invention to provide an apparatus which reliably ensures the detection of characteristics of translucent products at a high speed of conveying the products. Furthermore it is the object of the invention to propose a corresponding method.

This object is achieved by an apparatus having the features mentioned hereinbefore by the fact that at least two transmitting units with corresponding structure are provided, such that at least two independent light sources for illuminating the product are provided, wherein one transmitting unit is arranged in front of the receiving unit in the direction of conveying F of the products and the other transmitting unit is arranged

behind the receiving unit in the direction of conveying F. Hence in a surprisingly simple and reliable manner, illumination of the whole product is ensured. In addition to increasing the light intensity by a plurality of light sources, the arrangement of light sources according to the invention also ensures that the product is sufficiently illuminated over the entire area. Both when the products enter the inspection region and when they leave the inspection region, exposure to light of the product to be inspected is ensured. Also the increased light intensity ensures improved transillumination of the product. In other words, the light penetrates the products deeply.

An appropriate development of the invention provides that the two transmitting units are shielded from the receiving unit by means of a shading element. This ensures that light radiation which is scattered by the lenses in the direction of the inspection region is reliably shielded, so that the possibility of impairing pick-up of the light reflected by or, to be more precise, from the product and/or by the transport element and/or by the apparatus itself is excluded.

In other words, the object of the present invention is achieved by an apparatus for contactless detection of characteristics of continuously conveyed, translucent products, comprising:

first and second transmitting units each having

an independent light source to generate high-intensity light radiation to illuminate the product,

a light-converting element to form a planar light field from the light radiation, and

a focusing element to form a line of light from the planar light field, wherein the line of light extends transversely to a direction of conveying F of the products and parallel to the line of light generated by the other transmitting unit, wherein the line of light and a centre axis of the focusing element define a first plane perpendicular to the direction of conveying;

a receiving unit having a detection device to pick up the light radiation transflected by the product in an inspection region, and wherein the detection device and the inspection region define a second plane parallel to the first plane; and

shading elements each arranged between the receiving unit and a respective one of the first and second transmitting units, wherein the first and second transmitting units are shielded from the receiving unit by the respective shading elements,

wherein the first transmitting unit is arranged in front of the receiving unit in the direction of conveying F of the products and the second transmitting unit is arranged behind the receiving unit in the direction of conveying F.

Advantageously, each transmitting unit is assigned at least two shading elements, such that the transmitting units are shielded by means of a shading element on either side. This construction according to the invention prevents scattered light from impairing the inspection region on the side facing away from the receiving unit.

A particularly preferred embodiment is characterised in that the focusing element is a cylindrical lens. Hence linear light radiation is generated in a simple manner, so that the products are exposed to light across their whole width transversely to the direction of conveying F when passing through the inspection region.

A preferred embodiment is characterised in that the lenses of the two transmitting units are oriented parallel to each other. Hence optimum illumination of the inspection region is achieved for the whole product. In other words, an illumination-free section of the continuously conveyed product is prevented with the embodiment described.

Particularly advantageous is an apparatus which is distinguished in that the distance between the two lines of light generated by the light sources or lenses is approximately 40 mm. Thereby the above-mentioned advantage is supported even further.

The object is also achieved by a method having the steps mentioned hereinbefore by the fact that the products are exposed to high-intensity light radiation from separate light sources both on entering the inspection region of a detection means of the receiving unit and on leaving the inspection region of the detection means. The resulting advantages have already been described in connection with the apparatus, so that reference is made to the appropriate passages to avoid repetition.

Further appropriate and/or advantageous features and developments are apparent from the subsidiary claims and the description. A particularly preferred embodiment is described in more detail with the aid of the attached drawings. The drawings show:

Figure 1 a schematic view of a first embodiment of the apparatus according to the invention in a front view,

Figure 2 a schematic view of a further embodiment of the apparatus according to the invention in a front view, and

Figure 3 a top view of a product to be inspected with lines of light shown and inspection region shown.

The apparatuses described serve to detect parasites in fish fillets. The apparatus is, however, equally suitable for the detection of characteristics of other translucent products.

The apparatus 10 shown in Figure 1 comprises a first transmitting unit 11, a second transmitting unit 12 and a receiving unit 13. The apparatus 10 is usually arranged above a transport element 14. Arrangement beneath the transport element 14 is, however, also possible. On the transport element 14 the products 15 are conveyed continuously and at

high speed in the direction of conveying F, wherein the direction of conveying F may also be reversed.

