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(54) **LABEL SCANNING SYSTEM**
ETIKETTENABTASTSYSTEM
SYSTEME DE SCANNAGE D'ETIQUETTES

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Description

TECHNICAL FIELD:

[0001] The present invention relates to a labelling method and in particular to a roll fed labelling method in which labels are scanned and cut in registration prior to their application to a bottle or other container.

BACKGROUND ART:

[0002] In conventional roll fed labeling methods, labels are scanned by an electronic scanner designed to detect a change in coloration between a triggering mark and the adjacent label graphics. For the method to work properly, there must be sufficient opacity of the triggering mark color; sufficient contrast between the triggering mark color and the adjacent graphics and sufficient spacing between the triggering mark and the adjacent graphics so that the scanning equipment does not confuse the one for the other.

[0003] It is possible to improve detection accuracy by interposing a colored filter between the mark and the detector, the particular color chosen to enhance contrast. This is not convenient because it entails changing filters and adjusting sensitivity levels each time there is a change in the material being scanned. This is especially so for bottlers who must change labels periodically.

[0004] Bottlers experience considerable downtime resulting from problems associated with the conventional scanning system. This is partially due to the increased use of more complex graphics and more frequent packaging changes, which require realignment and adjustment of the scanning equipment. In addition, the use of stylized, distinctly designed, bottles often requires small labels because of the contours of the bottle, thereby reducing the spacing available between a triggering mark and adjacent graphics. Finally, the increased use of promotional banners across the label to announce special offers and promotions require sharp contrasts with the remainder of the label thereby potentially interfering with the ability of conventional scanning equipment to distinguish the triggering mark from the graphics or confusing the banner or a portion thereof for the triggering mark.

[0005] It is known from US patents numbers 4,467,207 and 2,888,570, for example, to provide the product being scanned with a mark comprising fluorescent material and to irradiate it with ultraviolet light with a wavelength of about 365 nanometers. The mark converts the UV light to a different wavelength which is predominantly visible light and is detected by a suitable detector.

[0006] US patent No. 3,536,550 issued 27 October 1970 naming George W. Von Hofe as inventor discloses a system for scanning a continuous web of printed labels having register marks in registration with individual labels. A control system detects the register marks and controls a cutter which severs individual labels from the roll for application to bottles, cans, and so on.

[0007] As a general rule, scanning systems for labels and the like operate in ambient light which may cause some colors, such as certain greens and yellows, to emit light of much the same wavelength as that emitted by the mark. This results in high levels of interference or noise making it difficult for the detector to detect the mark. This interference or noise will depend upon the colors used in the label, and exacerbate the problem of adjusting sensitivity levels every time a label type is changed.

[0008] Further difficulties stem from the high operating speeds of modern bottling machinery, which demand speed and precision in the detection of the triggering mark to ensure that the labels are cut at the correct position.

DISCLOSURE OF INVENTION:

[0009] In view of the above, it is the principle object of the present invention to provide an improved label scanning method which is far less sensitive to the label graphics for registration and alignment.

[0010] A further object is to provide such a scanning method that requires a nominal change to existing labeling equipment and can be readily adapted to existing bottling lines.

[0011] According to the present invention, there is provided a method of producing rolls of labels for use in a continuous feed labeling system in which triggering marks on said rolls registered to respective interfaces between adjacent labels are detected by irradiating the labels in succession with modulated UV light and detecting corresponding modulated fluorescence emitted by the triggering marks, each of the triggering marks comprising a luminophor material which, when exposed to said UV light, emits fluorescence and each label has coloured portions that also emit fluorescence when irradiated by UV light, the method characterized by the steps of:

- (i) providing sample labels having triggering marks comprising a predetermined amount of luminophor registered to respective interfaces between adjacent labels;
- (ii) scanning the sample labels using modulated UV light and measuring correspondingly modulated fluorescence emitted by said triggering marks in response to irradiation by the modulated UV light;
- (iii) comparing the measured modulated fluorescence from the triggering marks with a reference level representing a maximum level of the modulated fluorescence detected from said coloured portions when irradiated by said modulated UV light to determine whether or not the measured modulated fluorescence from the triggering marks exceeds said reference level by a predetermined minimum ratio; and

(iv) if the measured modulated fluorescence from the triggering marks does not exceed said reference maximum level by said ratio, increasing the amount of luminophor material in the triggering marks.

