(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 265 081 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **87308351.3**

(51) Int. Cl.4: **B65H 23/02**

(22) Date of filing: **21.09.87**

(30) Priority: **24.09.86 GB 8622972**

(43) Date of publication of application:
27.04.88 Bulletin 88/17

(84) Designated Contracting States:
CH DE GB IT LI

(71) Applicant: **CROSFIELD ELECTRONICS LIMITED**
De La Rue House 3/5 Burlington Gardens
London W1A 1DL(GB)

(72) Inventor: **Isherwood, Jeffrey**
15 Parsonage Gardens
Enfield Middlesex EN2 6JS(GB)

(74) Representative: **Rackham, Stephen Neil et al**
GILL JENNINGS & EVERY 53-64 Chancery Lane
London WC2A 1HN(GB)

(54) Lateral position sensing device.

(57) A device for sensing the lateral position of the edge of a longitudinally moving web (2) includes a source (1, 4, 5, 16) of light directed laterally onto the edge of the web (2). At least one edge of the light from the source (1, 4, 5, 16) is directed non-normally onto the edge of the web substantially in the plane of the web so that the location of the the edge of the illumination on the edge of the web (2) is dependent upon the distance of the edge of the web (2) from the source (1, 4, 5, 16) and hence upon the lateral position of the edge of the web (2). A sensor system (6, 7, 8, 9) produces a signal which is dependent upon the location of the said edge of the illumination on the edge of the web (2), the signal indicating the lateral position of the edge of the web (2).

The source of light (16) may emit a generally parallel sided beam of light, in which case the sensor system (6, 7, 8) senses the location of the edge of the illumination on the edge of the web. Alternatively the source may emit a single converging or diverging beam to illuminate a region of the edge of the web (2), in which case the sensor (6, 7, 8, 9) senses the length of the illuminated region.

Fig. 2.

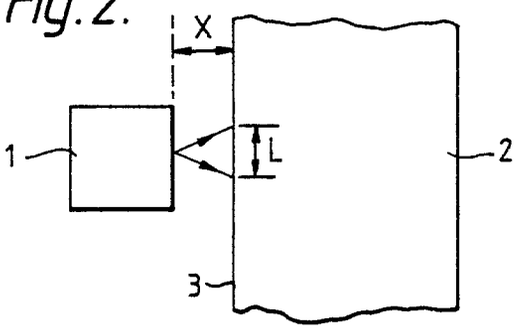
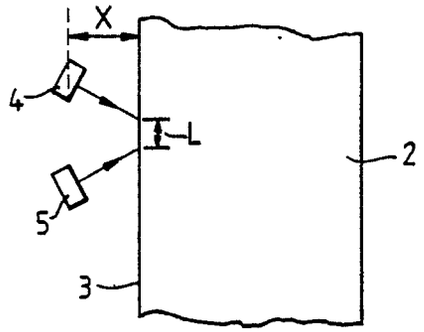


Fig. 3.



EP 0 265 081 A1

Lateral Position Sensing Device

Conventional devices for sensing the lateral position of a moving web of material include a transmitter located on one side of the web for transmitting a beam of radiation normal to the plane of the web and a receiver on the other side of the web. The lateral edge of the web obscures part of the radiation transmitted from the transmitter to the receiver and thus, the amount of radiation received by the receiver provides an indication of the lateral position of the edge of the moving web of material. The radiation may be ultrasonic energy or light and pneumatically operated devices have also been provided in which the lateral edge of the web interferes with air jets. These conventional devices are generally satisfactory for single webs but since the transmitter and receiver of each device must enclose the edge of the web it is difficult to mount the devices on an apparatus for handling multiple webs particularly when it is desired for these to be close together.

According to this invention a device for sensing the lateral position of the edge of a longitudinally moving web comprises a source of light directed laterally onto the edge of the web, at least one edge of the light from the source being directed non-normally to the edge of the web substantially in the plane of the web so that the location of the said edge of the illumination on the edge of the web is dependent upon the distance of the edge of the web from the source and hence upon the lateral position of the edge of the web, and means for sensing and producing a signal which is dependent upon the location of the said edge of the illumination on the edge of the web, the signal indicating the lateral position of the edge of the web.