Each transmitting unit 11, 12 has a light source 16 or 17 for generating high-intensity light radiation, a light-converting element 18 or 19 for forming a planar light field from the light radiation emanating from the light sources 16, 17, and a focusing element 20 or 21 for forming a line of light L_L running transversely to the direction of conveying F of the products 14 from the planar light field. The receiving unit 13 has a detection means 22 which can be e.g. a camera or the like. Each light source 16, 17 can be arranged inside or outside the light-converting element 18, 19 and be composed for example of several, preferably three halogen lamps (e.g. with a power of 150 W each and a colour temperature of approximately 3200 K) with associated reflectors.

In the embodiment shown in Figure 1, between the transmitting units 11, 12 and the receiving unit 13 is provided one shading element 23 or 24 each. The shading elements 23, 24 are light-impermeable and extend transversely to the direction of conveying F across the full width of the apparatus 10 and vertically to the plane of conveying from the detection means 22 to just above the products 15 to be inspected. The length of the shading elements 23, 24 can vary particularly in the vertical dimension.

The separate transmitting units 11, 12 are arranged on both sides of the receiving unit 13. In the direction of conveying F of the products 15, one of the transmitting units 11, 12 is arranged in front of the receiving unit 13 and the other transmitting unit 12, 11 is arranged behind the receiving unit 13. Thus the receiving unit 13 is in each case sandwiched between the transmitting units 11, 12, separated by the shading elements 23, 24. Further arrangements of the transmitting units 11, 12 in relation to the receiving unit 13, for example offset from the receiving unit 13, are possible too. As already mentioned, both transmitting units 11, 12 are preferably arranged above the transport element 14. But also possible is an arrangement of both transmitting units 11, 12 beneath the transport element 14, which is then light-permeable, or a variable arrangement with one transmitting unit 11 or 12 above and one transmitting unit 12 or 11 below the transport element 14.

The focusing elements 20, 21 are preferably constructed as a cylindrical lens. The design and dimensions of the lenses can vary. Preferred is a lens having a diameter of approximately 25 mm and a length of approximately 200 mm. The lenses are preferably made of poly(meth)acrylates. Other suitable materials are also possible, however. The lenses are in each case releasably attached to the light-converting element 18, 19, for example by clamps or the like. The lenses run preferably parallel to each other. In other words, the centre axes of both lenses are oriented transversely to the direction of conveying F of the products 15. The distance between the lenses can vary dependent on different factors (e.g. product size). A particularly preferred distance is selected such that the lines of light L_L generated by the light sources 16, 17 or the light-converting elements 18, 19 and the focusing elements 20, 21 have a distance of approximately 40 mm between them.

The detection means 22 comprises a camera. Optionally, a sensor unit can be provided as well. Naturally all other known elements for receiving signals and in particular for detecting and picking up transflected light can be used as well. Preferably the detection means 22 can also be a spectrometer with spatial resolution. Preferably a spectrometer with 128 spectral bands within a range from 400 to 1000 nm and a spatial resolution of approximately 0.5 mm^2 (0.5 mm transversely to the direction of conveying F and 1 mm in the direction of conveying F) is provided. The preferred speed of reading is 400 Hz. The spectrometer is arranged at a given distance from the transport element 14. The distance can vary, but is preferably approximately 1000 mm. The detection means 22 can be assigned an evaluating unit (not shown). Part of the evaluating unit can also be a computer unit and/or a control unit by means of which a reaction can be given to the results evaluated, for example to separate out unwanted or defective products or the like.

In the embodiments described, the light-converting element 18, 19 is a cuboid box with the preferred dimensions width x height x length of 25 x 100 x 200 mm. Of course, the dimensions are variable almost as desired. The box is made of a light-impermeable material such as e.g. aluminium painted black, and has in the interior several, preferably three glass fibre bundles. The box has a light input opening. In the region of this light input opening is arranged the light source 16, 17. Furthermore, the box has a light

output opening which is formed on the side facing towards the lenses. The light output opening is preferably rectangular, so that the light conducted by the glass fibre bundles from the light input opening to the light output opening emerges from the box in a planar light field L_F (or light band). The size and shape of the light output opening can of course vary. In addition to the preferred embodiment, naturally other designs and constructions of the light-converting element 18, 19 are possible as well.

