United States Patent

[11] 3,589,816

[72] Inventor **Fumio Sugaya**
Kanagawa, Japan

[21] Appl. No. **802,947**
[22] Filed **Feb. 27, 1969**
[45] Patented **June 29, 1971**
[73] Assignee **Fuji Photo Film Co., Ltd.**
Kanagawa, Japan
[32] Priority **Feb. 27, 1968**
[33] **Japan**
[31] **43/11960**

[54] **APPARATUS FOR DETECTING IMPERFECTIONS ON A WEB**
3 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **356/199,** 250/219, 356/200, 356/238, 356/239
[51] **Int. Cl.** G01n 21/18, G01n 21/30, G01n 21/16
[50] **Field of Search** 356/72, 158, 167, 199, 200, 237, 238, 239; 250/219

[56] **References Cited**

UNITED STATES PATENTS

2,686,452	8/1954	Bentley	250/228 X
3,134,021	5/1964	Ploke	356/225 X
RE25,671	10/1964	Larew et al.	356/199 X
3,157,915	11/1964	Gilbo	356/199 X
3,206,606	9/1965	Burgo et al.	356/200 X
3,410,643	11/1968	Jorgensen	356/200
3,479,518	11/1969	Akamatsu et al.	356/200 X
3,495,089	2/1970	Brown	356/199 X

FOREIGN PATENTS

79,613	11/1962	France	356/199

Primary Examiner—Ronald L. Wibert
Assistant Examiner—Warren A. Sklar
Attorney—Sughrue, Rothwell, Mion, Zinn & MacPeak

ABSTRACT: The imperfections on a moving web are detected by optical means. A plurality of photoconductive elements are arranged laterally with respect to the advancing direction of the web. The photoconductive elements are reciprocated together in one direction parallel to the direction in which the photoconductive elements are arranged.