The source of light may emit a single generally parallel sided beam of light. In this case, it is the location of the edge of the illumination on the edge of the web in the direction of movement of the web which is indicative of the lateral position of the web. To avoid calibration errors and difficulties it is preferred that the device is used to provide an indication of a change in the position of the edge of the moving web by the means for sensing and producing a signal comparing the location of the said edge at one instant with its location at a previous instant to detect movement of the edge of the web from its initial position.

The source of light may emit a single converging or diverging beam to illuminate the entire region of the edge of the web falling within the converging or diverging beam. In this case it may be the length of the illuminated region of the edge of the web which is sensed by the means for sensing and which gives an indication of the lateral position of the web. Alternatively, the source of light may provide two generally parallel beams of light the axes of which converge or diverge. In this case two separate regions of the edge of the web are illuminated and it is the separation of these two regions which is sensed by the means for sensing and which gives an indication of the lateral position of the web.

Preferably the device for sensing forms part of an apparatus for controlling the lateral position of a moving web of material and, in this case, the apparatus also includes adjusting means for adjusting the transverse position of the moving web the adjusting means being responsive to the signal produced by the means for sensing to maintain the lateral position of the edge of the web constant.

The means for sensing and producing a signal which is dependent upon the location of the said edge of illumination or the separation of the edges of the illumination on the edge of the web may include a photodetector surrounded by a rotatable slit, means to monitor the angular position of the rotatable slit and means to correlate the monitored angular position of the rotatable slit with the reception of light by the photodetector to produce the signal. When the device is arranged to sense the lateral position of a number of different webs the means for sensing preferably includes a corresponding number of photodetectors arranged one above the other in a direction generally perpendicular to the planes of the webs with the detectors located adjacent their corresponding webs.

Alternatively the means for sensing may comprise a video camera focussed onto the lateral edge of the moving web of material together with means to monitor and analyse the video output of the camera to produce a signal dependent upon the location of the said edge of illumination or the separation of the regions of illumination on the edge of the moving web of material. In this case the preferred target of the video camera is a charge coupled device matrix since the output of this matrix can readily be processed to produce a digital output corresponding to the location of the said edge or the separation of the edges of the illumination on the edge of the web. When a video camera is used as the means for sensing it is especially useful when the device is arranged to handle a number of different webs. The video output of the camera readily provides the information of the separation of the edges of the illumination on

the edges of the number of different webs irrespective of the exact position of the lateral edges of the moving webs in a direction normal to the planes containing them.

Various devices in accordance with this invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a sectional elevation through the moving web showing the light source;

Figure 2 is a plan showing the first example of light source;

Figure 3 is a plan showing a second example of light source;

Figure 4 is a plan of a first example showing both the light source and the detector;

Figure 5 is a plan showing the detector in the second example;

Figure 6 is a graph of the output signal obtained from the second example;

Figure 7 is a plan view showing an alternative detector for the second example;

Figure 8 is a perspective view of the second example with the alternative detector;

Figure 9 is a representation of the image produced on the target of the video camera in the second example.

Figure 10 is a plan of a third example; and,

Figure 11 is a graph illustrating the output of the third example.

In the first example shown in Figures 1 and 2 a single diverging light source 1 is located adjacent the lateral edge of a moving web 2. A diverging light beam is emitted from the source 1 in a direction generally parallel to the plane containing the web 2 as shown in Figure 1. The length L of the lateral edge 3 of the web 2 which is illuminated by the diverging light beam from the source 1 is dependent upon the separation X of the lateral edge 3 and the light source 1. The further the lateral edge 3 moves away from the light source 1 the greater the illuminated length of the lateral edge 3.

In the second example shown in Figure 3 two separate light sources 4 and 5 each of which emits a parallel beam of light are arranged with the axes of their parallel beams converging towards the lateral edge 3 of the moving web 2. In this case the parallel beams from the sources 4 and 5 each illuminate a separate small region of the edge 3 of the moving web 2. The separation L of the illuminated regions is again dependent upon the separation X between the sources 4 and 5 and the lateral edge 3 of the moving web 2. In this case, since the beams from the sources 4 and 5 are converging L is inversely proportional to X.