[0012] Preferably, the modulation is at a modulation frequency which is outside the frequency of visible light and may be in the kilohertz range, conveniently about 33 kHz.

[0013] Even when such a modulated UV light source is used, there may be interference from certain colors which are slightly fluorescent and so will also convert the modulated UV light into modulated visible light, in the same way that the triggering mark converts it. This can lead to difficulties in setting the sensitivity of the sensor so that it will detect the triggering mark but not respond to the background colors. Clearly, the signal to noise ratio, i.e. the amount of light reflected from the triggering mark as compared to light reflected from neighbouring parts of the label, will be increased by increasing the amount of luminophor material in the triggering mark. The fluorescent optical brightening material is very expensive so it is desirable to minimize the amount used. On the other hand, if there is insufficient optical brightening agent in the triggering mark, the sensor may not be able to detect it against the background "noise" or interference. The problem is exacerbated where, as is usual, the rolls of labels are produced by an independent supplier and it is left to the bottler to adjust sensitivity levels to suit the different labels and compensate for different colors and color combinations. The colored portions selected may be those which will subsequently be scanned by the sensor.

[0014] Preferably, the reference level is derived by a prior step of measuring modulated fluorescence emitted by said coloured portions of the label when irradiated by said UV light.

[0015] The measurement of the modulated fluorescence from the triggering marks may include filtering light received from said label roll, producing a signal in dependence upon said modulated fluorescence emitted by the triggering marks and filtering said signal to detect said modulation frequency.

[0016] The predetermined ratio preferably is at least three-to-one.

[0017] Preferred embodiments of the invention include the subsequent steps, in a continuous feed labeling system, of:

feeding rolls of the labels into the system;
directing modulated UV light at said labels whereby to cause said triggering marks to emit correspondingly modulated fluorescence that exceeds by a predetermined ratio a reference level of modulated fluorescence detected from said coloured portions;
receiving modulated fluorescence from said label roll and detecting the modulated fluorescence from said triggering marks;

controlling a cutter to slice a label off said roll at a said interface based upon the said detection of said modulated fluorescence from the triggering mark; and adhering the label to an article.

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BRIEF DESCRIPTION OF THE DRAWINGS:

[0018]

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An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

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Figure 1 is a plan view of a series of labels on a roll containing triggering marks in accordance with the present invention;

Figure 2 is an enlarged plan view of two adjacent label repeats from the roll;

Figure 3 is a schematic representation of a typical label structure used for soft drink bottles; and Figure 4 is a schematic view of a bottle labelling system in accordance with the present invention.

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BEST MODE FOR CARRYING OUT THE INVENTION:

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[0019] Reference is now made to the drawings and to Figure 1 in particular wherein a roll 10 of labels 12 as typically used by the beverage packaging industry is illustrated. In practice several labels are printed at the same time transversely across a master roll, which is then sliced to form a plurality of single rolls 10. Each of the rolls 10 contains a plurality of repeats of the individual labels 12 arranged immediately adjacent each other. As shown in Figure 3, the labels are commonly formed of a laminate consisting of a bottom ply 14 of white OPP (oriented polypropylene) on which the label graphics are printed. An adhesive coating 18 is applied over the printing ink layer 16 and a clear OPP layer 20 is applied to the adhesive.

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[0020] A typical label may include graphics indicating the brand, flavor, logo etc. and a banner announcing a special price or promotion. Labels are commonly printed in multi-colors for enhanced eye-appeal to the consumer.

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The individual labels are separated from each other by a line 26 that is registered to a triggering mark 28. The triggering mark 28 may be on the cut line 26 or a fixed distance from the cut line. In either case, the triggering mark serves to activate a cutting mechanism to separate a single label from the roll as will be described. The cut line 26 may be a visible line, actually separating the graphics of the individual labels from one another, or simply the line at which the roll is to be cut but not bearing any particular distinguishing characteristic. That is, the graphics of labels 12a and 12b may simply run into each other on the roll across the interface between the labels.

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[0021] In accordance with the present invention, the triggering mark 28 is formed with a luminophor ink, i.e.

an ink which includes a fluorescent optical brightening agent. Such fluorescent optical brightening agents are available commercially under the trade name UVITEX OB from the Ciba Additives division of Ciba-Geigy, Hawthorne, New York and under the trade name BLANKOPHOR SOL from Bayer Corporation, Industrial Chemicals Division. The fluorescent optical brightening agents, and hence the luminophor inks, have the property of reflecting invisible UV light as longer wave length visible light.

