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BACKGROUND OF THE INVENTION

The present invention relates to a housing for a UV light source.

The housing can be used in a method for detecting leaded pieces of glass in a
5 single-layer material flow of objects made predominantly of waste glass, with the
objects being irradiated with substantially monochromatic UV-light and the
fluorescent light resulting therefrom being detected.

DESCRIPTION OF THE PRIOR ART

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Waste glass usually contains normal glass shards, but can also contain leaded
pieces of glass (lead glass).

For the purpose of color sorting and the recognition of impurities, mostly
contactless measuring methods by means of infrared or RGB sensors are used,
15 which initiate a separation of the undesirable impurities from the waste glass
material flow or a deflection of colored glasses into fractions provided for this
purpose by downstream blow-out or suction nozzles on the basis of the recorded
degree of transmission or absorption of light directed against the waste glass
material flow. The object of the mixed waste glass material flow to be sorted out
20 is irradiated by radiation sources on a sorting belt or during a free-falling passage,
and the radiation passing through the waste glass material flow or reflected
therefrom is detected in its intensity by a detection unit and compared with the
reference values. An evaluation and control unit which has a data connection with
the detecting unit subsequently performs an allocation of the object to a
25 respective fraction and initiates the gripping of the same by pick-ups or a
deflection of the same into predetermined containers by means of compressed-air
or suction nozzles.

One area of problems that was of only low importance in the recycling of glass but
which has become more pressing recently is the recognition of special glass in the
30 waste glass material flow. Assortments of glass created for special applications
are referred to as special glasses, which in comparison to normal glass (soda-lime
glass) have strongly deviating chemical and physical properties, especially a
substantially higher melting point and better thermal properties. These include for
example glass-ceramics, silica glass, lead glass and temperature-resistant and

heat-shock-resistant technical glasses such as borosilicate glass. The primary production process of special glass is similar to the one in the production of normal glass, but a certain fraction of special oxides is added to the glass melt depending on the respective field of application.

- 5 The so-called lead glasses or leaded glass pieces contain lead oxides. Although they are very popular as so-called lead crystal glass as a result of their strong optical refraction and favorable surface working capability, they need to be recycled in special glassworks for environmental and health reasons however, where they are molten again under controlled conditions. On the other hand, lead
- 10 glass also includes screens (cathode ray tube screens), the components of which comprise a different fraction of lead oxide PbO: the front glass which forms the visible part of the screen has a content of 0.1 to 4% of PbO; in the case of low-lead or lead-free fronts the content is close to < 0.1% PbO. The cone glass however has a content of 10 to 25% of PbO. Fractures of screens therefore either
- 15 belong to the front glass, the cone glass or the transitional region between the front and the cone, which glass pieces thereof are known as front/cone frits and can represent a separate class of glass pieces to be sorted out.

Known methods for sorting special glass work with the property of fluorescence of special glass. In this case, the glass is irradiated with UV light of a specific

20 wavelength, whereupon it begins to fluoresce in a narrow visible spectral range because the irradiated light will partly be absorbed by impurities contained in the oxidic glass and will be converted into fluorescent radiation. Conclusions can be drawn on the type of the special glass on the basis of the color of the fluorescence. The UV light to be used depends on the type of the special glass to

25 be sorted out. Such a method is known from WO2004/063729A1 for example, with which lead glass can be recognized and sorted out among other things.

In order to enable the elimination of undesirable wavelengths, especially such of visible light, from the spectrum of the UV light source, the UV light should be filtered.

- 30 It is known from US 7 550 746 B2 to direct the light of a UV lamp to a UV dichroic mirror before exciting fluorescent light. From US 4 747 645 A it is known to deflect light from a UV lamp by two US mirrors arranged normally to each other.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a housing for a UV light source for use in a method for detecting leaded glass pieces whereas the housing eliminates undesirable wavelengths, especially such of visible light, from the spectrum of the UV light source.

This object is achieved by a housing according to claim 1, in that the UV light source can be installed in the housing, which has a reflector and at least one mirror filter, such that the light from the UV light source is directed through the reflector, which is arranged in a first direction, in the opposite direction to the first direction and is deflected and filtered via at least one mirror filter, namely deflected by 180° by two mirror filters arranged normally to each other and thus directed in the first direction to a single UV light passage of the housing, wherein the mirror filters are mirrors, which are provided with a coating which absorbs a majority of the light in the visible range emitted by the UV light source.