Figure 4 shows the remainder of the first example and shows a detector 4 sensing the illuminated length of the edge 3 of the moving web 2. In this case the sensor includes a photodetector 6 surrounded by a rotating cylinder 7 including a slit 8. Light scattered from the edge 3 is only received by the photodetector 6 when the rotating slit 8 is in a direct line between part of the illuminated edge 3 and the photodetector 6. Thus, the detector 6 only receives light whilst the slit 8 is in the segment Q shown in Figure 4. The angular extent of the segment Q provides an indication of the length L. The rotating cylinder 7 is linked to an angular positioning encoder (not shown) which outputs a series of pulses. The series of pulses are linked with the output of photodetector 6 in an AND gate. The output of the AND gate is then fed to a counter. Thus, for the entire duration of time that the photodetector 6 is receiving light from the illuminated edge 3 of the moving web 2 the counter is incremented by the output pulses of the angular positioning encoder attached to the rotating cylinder 7. Thus, the count accumulated in the count provides a signal which is proportional to L. When this example is used to control means to adjust the position of the lateral edge 3 of the moving web 2, the count accumulated in the counter is compared in a comparator with a preset reference corresponding to the required position of the edge 3 of the moving web. if the count is greater than the reference the adjuster moves the web closer to the light source 1 and the count is less than the reference it moves it further away from the light source 1. If the count is the same as the reference it maintains the portion of the web constant.

Figure 5 shows the same detector that is used in the first example applied to the second example. In the second example, since only two separate regions of the edge 3 of the web 2 are illuminated by the light beams from the sources 4 and 5 the output of the photodetector 6 is as shown in Figure 6. Assuming that the cylinder 7 rotates at a constant velocity the separation in time t at which the photodetector 6 receives pulses of light gives an indication of L, the separation of two illuminated regions of the edge of the sheet 2 which, in turn, gives an indication of the separation X of the lateral edge 3 from the light sources 4 and 5. The time T shown in Figure 6 is the time for one complete revolution of the cylinder 7. The time t between the receipt of the light from the two separated regions can again be used to control means to adjust the lateral position of the edge 3 of the web 2.

Figure 7 shows an alternative form of detector which can be used in either example but which, in Figure 7, is shown as being used with the second example. In the second example the detector is formed by a video camera 9 including a lens

assembly 10 and a target 11. The lens 10 focusses an image of the edge 3 of the moving web 2 onto the target 11 which is preferably formed by a charge coupled device matrix. The image formed on the target 11 either has the form of an illuminated line when used with the first example or two separated spots of light when used with the second example. Naturally, the length of the illuminated line or the separation of the two spots provides the indication of the distance L which, in turn, provides an indication of the separation X between the edge 3 of the moving web 2 and the light source 1 or 4 and 5.

The video output of the camera 9 is processed in a video frame store (not shown) to provide this information. The X and Y co-ordinates of the image intensity are read from the digital input/output port of the video frame store to calculate the separation of the edges of the illuminated region of the web edge. The variation in the Y-coordinate is a function of the variation of the lateral position of the web. With multiple webs the X-coordinate determines the web to which the measurement applies.

Figure 8 illustrates a configuration as shown in Figure 7 but with multiple webs 12, 13, 14, and 15. Light from the source 4 is indicated diagramatically in Figures 8 and 9 by a x and light from the source 5 is indicated diagramatically in Figures 8 and 9 with a 'O. The image formed on the target 11 of the video camera 9 is shown in Figure 9 and, as can be seen, the separation of the spots formed by the beams and the sources 4 and 5 provides an immediate indication of the lateral position of their edges 3.

Figure 10 illustrates a similar detector to that shown in Figures 4 and 5, and a light source 16 which produces a generally parallel beam of light which is non-normal to the edge 3 of the web 2. As the edge 3 of the web 2 moves laterally the region of the edge 3 of the web 2 illuminated by the light from the light source 16 moves longitudinally. The rotating slit 8 and photodetector 6 detect the angular location of the illuminated region by comparing coincidence of an output from the photodetector 6 with the output of the shaft encoder 17.