[0022] The UV light is modulated at a particular frequency and sensors which contain spectral filters and respond only to visible light modulated to the particular frequency serve to detect the triggering mark. Such sensors are made, for example, by SICK Optic-Electronics, Inc. of Eden Prairie, MN. A preferred sensor has a light source emitting light with a wavelength of about 365 nanometers and applies the modulation simply by interrupting the light source at the specified frequency of about 33 kilohertz. A suitable filter at the sensor output has a corresponding selection frequency of 33 kHz. so that the sensor is substantially insensitive to light from other sources which does not have the modulation. The present invention makes use of such inks and such sensors in the manner described.

[0023] In accordance with the present invention, the roll of labels 10 is printed in the usual manner except that the triggering marks 12 are printed with luminophor ink. The triggering mark 12 may comprise a line extending across the entire width of the label, merely comprise a block as shown, or comprise any relatively small portion of the label graphics. The latter is preferred since the cost of the luminophor ink is approximately 10 times that of conventional ink so that a substantial cost advantage can be achieved by minimizing the area of the label printed with the luminophor ink. The location of the triggering mark with respect to the edge of the individual label is immaterial so long as the distance is known. Similarly, the color of the triggering mark is immaterial and thus the triggering mark may be transparent or pigmented to invisibly blend into the adjacent graphics. Further, the graphics adjacent to the triggering mark need not contrast with the triggering mark (as in conventionally printed rolled labels) and thus the graphics can extend right up to the very edge of the label and even across the interface between adjacent labels.

[0024] The label application system of the present invention is depicted in Figure 4. A roll of labels 10 is fed through idler rolls 30 past a luminescence sensor 32. The sensor 32 contains a modulated UV light source as well as a spectral filter element that filters out light at wavelengths other than those emitted by the luminophor ink, such that the sensor 32 will generally respond only to the emitted visible light reflected off the triggering mark of a label. The light source emits light in the UV range, i.e. 365 nanometers. Modulation is applied to the light from the UV light source, conveniently by interrupting the light at a rate of 33 kHz. The corresponding visible light emitted

by the triggering mark will be in the visible range, but will still include the 33 kHz. modulation. The luminescence sensor 32 detects the light reflected from the label roll and uses a filter to detect the 33 kHz. modulation, rejecting visible light from other sources which also is reflected from the label roll but not modulated at 33 kHz. In particular, the sensor 32 will reject light from certain colors in the graphics, such as some yellows and greens, which may tend to fluoresce and emit light at much the same frequency as the triggering mark.

[0025] The detection of the triggering mark is used to control a cutter assembly 34 consisting of a blade 38 and rotor 36. The blade 38 is controlled by the sensor 32 to move toward the rotor to cut the lagging end of the leading label 12, thereby separating it from the remainder of roll 10. The separated label is transported by rotor 38 to a vacuum pick off 40 that holds a label in place as it rotates to move the label 12 past a glue applicator 42. The glued label is then rotated by the vacuum pick off to align with filled bottles, where the vacuum is released and the label 12 is transferred to a passing bottle 44.

[0026] Modulating the UV light reduces interference from ambient light reflecting off the label and/or the triggering mark. There is still a possibility, however, that one or more of the colors used in the label will be slightly fluorescent so that, as the color is scanned by the sensor 32, it too will emit modulated visible light. In order to ensure that the sensor 32 will respond to the modulated visible light from the triggering mark but not respond to the modulated visible light from the background colors, the amount of brightening agent in the ink used for the triggering mark is carefully controlled to ensure that the modulated visible light from the triggering mark, when scanned, is always significantly greater than that from any of the background colors.

[0027] The amount of brightening agent is controlled with reference to the sensitivity of the sensor 32 as well as emission levels of the various colors. The sensitivity of the sensor 32 is set at a level which is just low enough to ensure that it will not respond to modulated visible light of a predetermined level, which is arranged to be greater than that from any of the colors to be used in the labels. This level can be determined by measuring various colors.