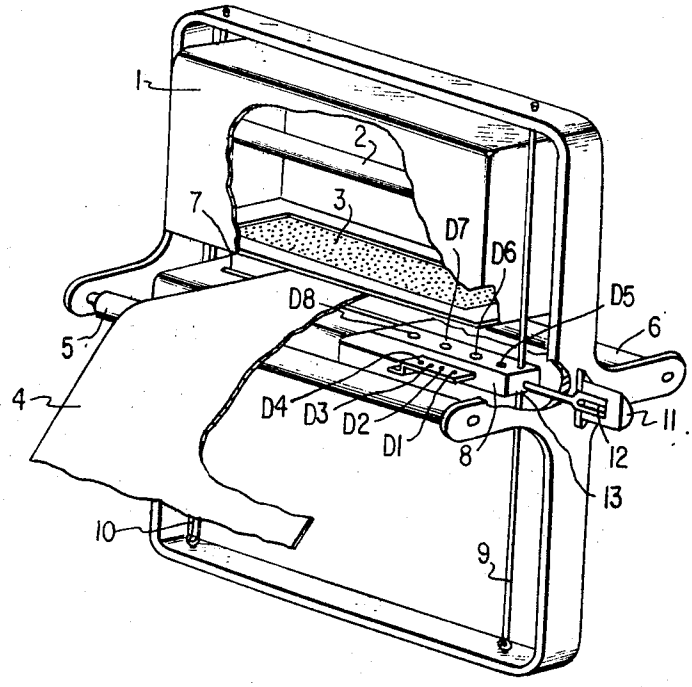


FIG. 1

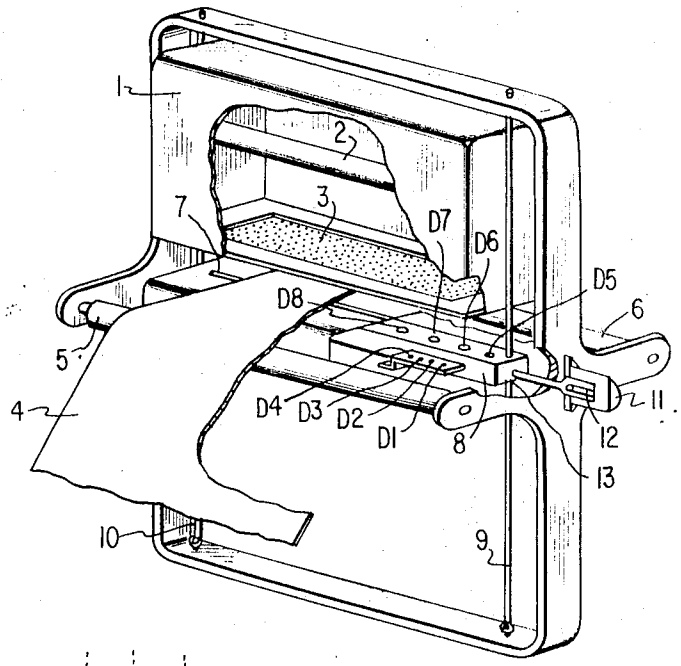
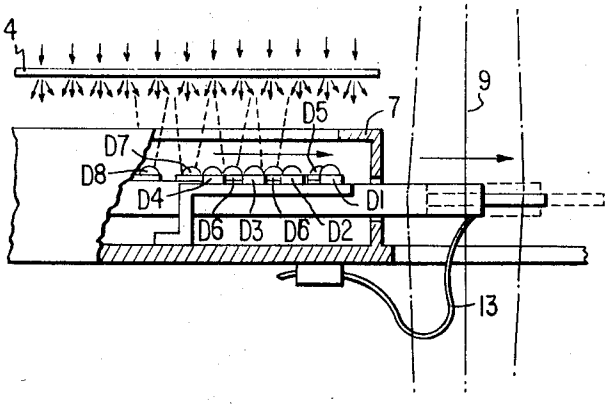