In further embodiments e.g. additional shading elements 25 or 26 may be provided. In the embodiment according to Figure 2, each transmitting unit 11, 12 is assigned at least two shading elements 23 and 25 or 24 and 26. The shading elements 23, 24 serve to shield the lenses on the side facing towards the inspection region. The shading elements 25, 26 serve to shield the lenses on the opposite side. All of the shading elements 23 to 26 are preferably made of aluminium painted black. But other designs are possible as well. In the event that only the shading elements 23, 24 facing towards the inspection region I are provided, these extend to just above the products to be conveyed. The shading elements 25, 26 facing away from the inspection region I have, in addition to the vertically extending sections, a horizontally extending section which partly shields the lenses on the lower side. In general the shading elements 23 to 26 serve to reduce the light scattered by the lenses.

The principle of the method is described below with the aid of the figures. The products 15, that is, e.g. the fish fillets, are conveyed at high speed in the direction of conveying F on the transport element 14. When the products 15 enter the inspection region I, the leading section of the product 15 is already exposed to light from the first transmitting unit 12, so that the receiving unit 13 can pick up transflected light, that is, light which is reflected within the product, scattered and/or directed. The continuously conveyed product 15 is then conveyed on through the inspection region I to the output region. When the trailing section of the product 15 is still in the inspection region I, the trailing region is exposed to light from the second transmitting unit 11. In between, both transmitting units 11, 12 illuminate the product 15 in parallel.

The arrangement of the apparatus 10 accordingly ensures that the products to be inspected are fully illuminated on the one hand, and on the other hand this illumination

also takes place with the necessary intensity. The products 15 can also be conveyed in the reverse direction of conveying.

Claims

1. An apparatus (10) for contactless detection of characteristics of continuously conveyed, translucent products (15), comprising:

first and second transmitting units (11, 12) each having

an independent light source (16, 17) to generate high-intensity light radiation to illuminate the product,

a light-converting element (18, 19) to form a planar light field from the light radiation, and

a focusing element (20, 21) to form a line of light from the planar light field, wherein the line of light extends transversely to a direction of conveying F of the products (15) and parallel to the line of light generated by the other transmitting unit, wherein the line of light and a centre axis of the focusing element define a first plane perpendicular to the direction of conveying;

a receiving unit (13) having a detection device (22) to pick up the light radiation transflected by the product (15) in an inspection region, and wherein the detection device and the inspection region define a second plane parallel to the first plane; and

shading elements (23, 24) each arranged between the receiving unit (13) and a respective one of the first and second transmitting units (11, 12), wherein the first and second transmitting units (11, 12) are shielded from the receiving unit (13) by the respective shading elements (23, 24),

wherein the first transmitting unit (12) is arranged in front of the receiving unit (13) in the direction of conveying F of the products (15) and the second transmitting unit (11) is arranged behind the receiving unit (13) in the direction of conveying F.

2. The apparatus according to claim 1, wherein the receiving unit (13) is sandwiched between the shading elements (23, 24) which are directed vertically to a plane of conveying of the products (15).

3. The apparatus according to claim 1 or 2, wherein at least two shading elements (23, 25; 24, 26) are assigned to each transmitting unit (11, 12), such that the transmitting units (11, 12) are shielded by one of said shading elements (23, 25; 24, 26) on either side.

4. The apparatus according to any one of claims 1 to 3, wherein the focusing element (20, 21) comprises a cylindrical lens.

5. The apparatus according to claim 4, wherein the lens comprise poly(meth)acrylates.

6. The apparatus according to claim 4 or 5, wherein the lens has a diameter of 25 mm and a length of 200 mm.

7. The apparatus according to any one of claims 4 to 6, wherein the lens is attached to the light-converting element (18, 19).

8. The apparatus according to any one of claims 4 to 7, wherein the lenses of the two transmitting units (11, 12) are oriented parallel to each other.

9. The apparatus according to any one of claims 4 to 8, wherein the lenses have centre axes that are oriented transversely to the direction of conveying F of the products (15).

10. The apparatus according to any one of claims 1 to 9, wherein a distance between the two lines of light generated by the light sources (16, 17) or lenses is approximately 40 mm.

11. The apparatus according to any one of claims 1 to 10, wherein the detection device (22) comprises a camera.

12. The apparatus according to any one of claims 1 to 11, further comprising an evaluation unit assigned to the detection device (22).