The variation in the lateral position of the web edge is calculated by measuring the variation of the signal position relative to the shaft encoder 17 driven synchronously with the rotating slit 8. When the desired position of the web edge is obtained, the encoder position at which the signal occurs is stored in a memory (not shown). Any movement in the lateral position produces a signal at a different angular position of the slit 8. The difference between the stored position and the present position is therefore a function of the change of position of the web edge. This is illustrated in Figure 11.

Claims

1. A device for sensing the lateral position of the edge of a longitudinally moving web (2) comprises a source (1, 4, 5, 16) of light directed laterally onto the edge of the web (2), at least one edge of the light from the source (1, 4, 5, 16) being directed non-normally to the edge of the web substantially in the plane of the web so that the location of the said edge of the illumination on the edge of the web (2) is dependent upon the distance of the edge of the web (2) from the source (1, 4, 5, 16) and hence upon the lateral position of the edge of the web (2), and means (6, 7, 8, 9) for sensing and producing a signal which is dependent upon the location of the said edge of the illumination on the edge of the web (2), the signal indicating the lateral position of the edge of the web (2).

2. A device according to claim 1, in which the source of light (16) emits a single generally parallel sided beam of light, and the means (6, 7, 8) senses the location of the edge of the illumination on the edge of the web (2) in the direction of movement of the web (2).

3. A device according to claim 2, in which an indication of a change in the position of the edge of the moving web (2) provided by the means (6, 7, 8) for sensing and producing a signal comparing the location of the said edge at one instant with its location at a previous instant to detect movement of the edge of the web.

4. A device according to claim 1, in which the light source (1) emits a single converging or diverging beam to illuminate the entire region of the edge of the web (2) falling within the converging or diverging beam, and in which the means (6, 7, 8, 9) senses the length of the illuminated region to give an indication of the lateral position of the web.

5. A device according to claim 1, in which the light source (4, 5) emits two generally parallel sided beams of light the axes of which converge or diverge to illuminate two spatially separate regions of the edge of the web, and in which the means (6, 7, 8, 9) senses the separation of the two separate regions of the edge of the web to give an indication of the lateral position of the web.

6. A device according to any one of the preceding claims, in which the device for sensing forms part of an apparatus for controlling the lateral position of a moving web (2) of material and, in which, the apparatus also includes adjusting means for adjusting the transverse position of the moving web (2), the adjusting means being responsive to the signal produced by the means for sensing to maintain the lateral position of the edge of the web constant.

7. A device according to any one of the preceding claims, in which the means (6, 7,8) for sensing and producing a signal which is dependent upon the location of the said edge of illumination or the separation of the regions of illumination on the edge of the web includes a photodetector (6) surrounded by a rotatable slit (8), means (17) to monitor the angular position of the rotatable slit and means to correlate the monitored angular position of the rotatable slit with the reception of light by the photodetector to produce the signal.

8. A device according to any one of claims 1 to 6, in which the means for sensing comprises a video camera (9) focussed onto the lateral edge of the moving web (2) of material together with means to monitor and analyse the video output of the camera to produce a signal dependent upon the location of the said edge of illumination or the separation of the regions of illumination on the edge of the moving web (2) of material.

9. A device according to any one claims 1 to 7, which, in use, senses the position of a plurality of webs (2) the means for sensing comprising a plurality of photodetectors (6) arranged one above the other in a direction generally perpendicular to the plane of the webs (2) with each photodetector (6) substantially adjacent a corresponding web (2).

Fig. 1.

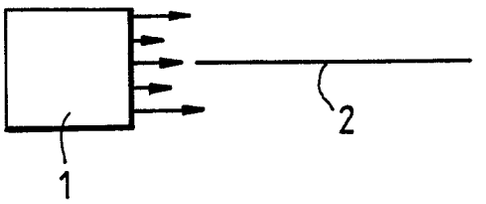


Fig. 2.