[0028] During production of the roll of labels, at least one label is scanned using a test sensor similar to sensor 32 but with a digital readout of detected light levels. For example, the test sensor may be a model LUT 1-5 by the above-mentioned SICK Optic-Electronics, Inc. Each color which subsequently will lie in the path scanned by the sensor 32 is scanned by the UV light source and the amount of corresponding visible light is measured to ensure that it is less than the above-mentioned predetermined level of modulated visible light. The triggering mark also is scanned using the UV light source and the amount of corresponding visible light measured to ensure that it is greater than a reference level and hence exceeds, by a predetermined margin, the maximum of the back-

ground light levels measured for the label colors. Typically, the margin will be a ratio of three or more to one. Alternatively, the reference level might be determined with reference to the predetermined level for the sensor 32. If the amount of modulated visible light from the triggering mark is insufficient, more brightening agent is added to the ink, following which the measurements may be repeated.

[0029] During the course of a production run, sample labels may be tested in the manner described above to ensure that the ratio between light levels for the triggering mark and the background colors is maintained.

[0030] In the event that the light emitted by one of the colors during the test exceeds the predetermined level for the sensor 32, and it is not possible to change it, the amount of brightening agent may be increased to obtain the required margin. Alternatively, the roll of labels may be rejected.

[0031] There is no need to change the sensitivity of sensor 32, even when the labels are changed, providing each roll of labels provides the required light emission levels.

INDUSTRIAL APPLICABILITY

[0032] The present invention advantageously improves the application of labels to containers, especially bottles, using high speed machinery. In view of the modulation of the light source, and the measurement of the triggering mark luminescence during production, the sensor is substantially oblivious to all of the graphics of the label other than the luminescent triggering mark, and the registration of the labels may be very closely controlled. Further, since the sensor is "blind" to all of the graphics of the label other than the triggering mark, the graphics can be designed without any concern for the triggering mark. That is, there need not be any sharp change between the colors of the triggering mark and adjacent graphics in order to provide the contrast necessary to set off the triggering mark for the detector.

[0033] Monitoring of the triggering marks during production and, where necessary, adjusting the amount of brightening agent, makes it possible to leave the sensitivity setting of the sensor used to control the cutting of the labels unchanged at a level which will ensure that the sensor does not detect background colors yet will detect the triggering marks consistently.

Claims

1. A method of producing rolls of labels for use in a continuous feed labeling system in which triggering marks on said rolls registered to respective interfaces between adjacent labels are detected by irradiating the labels in succession with modulated UV light and detecting corresponding modulated fluorescence emitted by the triggering marks, each of the

triggering marks comprising a luminophor material which, when exposed to said UV light, emits fluorescence and each label has coloured portions that also emit fluorescence when irradiated by UV light, the method **characterized by** the steps of:

- (i) providing sample labels having triggering marks comprising a predetermined amount of luminophor registered to respective interfaces between adjacent labels;
- (ii) scanning the sample labels using modulated UV light and measuring correspondingly modulated fluorescence emitted by said triggering marks in response to irradiation by the modulated UV light;
- (iii) comparing the measured modulated fluorescence from the triggering marks with a reference level representing a maximum level of the modulated fluorescence detected from said coloured portions when irradiated by said modulated UV light to determine whether or not the measured modulated fluorescence from the triggering marks exceeds said reference level by a predetermined minimum ratio; and
- (iv) if the measured modulated fluorescence from the triggering marks does not exceed said reference maximum level by said ratio, increasing the amount of luminophor material in the triggering marks.

- 2. A method according to claim 1, **characterized in that** the reference level is derived by a prior step of measuring modulated fluorescence emitted by said coloured portions of the label when irradiated by said UV light.
- 3. A method according to claim 1 or 2, **characterized in that** the UV light is modulated at a frequency of about 33 kilohertz.
- 4. A method according to claim 1, 2 or 3, **characterized in that** said measurement of the modulated fluorescence from the triggering marks includes filtering light received from said label roll, producing a signal in dependence upon said modulated fluorescence emitted by the triggering marks and filtering said signal to detect said modulation frequency.
- 5. A method according to claim 1, 2, 3 or 4, **characterized in that** said predetermined ratio is at least three-to-one.
- 6. A method according to any one of claims 1 to 5, **characterized by** the subsequent steps, in a continuous feed labeling system, of:

feeding rolls of the labels into the system;
directing modulated UV light at said labels

whereby to cause said triggering marks to emit correspondingly modulated fluorescence that exceeds by a predetermined ratio a reference level of modulated fluorescence detected from said coloured portions;
 receiving modulated fluorescence from said label roll and detecting the modulated fluorescence from said triggering marks;
 controlling a cutter to slice a label off said roll at a said interface based upon the said detection of said modulated fluorescence from the triggering mark; and
 adhering the label to an article.