13. The apparatus according to any one of claims 1 to 12, wherein the light-converting element (18, 19) is constructed to form a rectangular light field.

14. The apparatus according to any one of claims 1 to 13, further including a transport element (14) for conveying the products (15), and wherein both transmitting units (11, 12) are arranged above the transport element (14).

15. The apparatus according to claim 1, wherein the centre axes of the focusing elements (20, 21) are oriented transversely to the direction of conveying F, and wherein a distance between the centre axes of the focusing elements (20, 21) is equal to a distance between the lines of light generated by the first and second transmitting units (11, 12).

16. A method for the contactless detection of characteristics of continuously conveyed, translucent products (15), comprising the steps of:

- continuously conveying the products (15) through the inspection region of the detection device (22) of the receiving unit (13) of the apparatus of claim 1,

- exposing the products (15) to high-intensity light radiation from the independent light sources (16, 17) of the first and second transmitting units (11, 12) both on entering the inspection region and on leaving the inspection region of the detection device (22), and

- picking up the light radiation transflected by the products (15) by the receiving unit (13).

17. The method according to claim 16, wherein the exposing includes widening high-intensity light radiation emanating from each of the light sources (16, 17) into the planar light fields by the light-converting elements (18, 19) and

then focusing the planar light fields by the focusing elements (20, 21) into the lines of light running transversely to the direction of conveying F of the products (15).

18. The method according to claim 16 or 17, including shielding the first and second transmitting units (11, 12) at least two sides.

19. The method according to any one of claims 16 to 18, including processing the transflected light radiation picked up by the receiving unit (13) in an evaluating unit.