A substantially monochromatic UV light source is used, with which a single-layer material flow of objects of predominantly waste glass can be illuminated.

Preferred embodiments are UV light sources having a wavelength of approximately 270 nm and detectors for the fluorescent light in the wavelength range of 380 to 450 nm, or UV light sources having a wavelength of approximately 254 nm and detectors for the fluorescent light in the wavelength range of 420 to 500 nm.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is now explained in more detail based on schematic figures. In both cases the backlighting method is used which means that UV light source and detector for fluorescent light are disposed on different sides of the waste glass material flow.

Fig. 1 shows an apparatus with a housing in accordance with prior art, with filters for the UV light source;

Fig. 2 shows an apparatus with a housing in accordance with the invention, with mirror filters for the UV light source.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In Fig. 1, both a UV light source 3 and a second light source 4 are installed in a housing 1 for light sources.

The UV light source 3 can emit UV light in the range of 100 to 280 nm, especially between 250 and 275 nm. It can be arranged in form of a UV-C lamp, which is also known as a UV-C fluorescent lamp or UV-C fluorescent tube. One or several UV-C LEDs (LED line) can also be used instead of a UV tube.

10 The second light source 4 can emit light in the visible range (wavelength of 380 to 780 nm) and/or in the infrared range (wavelength of 780 nm to 1 mm) and can be arranged (as in this example) as a fluorescent lamp (VIS lamp) with wavelengths in the visible range. It is also possible to use one or several color or infrared LEDs (LED line) instead of a lamp (VIS lamp).

15 LEDs offer several advantages over fluorescent tubes:

- Better controllability of intensity
- Higher intensity
- Many different and also narrow wavelength ranges are possible
- Width of illumination (LED line) and illuminated area can be chosen freely
- 20 by the arrangement of several LEDs
- Predetermination of an intensity profile is possible

The disadvantages at least of LEDs in the UV-C range are the currently higher purchase costs and the higher diffusion effort in comparison with fluorescent tubes.

The two light sources 3, 4 are separated from one another by an opaque separating wall 5.

In the present example in Fig. 1, a UV-C lamp 3 emits UV-C radiation with a maximum intensity at a wavelength of 254 nm and is installed in the housing 1 in such a way that the UV light is guided by a reflector 7 disposed behind the UV-C lamp 3 in the direction towards the detectors. The UV light further passes through

a filter 6 which absorbs the major part of the light in the visible range emitted by the UV-C lamp 3 and therefore hardly conducts any visible light in the wavelength range of the fluorescent light to the detectors. If blue light for example would reach the detector for fluorescent light from the UV-C lamp 3, it would detect this
5 light as fluorescent light radiation because it also lies in the range of the blue light.

The VIS light emitted by the second light source also passes through a filter 6, which absorbs the emitted light in the UV and fluorescent range (< 500 nm).

The housing 1 consists of a silica-glass pane 9 at least in the region of the UV light
10 passage. Silica glass has a high optical transparency for UV-C light. The silica-glass pane 9 can also cover the light passage of the visible light.

The silica-glass pane 9 is also used as a chute for the objects 15 (glass shards, impurities) to be examined. In the mounted state of the apparatus in accordance with the invention, it has an inclination of approximately 25° in relation to the
15 perpendicular. The objects 15 will slide downwardly on said chute and are illuminated in this process by the two light sources 3, 4.

The distance between the fluorescent light to be detected and the transmission light to be detected (from light source 4) should ideally be as low as possible (and ideally congruent), so that both detectors – the one for the fluorescent light and
20 the one for the transmission light – are able to map an image of the moved objects 15 as congruently as possible. The distance between the central axes of the light rays of the visible light and the UV light is approximately 50 mm in this example when they exit from housing 1.

Both the visible light of the VIS lamp 4 which is allowed to pass through the
25 objects and also the fluorescent radiation in the blue visible range which is optionally induced by the UV light pass through a protective glass 13 into the further housing 2, where a detector 11 is attached for detecting the fluorescent light on the one hand and where a detector for detecting the transmission light of the second light source 4 is also arranged on the other hand.

30 The protective glass 13 consists of normal glass and protects the interior of housing 2 from dust and UV-C radiation.

The detector 11 for detecting the fluorescent light is sensitive in a wavelength range of 400 to 1000 nm. The sensitivity can further be changed by filters, e.g. to

the relevant wavelength range of 420 to 500 nm in this case for example. (If UV light with a wavelength of approximately 270 nm were used, the filter would be set in such a way that only fluorescent light in the wavelength range of 400 to 450 nm can be detected). The detector 11 will usually be arranged as a camera. It
5 can be arranged as a so-called TDI camera 11 for example.