FIG. 2



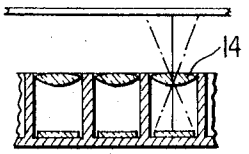


FIG. 3

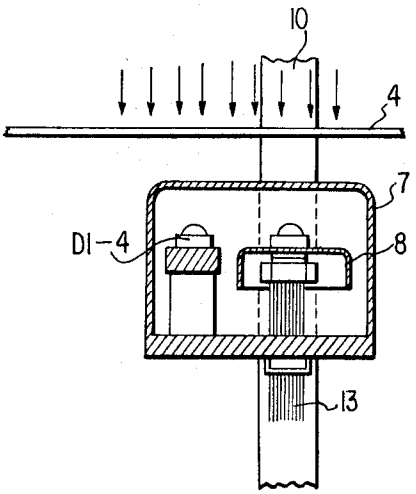


FIG. 4

INVENTOR
FUMIO SUGAYA

BY Sughrue, Rothwell, Mion, Zinn & Macpeak
ATTORNEYS

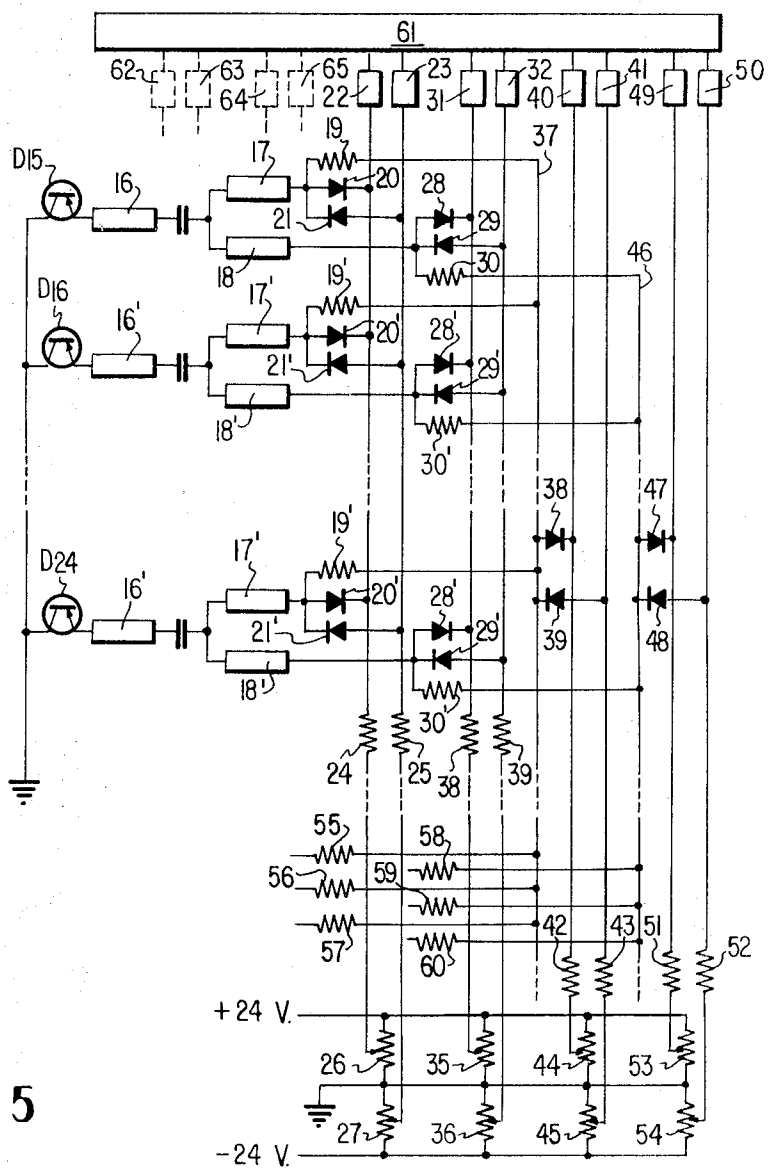


FIG. 5

INVENTOR
FUMIO SUGAYA

BY Sughrue, Rothwell, Mion, Zinn & Macpeak
ATTORNEYS.

APPARATUS FOR DETECTING IMPERFECTIONS ON A WEB

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus for detecting imperfections on a moving web by optical means, and in particular to an apparatus for detecting imperfections on a moving web where the arrangement of a plurality of photoconductive elements is reciprocated together in one direction.

2. Description of the Prior Art

Heretofore, there have been three types of apparatus for detecting imperfections in a web. In general, they employ the use of reflected and transmitted light. The three types are as follows: a type in which a number of photoconductive elements are arranged laterally and adjacent to the advancing web, a type called the "flying spot method" in which a light spot is swept in the effective site field of the photoconductive element, and a type called the "flying image method" in which the portion to be detected is uniformly illuminated at a point thereon which corresponds to the site field of the photoconductive element is swept. The first type in which a plurality of photoconductive elements are arranged laterally and adjacent to the advancing web is simple in construction and durable, but generally, it is difficult to detect imperfections such as scratches extending parallel to the direction in which the web is advancing because the signal is AC amplified. On the other hand, the third type called the "flying image method" is effective for continuous imperfections such as scratches extending parallel to the web-advancing direction, but it is necessary to make the scanning speed extremely large in order not to miss the scanned portion between successive scannings. Accordingly, the third type requires a complex and large apparatus.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a novel detecting apparatus which has the advantages present in the conventional types of detecting apparatus which are set forth as the first and third types above, but with none of the disadvantages which are found in those conventional types of detecting apparatus.

A number of photoconductive elements having separate fields of view are arranged laterally with respect to the advancing direction of the web and are reciprocated together in the direction of their arrangement at the definite amplitude and period. Thus, all of the imperfections, including the ones continuously extending in the advancing direction of the web, are detected.

It is an object of the present invention to provide an apparatus for detecting imperfections effectively.

It is another object of the present invention to provide an apparatus for detecting imperfections on a moving web by employing a plurality of photoconductive elements which are reciprocated laterally.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view partly cut away showing an embodiment of the detecting apparatus in accordance with the present invention.