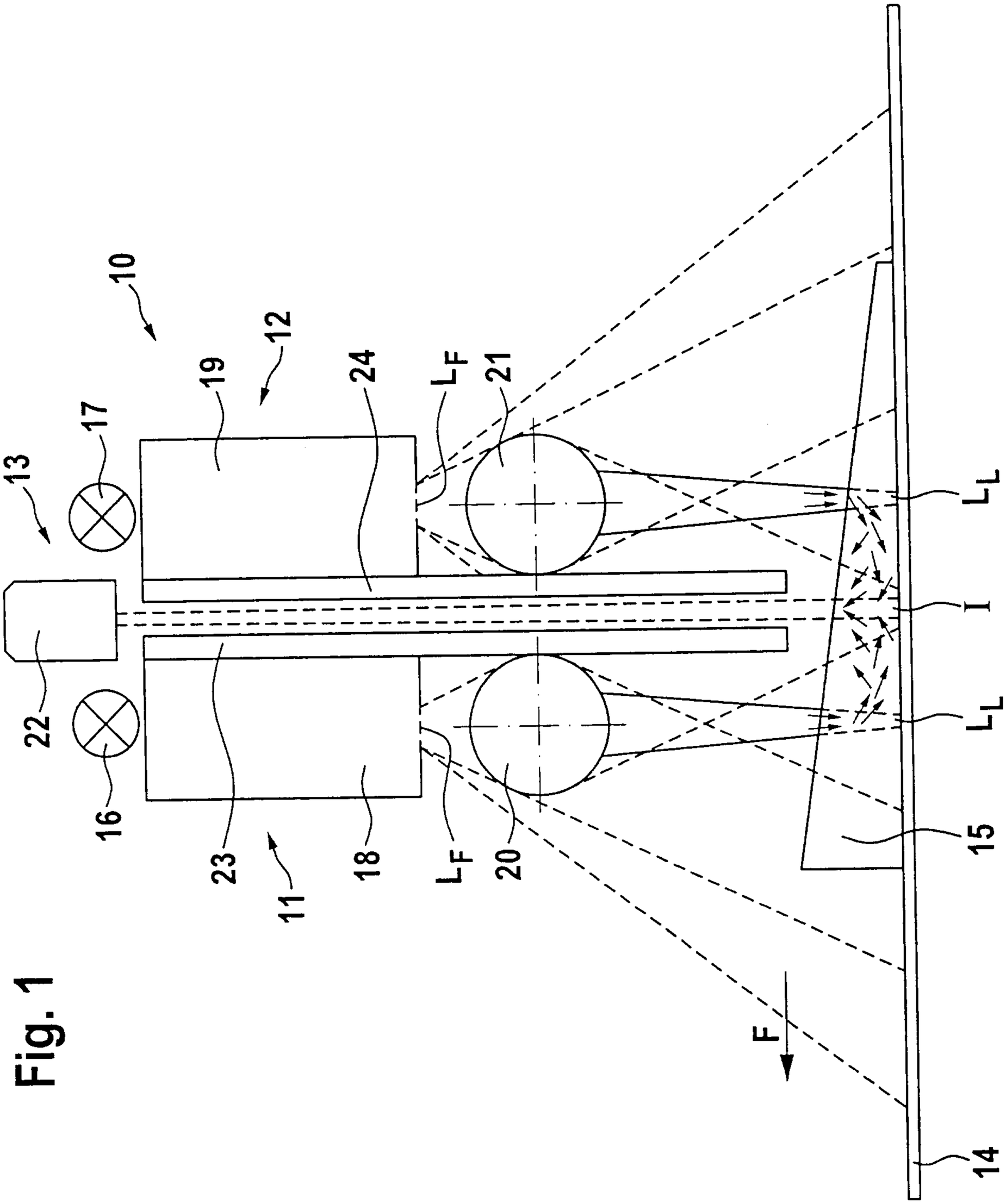


Fig. 1

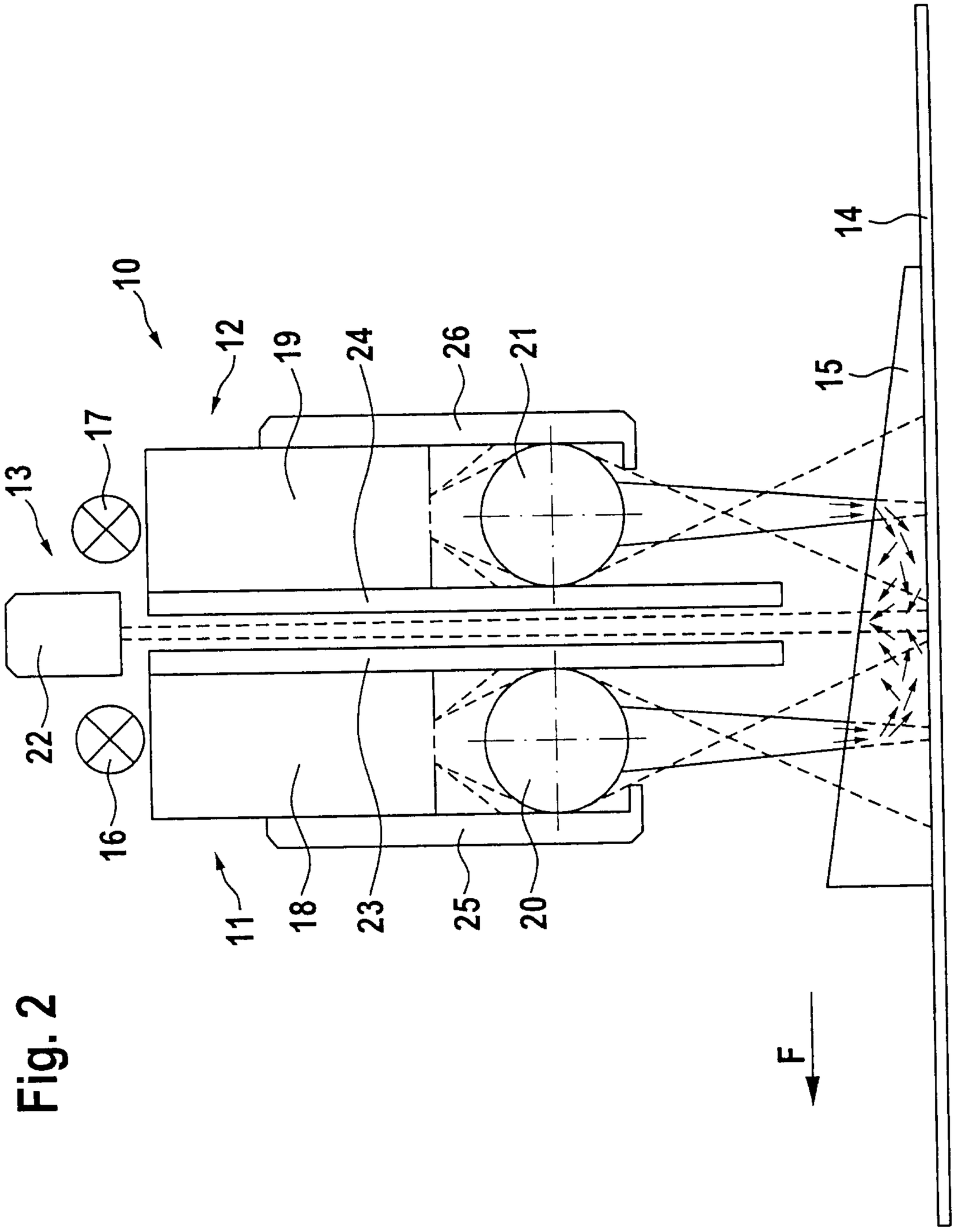