Patentansprüche

1. Verfahren zur Herstellung von Rollen von Etiketten zur Verwendung in einem Etikettierungssystem mit kontinuierlichem Durchlauf, in dem auf den Rollen Triggermarken erkannt werden, die entsprechenden Interfaces zwischen benachbarten Etiketten zugeordnet sind, indem die Etiketten nacheinander mit moduliertem UV-Licht bestrahlt werden und die entsprechende mit einer von den Triggermarken emittierte modulierte Fluoreszenz erkennen, wobei jede Triggermarke aus einem Luminophor besteht, der unter Einwirkung von UV-Licht Fluoreszenz emittiert, und wobei jedes Etikett gefärbte Teile aufweist, die bei Bestrahlung mit UV-Licht ebenfalls Fluoreszenz emittieren, **dadurch gekennzeichnet, dass** das Verfahren folgende Verfahrensschritte aufweist:

- (i) Bereitstellung von Musteretiketten mit Triggermarken, die eine vorgegebene Menge an Luminophor enthalten, der den entsprechenden Interfaces zwischen benachbarten Etiketten zugeordnet ist;
- (ii) Scanning der Musteretiketten unter Verwendung von UV-Licht und Messung der entsprechend modulierten Fluoreszenz, die von den Triggermarken unter Einwirkung des modulierten UV-Lichts emittiert wird;
- (iii) Vergleich der gemessenen modulierten Fluoreszenz von den Triggermarken mit einer Bezugsebene die eine Höchstebe der modulierten Fluoreszenz darstellt, die von den gefärbten Teilen erkannt wird, wenn sie vom modulierten UV-Licht bestrahlt werden, um festzustellen, ob die gemessene modulierte Fluoreszenz von den Triggermarken die Bezugsebene um ein vorgegebenes Mindestverhältnis überschreitet oder nicht; und
- (iv) wenn die gemessene modulierte Fluoreszenz von den Triggermarken die maximale Bezugsebene nicht um das Mindestverhältnis überschreitet, Erhöhung der Luminophormenge in den Triggermarken.

2. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die Bezugsebene aus einem vorherigen Verfahrensschritt abgeleitet wird, in dem durch die gefärbten Teile der Etiketten bei UV-Licht-Bestrahlung emittierte modulierte Fluoreszenz gemessen wird.
3. Verfahren gemäß Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** das UV-Licht auf einer Frequenz von ca. 33 kHz moduliert wird.
4. Verfahren gemäß Anspruch 1, 2 oder 3, **dadurch gekennzeichnet, dass** der Messwert der modulierten Fluoreszenz von den Triggermarken Filterlicht beinhaltet, das von der Etikettenrolle empfangen wird, wodurch in Abhängigkeit der von den Triggermarken emittierten modulierten Fluoreszenz ein Signal erzeugt wird und das Signal gefiltert wird, um die Modulationsfrequenz zu erkennen.
5. Verfahren gemäß Anspruch 1, 2, 3 oder 4, **dadurch gekennzeichnet, dass** das vorgegebene Verhältnis mindestens drei zu eins beträgt.
6. Verfahren gemäß einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** es aus folgenden anschließenden Verfahrensschritten in einem Etikettierungssystem mit kontinuierlichem Durchlauf besteht:

Einzug der Etikettenrollen in das System;
 Einwirkung des modulierten UV-Lichts auf die Etiketten zur Erzeugung der Triggermarken, welche eine entsprechend modulierte Fluoreszenz emittieren, die eine Bezugsebene der von den gefärbten Teilen erkannten modulierten Fluoreszenz um ein vorgegebenes Verhältnis überschreitet;
 Empfang modulierter Fluoreszenz von der Etikettenrolle und Erkennung der modulierten Fluoreszenz von den Triggermarken; Regelung eines Abschneiders, der an einer von der Erkennung der modulierten Fluoreszenz von den Triggermarken abhängigen Interface ein Etikett von der Rolle abschneidet;
 und
 Anhaften des Etiketts an einen Artikel.