FIG. 2 is a cross-sectional side view partly broken showing the detecting portion of the detecting apparatus in accordance with the present invention.

FIG. 3 is an enlarged sectional view showing another embodiment of the photoconductive elements provided at the detecting portion of the detecting apparatus in accordance with the present invention.

FIG. 4 is an enlarged sectional view of the detecting portion of the present invention.

FIG. 5 is an electric circuit diagram employed in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1 showing an embodiment of the present invention, the reference character 1 denotes a lamp housing having a tubular lamp 2 therein. A filter 3 is provided at a window disposed at the bottom of the lamp housing 1. The filter 3 is an infrared transparent filter to be used for a web of photosensitive material such as photographic film, and is not necessary for every web used in the present invention. The light passing through the filter 3 is irradiated onto the web 4. The web 4 is tensioned in its horizontal position by rollers 5 and 6.

Under the web 4 there is provided a slit 7. Under the slit 7, there is positioned a reciprocating support 8 carrying a plurality of phototransistors D5—D84 thereon. The reciprocating support 8 is suspended by a pair of springs 9 and 10 in the horizontal position. One end of the reciprocating support 8 is connected to a coil 12 of a vibrator 11 provided at the end of the reciprocating support 8. By connecting an alternating current source of approximately eight cycles per second with the coil 12, the reciprocating support is reciprocated or vibrated in the horizontal direction. The output of the respective phototransistors is taken out through a cable 13 containing soft thin lead wires. There is another cable 13' on the opposite side though not shown in the drawing.

Referring now to FIG. 2 there is shown in detail the detecting portion of the detecting apparatus in accordance with the present invention. A plurality of phototransistors D1—D4 and D85—D88 are provided on the opposite ends adjacent the reciprocating support 8. The above-described phototransistors D1—D4 and D85—D88 (not shown) are secured to a fixed support and serve to detect the near edge portions on the opposite side of the web 4 irrespective of the location of the other phototransistors D5—D84 on the reciprocating support 8. The fixed phototransistors D1—D4 and D85—D88 detect only light value variations which have a shorter period than the reciprocating period of the reciprocating support 8. The imperfections having a longer period of light value variation than the period of reciprocation of the reciprocating support 8 are detected by the phototransistors D5—D84 arranged on the reciprocating support 8.

The light value transmitted through the web 4 is constant if the web 4 is normal and has no imperfections, but varies if the web 4 has any imperfection. Imperfections on the web are detected by variations in the transmitted light value received. However, as in the present embodiment, if the web 4 is half transparent, the light transmitted through the web is scattered and it becomes difficult to detect the variation effectively by the photoconductive elements 8 disposed under the web. In this respect, the photoconductive elements 8 employed in the present invention have an individual field of view which does not receive the scattered light but only the transmitted light. Thus, the phototransistors 8 provided in accordance with the present invention can detect the imperfections even of a semitransparent web.

Although phototransistors are employed in the above described embodiment, it is apparent that other photoconductive elements having a relatively large field of view can be employed if optical lenses 14 are adapted thereto as shown in FIG. 3. The fields of view adjacent to each other are overlapped to some extent.

The amplitude of movement of the reciprocating support 8 is preferred to be more than twice as long as the distance between two adjacent phototransistors. Uniform sensitivity cannot be achieved for every imperfection at every position on the web, unless the phototransistor scans the imperfection at a speed greater than a minimum speed.

FIG. 5 illustrates a part of the electric circuit for recognizing and judging the signals taken out of the cables 13, 13'.

In the present embodiment of the invention, 88 phototransistors are provided. 80 of them, with the exception of the eight fixed phototransistors D1—D4 and D85—D88, are divided into eight channels. Each channel has 10 phototransistors. The residual phototransistors D1—D4, D85—D88 are included in the opposite end channels. One channel, of the 10 channels present is illustrated in FIG. 5.