In order to prevent a disturbance of the fluorescent light by a further light source in this wavelength range, the second light source 4 should potentially only emit light outside of this frequency range. It is frequently the case in practice however that even light sources in the yellow or red range, which therefore "emit light in
10 the visible range or infrared light outside of the wavelength range of fluorescent light" as defined, still have a blue fraction in the light which might optionally have to be filtered out, as explained above in connection with filter 6 for the second light source 4.

In order to detect the transmission light from the second light source 4 it is
15 principally sufficient when a detector 10 such as a camera for example can supply at least one image of glass pieces in grey shadings. The position and the shape of the object 15 which is necessary in order to optionally remove the object from the flow of material by means of downstream removal devices can then be determined on the one hand. On the other hand, the optical transparency of the
20 object (piece of glass) 15 is thereby determined and it has been recognized as being transparent (whereby it can still be leaded or non-leaded) or as low-transparent or non-transparent (in which case it would be an impurity).

Accordingly, the impurity will then be removed from the flow of material by the removal devices. The edges and the inside areas of the pieces of glass can also be
25 defined by means of this detector by image recognition and the intensity of the fluorescent radiation can be used for evaluating the lead glass content on the basis of only these partial areas of the shard of glass.

Both fluorescent light and also transmitted light impinge on a beam splitter 12 which reflects blue light in the wave length range of 400 to 500 nm for example
30 as completely as possible and allows visible light >500 nm (transmitted light) to pass through as completely as possible. The reflected light beam is guided into the TDI camera 11; the light beam that is allowed to pass through reaches the RGB camera 10.

The detected data are supplied to an evaluation and control unit which allocates the individual glass shards to the different fractions of

- lead glass (optionally with different fractions with different lead content);
- impurities (ceramics, stones and chinaware, "CSC");
- 5 - normal glass, and
- optionally glass ceramic materials;

and controls the removal units which move the pieces of glass to the respective containers.

In Fig. 2, both a UV light source 3 and a second light source 14 are installed in a
10 housing 1 for light sources, but are separated from one another by an opaque separating wall 5.

The UV light source 3 can emit UV light in the range of 100 to 280 nm, especially between 250 and 275 nm. It is arranged in this case again in form of a UV-C lamp. It would also be possible to use one or several UV-C LEDs instead of a UV
15 tube.

The second light source 14 can emit light in the visible range (wavelength of 380 780 nm) and/or in the infrared range (wavelength of 780 nm to 1 mm) and can be arranged as in this example as one or several infrared LEDs (LED line). Similarly, a lamp with wavelengths in the visible range and/or in the infrared
20 range or one or several daylight or color LEDs (LED line) could also be used.

The UV-C lamp 3 emits UV-C radiation with a wavelength of 254 nm and is installed in the housing 1 in such a way that the UV light is guided away from the detectors by a reflector 7 arranged in the direction of the detectors and deflected by 180° by two mirror filters 16 which are arranged at a right angle with respect
25 to each other and is therefore guided in the direction towards the detectors. The mirror filters 16 are mirrors which are provided with a coating which absorbs the major part of the light in the visible range which is emitted by the UV-C lamp 3 and therefore virtually does not reflect any visible light in the wavelength range of the fluorescent light and guides it to the detectors. If blue light would reach the
30 detector for fluorescent light from the UV-C lamp 3 for example, it would be detected as fluorescent radiation because it also lies in the range of the blue light.

In addition to the coated mirror filters 16 it is also possible to provide filters for visible light in the wavelength range of the fluorescent light in the beam path of the UV light.

Mirror filters 16 come with the advantage that they can be produced at low cost
5 even in large widths of approximately 1000 mm for example, which corresponds to the width of the conveyor belts or the chute for waste glass. Classical filters come with disadvantage on the one hand that they can only be produced in small widths (<200 mm) and therefore no integral filter can be produced for the apparatus in accordance with the invention which is able to cover the entire width
10 of the conveyor belt or the chute for the waste glass.

A mirror filter 16 has a height of approximately 5 to 10 cm in this example (as measured in the plane of projection), especially 7 cm in this case. The width (as measured normally to the plane of projection) is 50 to 150 cm, especially 100 cm in this case.