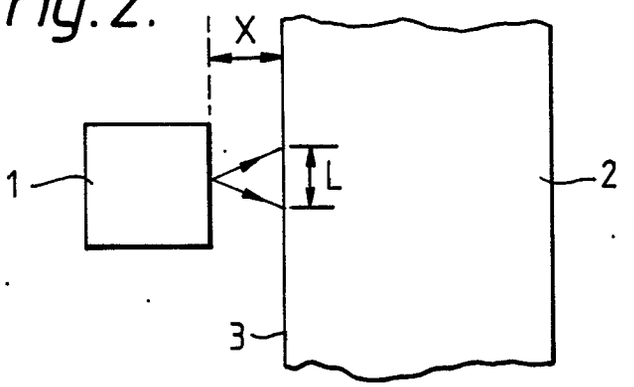


Fig. 3.

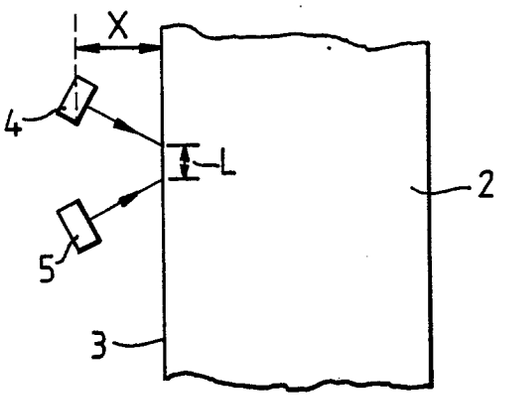


Fig.4.

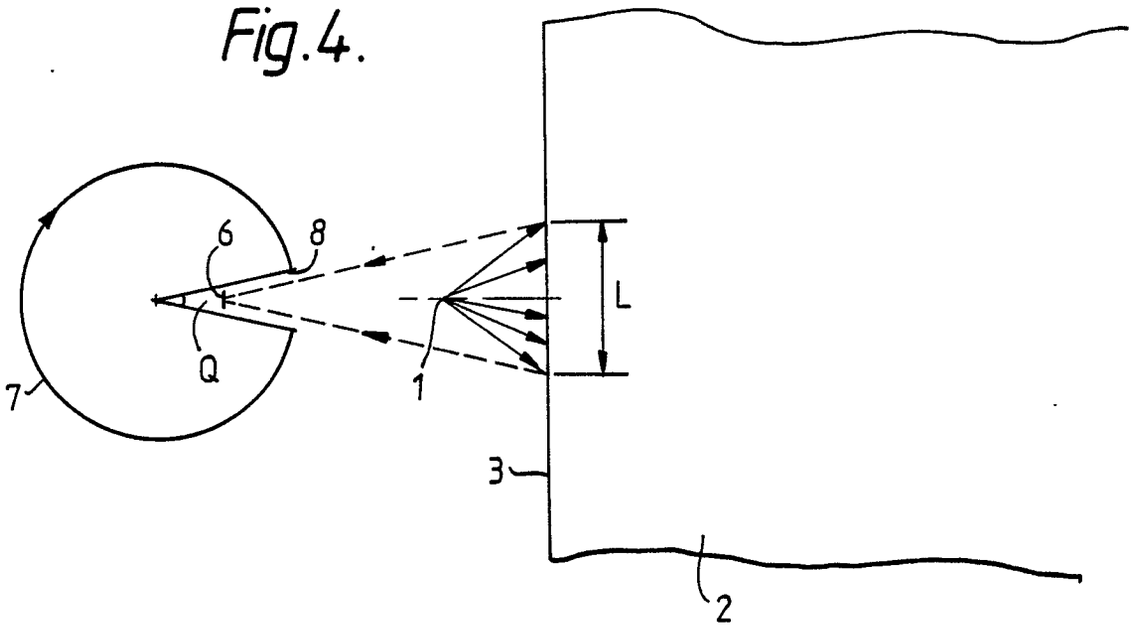


Fig.5.