In the circuit of FIG. 5, the signal from the phototransistors is amplified through amplifiers 16, 16' and then transmitted to high pass filters 17, 17' and low-pass filters 18, 18'. The output of amplifiers 16, 16' includes a single imperfection signal, whereas, the output of the high and low-pass filters includes a continuous imperfection signal.

These signals are regarded as the imperfection signals if the signals become larger than a definite level in the positive and negative direction. The recognition of the level is carried out by the diodes 20, 21, 28, 29, resistors 24, 25, 38, 39, and amplifiers 22, 23, 31, 32. The level is determined by the potentiometers 26, 27, 35, and 36. The signal from the amplifiers 22, 23, 31, 32 is transmitted to a recorder 61 together with a signal from the amplifiers 62, 63, etc., in the other channel. This signal may be transmitted to a memorizing device capable of driving a marking device for marking the existence of the imperfections on the web, or the memory device can drive a solenoid for taking out the portion of the web containing the imperfections where the feeding device has a cutter attached to it.

The electric circuit described hereinabove, also contains a resistor 19 which is connected with resistors 55, 56, etc., from another channel and a resistor 30 is connected with resistors 58, 59, etc., from another channel. The signals from all the phototransistors are collected by their connection to lines 37 and 46. By the above-described electric circuit, a continuous imperfection extending laterally with respect to the advancing direction of the web cannot be detected independently, although a single imperfection and a continuous imperfection extending longitudinally can be detected. However, by collecting the signals of all the elements as described above, the imperfections extending laterally can also be detected.

In accordance with the present invention as described, the scattered light is not received so that the imperfections in the semitransparent web can be detected by the transmitting method. This is because the respective photoconductive elements have definite fields of view. Three types of imperfections in the web can be detected and distinguished from each other by the unique circuit set forth above, they are: a single imperfection, a continuous imperfection extending longitudinally, and a continuous imperfection extending laterally.

Since the fields of view of adjacent photoconductive elements are not separate but do overlap on the web surface, all areas of the web are scanned if the scanning speed is not too high. Moreover, there is no part in the apparatus which has excessive force exerted on it so that the construction of the apparatus can be simple and durable.

What I claim is:

1. An apparatus for detecting imperfections on a longitudinally moving web which comprises:
   a. a plurality of photoconductive elements positioned below said web,
   b. means for reciprocating said photoconductive elements laterally to the longitudinal advancing direction of said moving web,
   c. a light source disposed on the side of said web opposite from that of said photoconductive elements,
   d. shielding means positioned between said web and said photoconductive elements and including a laterally extending slot aligned with and overlying said laterally moving photoconductive elements,
   e. individual lenses for each photoconductive element overlying said photoconductive elements and positioned between said photoconductive elements and said web for sharply focusing the imperfections of the web within the limited fields of view of each of said underlying photoconductive elements, and
   f. an electric circuit responsive to the output of said photoconductive elements for indicating the presence of an imperfection in said moving web.

2. An apparatus for detecting imperfections on a longitudinally moving web which comprises:
   a. a plurality of said photoconductive positioned below said web,
   b. means for reciprocating said photoconductive elements laterally to the longitudinal advancing direction of said moving web.
   c. a light source disposed on the side of said web opposite that of said photoconductive elements,
   d. shielding means positioned between said web and said photoconductive elements including a laterally extending slot aligned with and overlying said laterally moving photoconductive element,
   e. additional photoconductive elements fixedly mounted to a support so as to be fixed relative to said moving web and to said reciprocating photoconductive elements and adjacent to said reciprocating photoconductive elements for detecting imperfections at the edges of said web during reciprocation of said moving photoconductive elements, and
   f. an electric circuit responsive to the output of said photoconductive elements for indicating the presence of an imperfection in said moving web.

3. The apparatus for detecting imperfections on a web as defined in claim 1, wherein said laterally reciprocating photoconductive elements constitute a first row, and said apparatus further includes additional photoconductive elements stationarily mounted parallel to said moving photoconductive elements at opposite ends of the path of movement of the same and constituting a second and fixed parallel row for detecting imperfections at the edges of said longitudinally moving web.