Fig. 2

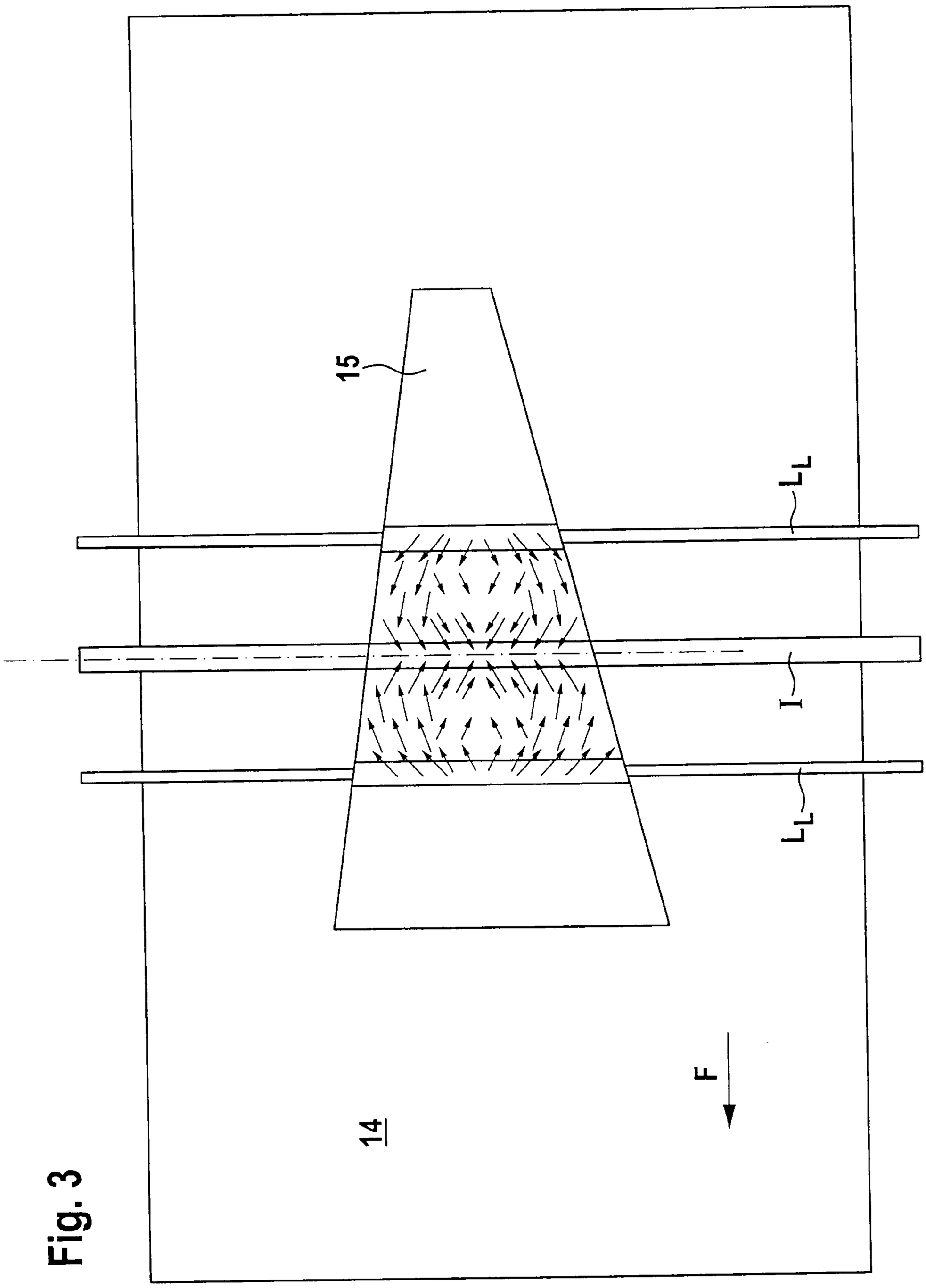