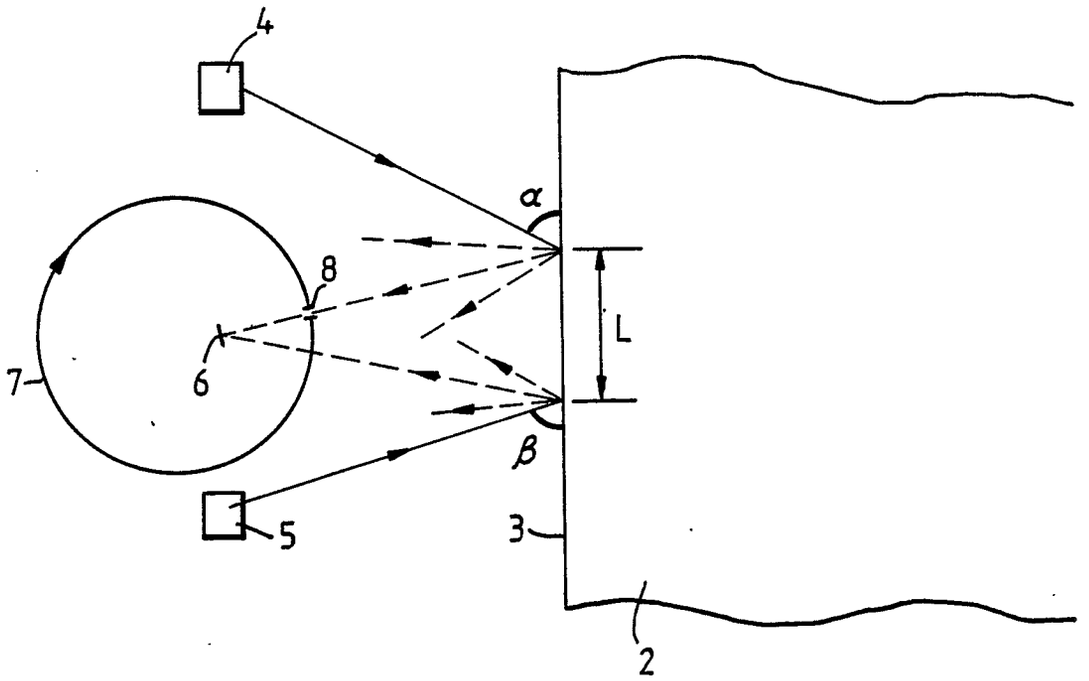


Fig.6.

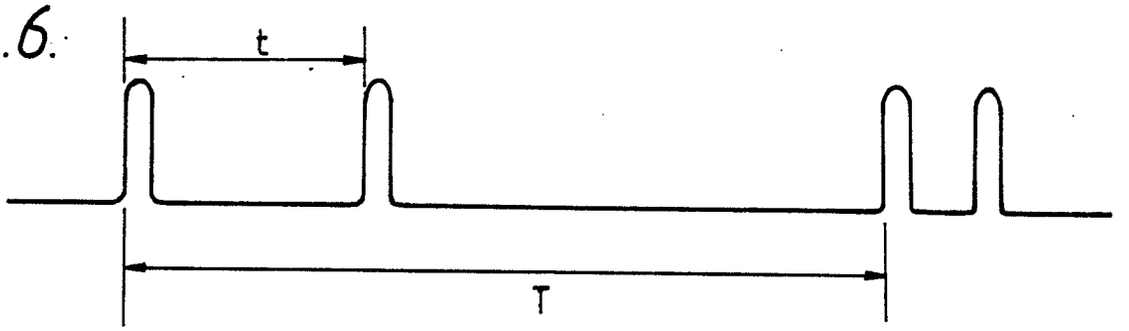


Fig.7.