Revendications

1. Procédé de production de rouleaux d'étiquettes destinés à être utilisés dans un système d'étiquetage à alimentation en continu dans lequel des repères de déclenchement calés sur lesdits rouleaux par rapport à des interfaces respectives entre des étiquettes adjacentes sont détectés en envoyant successivement sur les étiquettes de la lumière UV modulée et

en détectant la fluorescence modulée correspondante émise par les repères de déclenchement, chacun desdits repères de déclenchement comprenant un matériau luminophore qui, lorsqu'il est exposé à ladite lumière UV, émet une fluorescence et chaque étiquette possédant des parties colorées qui émettent également une fluorescence lorsqu'elles reçoivent de la lumière UV, ledit procédé étant **caractérisé par** les étapes consistant à :

- (i) obtenir des étiquettes échantillons munies de repères de déclenchement comprenant une quantité prédéterminée de luminophore et calés par rapport à des interfaces respectives entre des étiquettes adjacentes ;
- (ii) scanner les étiquettes échantillons en utilisant de la lumière UV modulée et mesurer la fluorescence modulée correspondante émise par lesdits repères de déclenchement en réponse à la réception de la lumière UV modulée ;
- (iii) comparer la fluorescence modulée mesurée émise par les repères de déclenchement avec un niveau de référence représentant un niveau maximum de la fluorescence modulée détectée à partir desdites parties colorées lorsqu'elles reçoivent ladite lumière UV modulée afin de déterminer si oui ou non la fluorescence modulée mesurée émise par les repères de déclenchement dépasse ledit niveau de référence selon un rapport minimum prédéterminé ; et
- (iv) si la fluorescence modulée mesurée émise par les repères de déclenchement ne dépasse pas ledit niveau de référence maximum selon ledit rapport, augmenter la quantité de matériau luminophore dans les repères de déclenchement.

2. Procédé selon la revendication 1, **caractérisé en ce que** le niveau de référence est dérivé par une étape préalable de mesure de la fluorescence modulée émise par lesdites parties colorées de l'étiquette lorsqu'elles reçoivent ladite lumière UV.

3. Procédé selon la revendication 1 ou la revendication 2, **caractérisé en ce que** la lumière UV est modulée à une fréquence d'environ 33 kilohertz.

4. Procédé selon la revendication 1, 2 ou 3, **caractérisé en ce que** ladite mesure de la fluorescence modulée émise par les repères de déclenchement comprend les étapes consistant à filtrer la lumière renvoyée par ledit rouleau d'étiquettes, générer un signal en fonction de ladite fluorescence modulée émise par les repères de déclenchement et filtrer ledit signal afin de détecter ladite fréquence de modulation.

5. Procédé selon la revendication 1, 2, 3 ou 4, **carac-**

térisé en ce que ledit rapport prédéterminé est au moins égal à 3:1.

6. Procédé selon l'une quelconque des revendications 1 à 5, **caractérisé en ce qu'il** comprend, dans un système d'étiquetage à alimentation en continu, les étapes consistant à :

- alimenter des rouleaux des étiquettes dans le système ;
- envoyer de la lumière UV modulée sur lesdites étiquettes afin de provoquer l'émission par lesdits repères de déclenchement d'une fluorescence modulée correspondante qui dépasse selon un rapport prédéterminé un niveau de référence de fluorescence modulée détectée à partir desdites parties colorées ;
- recevoir la fluorescence modulée venant dudit rouleau d'étiquettes et détecter la fluorescence modulée émise par lesdits repères de déclenchement ;
- commander une lame pour couper une étiquette dudit rouleau au niveau d'une desdites interfaces sur la base de ladite détection de ladite fluorescence modulée émise par le repère de déclenchement ; et
- coller l'étiquette à un article.