15 A sheet metal of a thickness of 1 to 2 mm is used as the base material for the mirror filter 16. The coating consists of oxides and has a thickness of a few micrometers.

The infrared light of the infrared LEDs 14 is guided through a diffusion screen 8 in order to make the light of the point-shaped infrared LEDs 14 more homogeneous
20 and leaves the housing 1 parallel to the UV light. It is also possible to use other devices instead of a diffusion screen 8 in order to distribute the light more evenly, e.g. a reflection conduit which is mirrored on its inside, as is illustrated in AT 10184 U1.

The housing 1 consists of a silica glass pane 9 at least in the region of the UV light
25 passage, as shown in Fig. 1. The silica glass pane 9 can also cover the light passage of the second light source (the infrared LEDs 14) and can be used as a chute for the objects to be examined.

The distance between the fluorescent light to be detected and the transmission light to be detected should also be as small as possible (and ideally congruent), so
30 that both detectors (the one for the fluorescent light and the one for the transmission light) are able to project the image of the moved object in the highest congruent manner. The distance between the central axes of the light

beams of the infrared light and the UV light is in this case also approximately 50 mm when they exit from the housing 1.

Both the infrared light of the infrared LEDs 14 which is allowed to pass through the objects 15 and also the fluorescent radiation in the blue visible range which is
5 optionally induced by the UV light will pass through a protective glass 13, as described under Fig. 1, into the further housing 2, where a detector 11 for detecting the fluorescent light is attached on the one hand, which detector is to be arranged as described under Fig. 1 and which is arranged in this case too in Fig. 2 as a so-called TDI camera 11, and where on the other hand a detector 10 for
10 detecting the transmission light of the second light source 14 (the infrared LEDs 14) is arranged. The detector 10, which is usually a camera again, is therefore sensitive in at least the wavelength range in which the second light source 14 emits light, i.e. in this case in a range within the wavelength range of 780 nm to 1 mm. In this case too, an RGB camera with an optionally provided upstream filter
15 can also be used here.

In order to prevent any disturbance in the detection of the fluorescent light by a further light source in this wavelength range, the second light source should only emit light outside of this frequency range. A light was therefore chosen for this embodiment which is as far as possible away from the fluorescent light, namely
20 infrared light with a wavelength of 860 nm.

As already explained in connection with Fig. 1, it is principally sufficient for detecting the transmission light that the detector 10 such as a camera for example is capable of supplying at least one image of objects 15 in grey shading. The shape and position of the object 15 can then be determined therefrom, which
25 is necessary in order to optionally remove the object 15 by means of downstream removal devices from the material flow. On the other hand, the optical transparency of the object (piece of glass) 15 is determined thereby and it is recognized as transparent (it can still be leaded or non-leaded) or as low-transparent or non-transparent (in which case it would be an impurity). The
30 impurity will then accordingly be removed by the removal devices from the material flow. This detector can also be used for defining the edges and inner regions of the pieces of glass by image recognition and the intensity of the fluorescent radiation can be used only in these partial areas of the glass shard for evaluating the lead glass content.

Both fluorescent light and also transmitted infrared light will impinge on a beam splitter 12 which reflects blue light in the wavelength range of 400 to 500 nm for example as completely as possible and which allows infrared light such as in the wavelength range of 860 nm to pass through to the highest possible extent. The reflected light beam is guided to the TDI camera 11, and the light beam that is allowed to pass through is guided to the RGB camera 10. The detected data are supplied to an evaluation and control unit which associates the individual pieces of glass to the different fractions of

- lead glass (optionally with different fractions with different lead content);
- 10 - impurities (ceramics, stones and chinaware, "CSC");
- normal glass, and
- optionally glass ceramic materials;

and controls the removal units which move the pieces of glass to the respective containers.