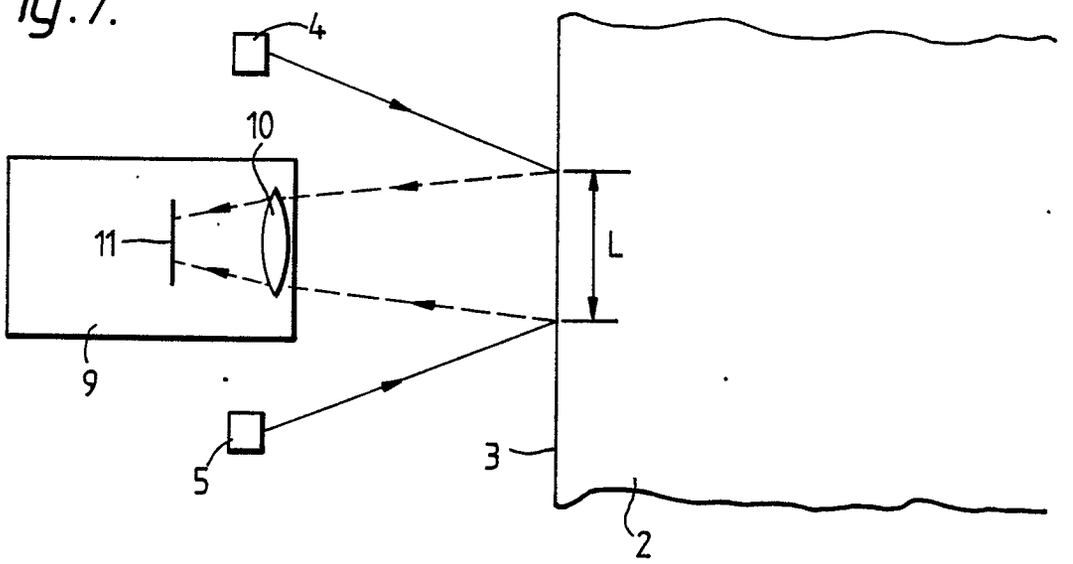


Fig.8.

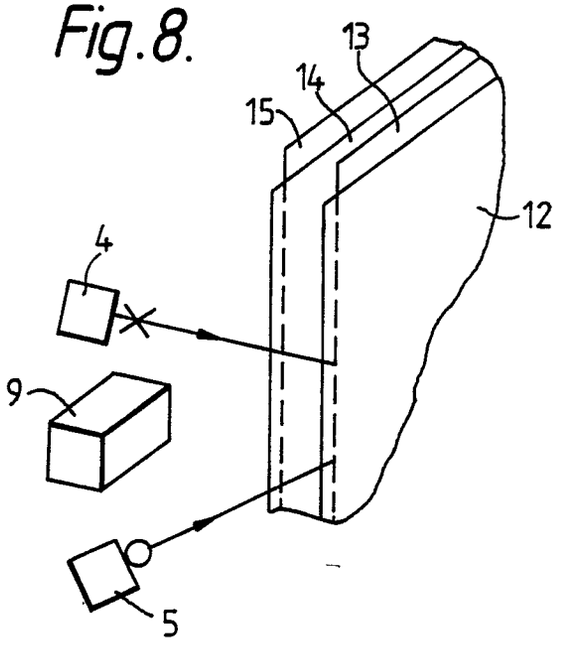


Fig.9.

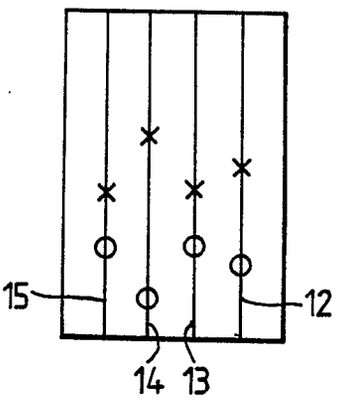


Fig.10.