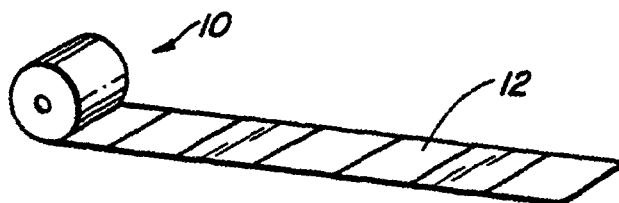


FIG. 1

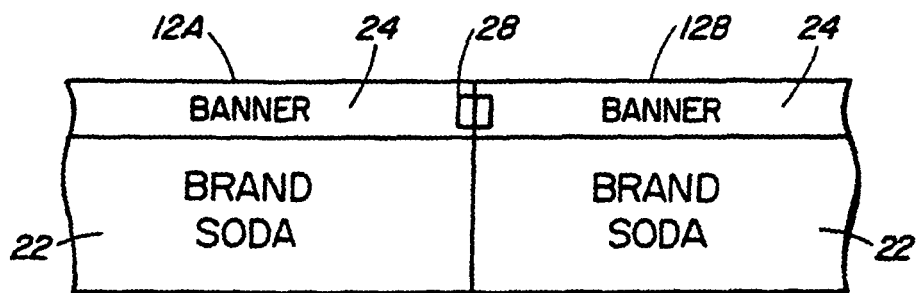


FIG. 2

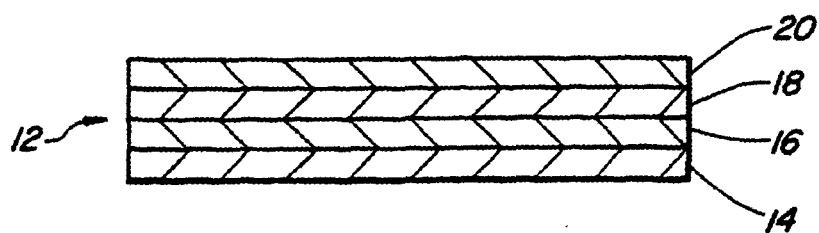


FIG. 3

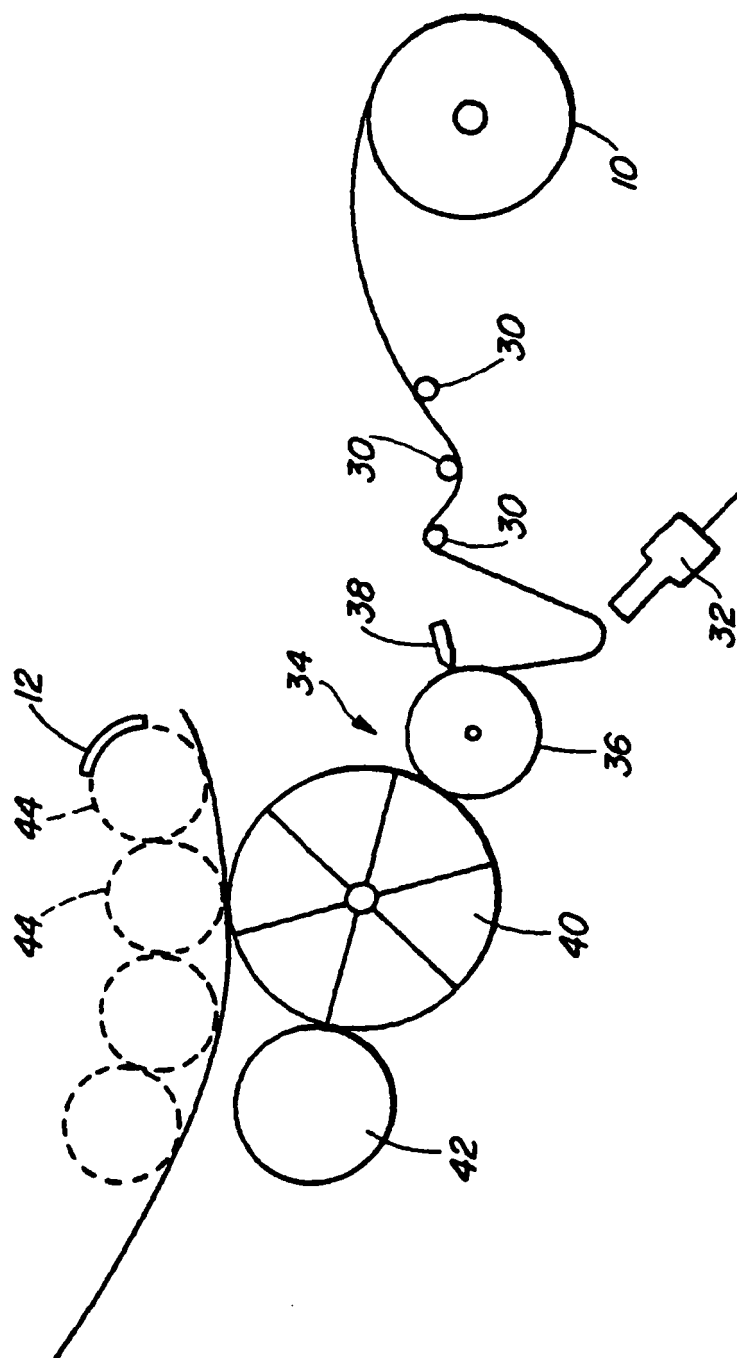


FIG. 4

REFERENCES CITED IN THE DESCRIPTION

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