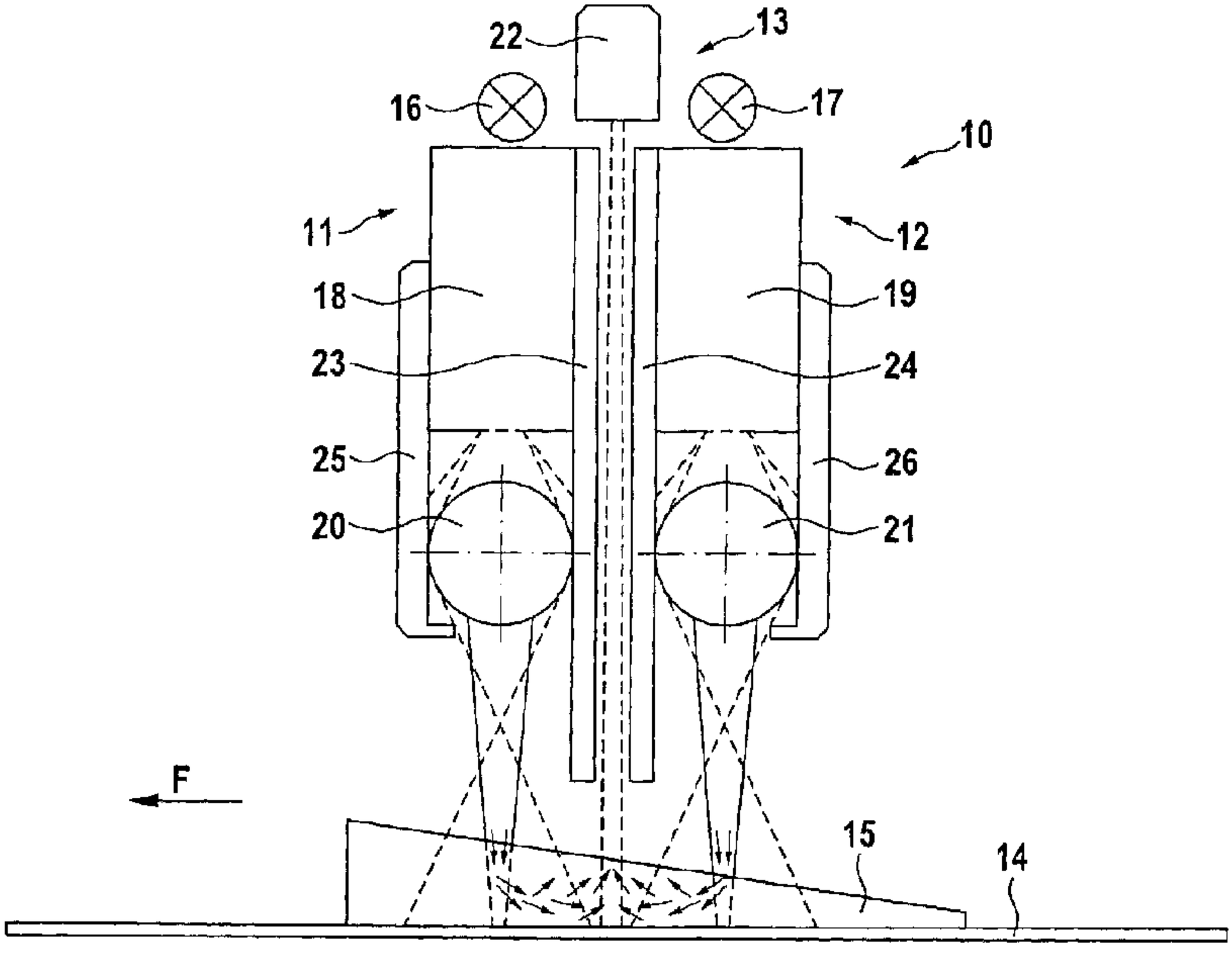


Fig. 3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