15

LIST OF REFERENCE NUMERALS

- | | | |
|----|----|--|
| 20 | 1 | Housing for light sources |
| | 2 | Housing for detectors |
| | 3 | UV light source (UV-C lamp) |
| | 4 | Second light source (VIS lamp) |
| | 5 | Separating wall |
| 25 | 6 | Filter |
| | 7 | Reflector |
| | 8 | Diffusion screen |
| | 9 | Silica glass pane |
| | 10 | Detector for detecting the transmission light (RGB camera) |
| 30 | 11 | Detector for detecting the fluorescent light (TDI camera) |
| | 12 | Beam splitter |
| | 13 | Protective glass |

11

- 14 Second light source
- 15 Object (piece of glass or impurity)
- 16 Mirror filter

5

Patentkrav

1. Hus (1) til en UV-lyskilde til anvendelse i en fremgangsmåde til at detektere bly-indeholdende glasstykker i en enkelt-lags-materialestrøm af objekter af hovedsageligt affaldsglas, **kendetegnet ved at** UV-lyskilden (3) kan installeres i
5 huset, som har en reflektor (7) og mindst et spejlfilter (16), således at lyset fra UV-lyskilden (3) ledes gennem reflektoren (7), der er anbragt i en første retning, i den modstående retning til den første retning og afbøjes og filtreres via mindst et spejlfilter (16), nemlig afbøjes med 180° af to spejlfiltere (16) indrettet normalt til hinanden og derved ledes i den første retning til en enkelt UV-lyspassage af huset
10 (1), hvor spejlfilterene (16) er spejle, der er forsynet med en coating der absorberer en størstedel af lyset i det synlige område udsendt af UV-lyskilden (3).
2. Hus (1) ifølge krav 1, **kendetegnet ved at** en UV-lyskilde (3) er installeret.
- 15 3. Hus (1) ifølge krav 2, **kendetegnet ved at** en UV-C-lampe er installeret.
4. Hus (1) ifølge krav 2, **kendetegnet ved at** én eller flere UV-C LED'er er installeret.
- 20 5. Hus (1) ifølge et af kravene 2 til 4, **kendetegnet ved at** UV-lyskilden (3) kan udsende UV-lys med en bølgelængde i området på 100 til 300 nm, især mellem 250 og 275 nm.
6. Hus (1) ifølge krav 5, **kendetegnet ved at** UV-lyset har en bølgelængde på
25 omtrent 270 nm.
7. Hus (1) ifølge krav 5, **kendetegnet ved at** UV-lyset har en bølgelængde på omtrent 254 nm.
- 30 8. Hus (1) ifølge et af kravene 1 til 7, **kendetegnet ved at** bredden af spejlfilterene (16) er 50-150 cm.

9. Hus ifølge et af kravene 1 til 8, **kendetegnet ved at** en metalbane har en tykkelse på 1-2 mm anvendes som basismateriale for spejlfiltrene (16).