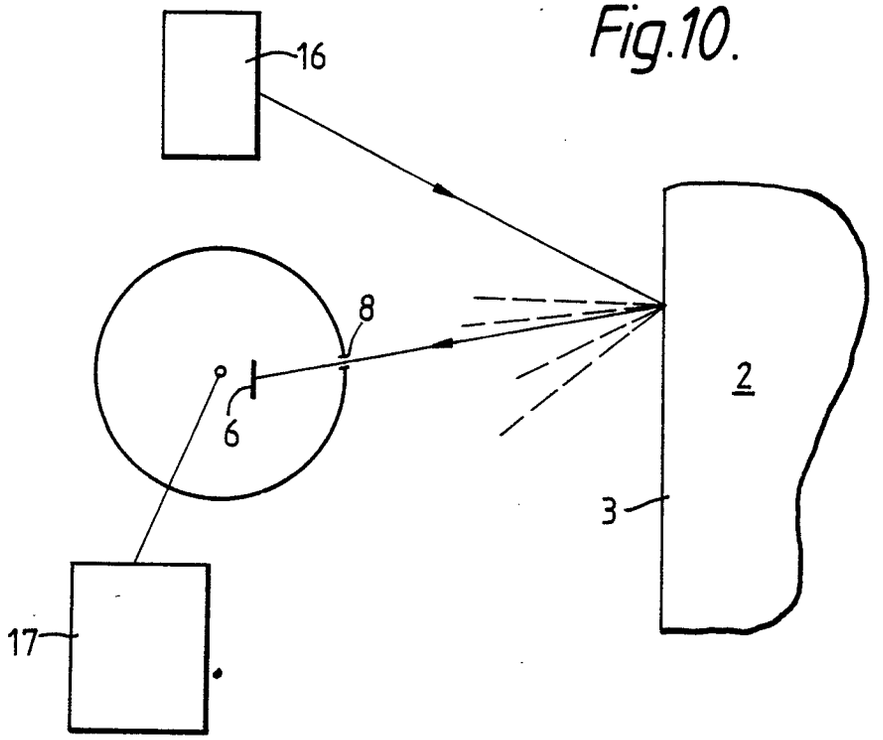
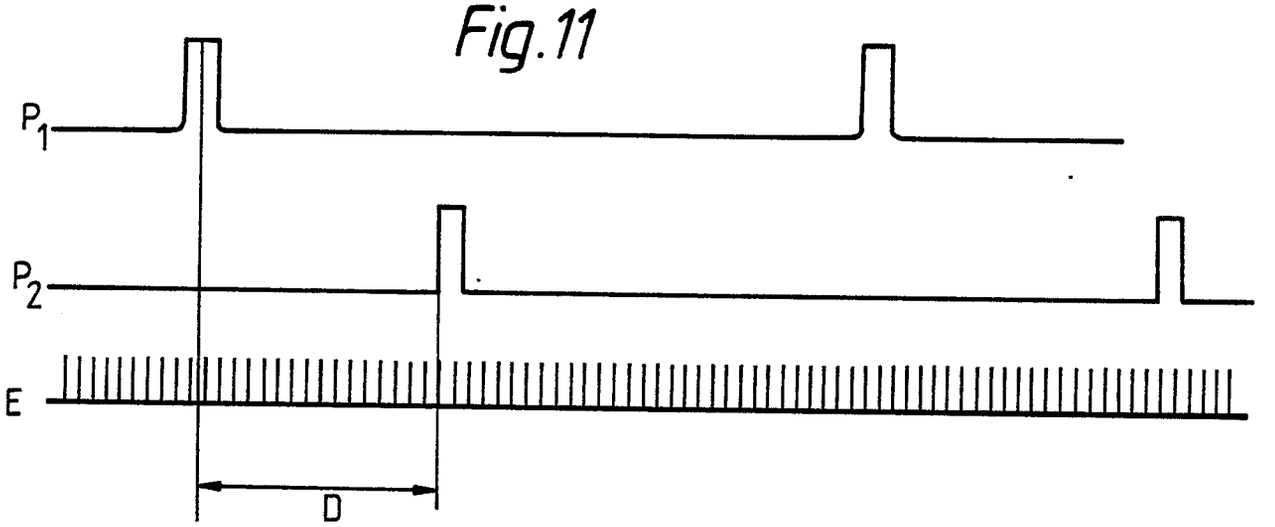


Fig.11



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 87 30 8351

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US-A-4 157 477 (KALL et al.) * Figures 1,2; column 3, lines 8-66 *	1	B 65 H 23/02

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 65 H
G 01 B
G 01 N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21-12-1987	EVANS A.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)