10. Hus ifølge krav 9, **kendetegnet ved at** coatingen består af oxider.

5

11. Hus ifølge krav 10, **kendetegnet ved at** coatingen har en tykkelse på få mikrometer.

10

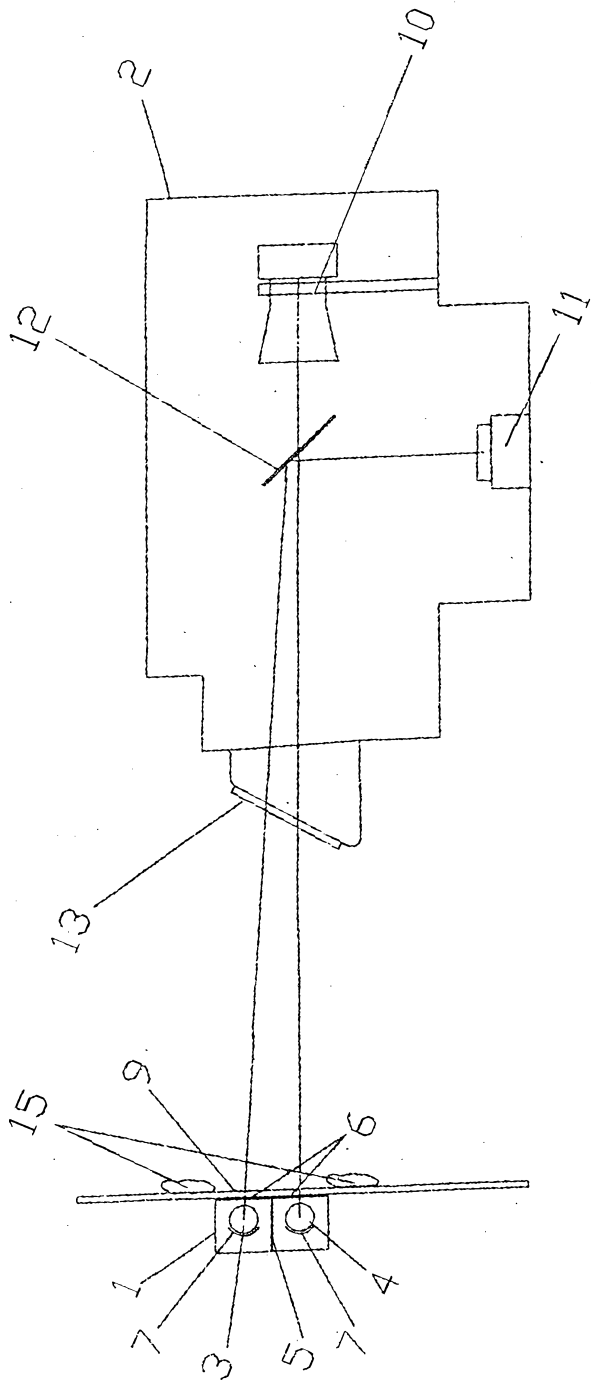


Fig. 1

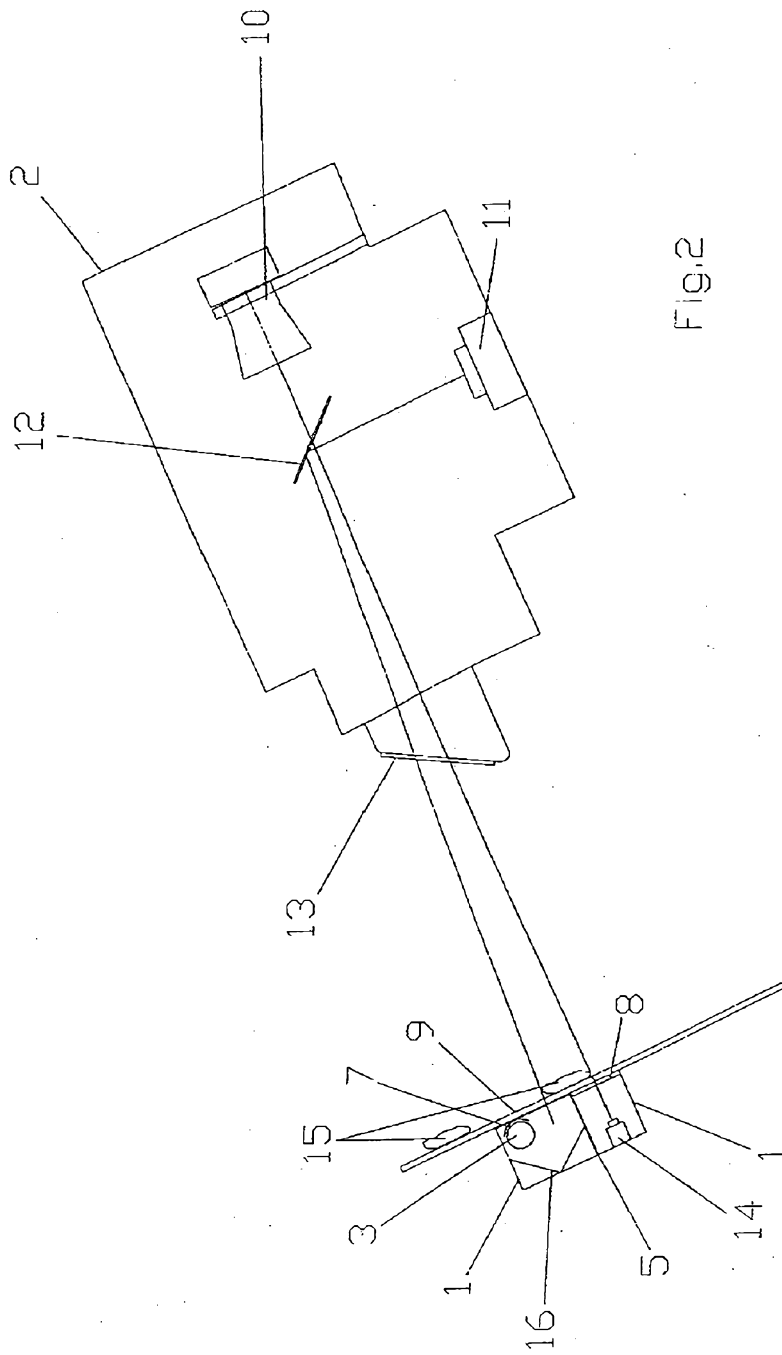


FIG. 2