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(54) Apparatus for sensing optical characteristics of a banknote

Vorrichtung zur Erfassung von optischen Eigenschaften eines Geldscheins

Appareil pour détecter des caractéristiques optiques d'un billet de banque

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(56) References cited:
EP-A- 0 537 513
EP-A- 0 718 809
DE-A- 10 005 514
GB-A- 894 570

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Description

[0001] This invention relates to an apparatus for sensing optical characteristics of a banknote.

[0002] Such apparatus is commonly used to determine the authenticity and denomination of banknotes. Often, a banknote is moved along a path past optical transmitters and receivers so that the transmission or reflection characteristics in respective areas of the banknote can be determined by scanning. The apparatus may include transmitters which operate in multiple wavelengths, such as red, green, blue and infra-red. (It is noted that the terms "optical" and "light" are used herein to refer to any electromagnetic wavelength, and not merely visible wavelengths.)

[0003] EP-A-0 537 513 relates to a device for measuring banknotes which includes rows of LEDs situated below and above a banknote to be measured. A CCD sensor is arranged to detect both diffusely reflected and refracted light from the banknote.

[0004] EP-A-0 718 809 relates to a device for characterising banknotes which includes two light sources, one arranged on each side of a banknote and means for detecting light which is both reflected and transmitted by the banknote.

[0005] It would be desirable to provide an apparatus for detecting the optical characteristics of banknotes, which is more compact, less costly, more efficient and/or easier to calibrate than the apparatuses of the prior art.

[0006] US-A-6061121 discloses a banknote processor which includes an illumination device for continually illuminating a sheet to be tested and a receiving device for receiving reflected and filtered light, both devices preferably being arranged along an axis perpendicular to the sheet. The illumination device emits divergent light which is reflected on its path to the sheet by various mirrors to increase the uniformity of illumination.

[0007] Aspects of the present invention are set out in the accompanying claims.

[0008] In accordance with a preferred embodiment of the invention, a receiver is arranged to receive both light transmitted through the banknote and light reflected from the banknote. Accordingly, the reflection and transmission characteristics of the banknote can be measured in a simple and economic manner. Preferably, the receiver is located in proximity to a transmitter which transmits the light which is reflected by the banknote to the receiver. Also, the arrangement is preferably such that the receiver receives light which is diffusely reflected by the banknote, because this provides a much more representative measurement of the optical characteristics of the banknote than directly reflected light. For this purpose, the light paths to and from the banknote are preferably arranged to be inclined with respect to the normal to the plane of the banknote. Because the receiver and transmitter are in proximity, and possibly mounted on the same circuit board, it is easier to make the apparatus more compact.

[0009] In accordance with preferred embodiments of the invention, a light transmitter and a light receiver are arranged on the same side of the path of a banknote, the receiver being arranged to receive light diffusely reflected by the banknote and travelling in a direction which is substantially opposite to that of the light transmitted by the transmitter. Direct reflection can be avoided by arranging for the light paths to be inclined with respect to the normal to the banknote and for the light incident on the banknote to be collimated so that it does not diverge when considered in at least one plane containing the normal to the banknote.

[0010] Preferably, the banknote is moved in a scanning direction relative to the incident light, and the light is collimated so that it does not diverge when considered in a plane containing both the scanning direction and the normal to the plane of the banknote. Preferably, the incident light is arranged to diverge when viewed in a plane which contains the normal to the banknote and which is transverse to the scanning direction, so that a single transmitter can be used to illuminate a relatively wide area of the banknote as the banknote is moved in the scanning direction past the transmitter. Preferably, each transmitter is associated with at least two receivers, which could be mounted on opposite sides of the transmitter (displaced in a direction transverse to both the scanning direction and the direction normal to the plane of the banknote) for receiving light from respective areas of the banknote.

[0011] It is known to provide a reference surface within an apparatus for measuring the optical characteristics of banknotes, so as to permit calibration of an arrangement for detecting the reflectance characteristics of banknotes. See, for example, EP-0731737-A. It is also known to provide for a manual calibration operation which involves inserting, instead of a banknote, a sheet of calibration paper of known reflectance and/or transmittance characteristics. This will travel along the banknote path so that the apparatus can be calibrated.

[0012] It would, however, be desirable to permit automatic calibration of devices used for measuring the transmittance characteristics of a banknote.

[0013] In accordance with a further embodiment of the invention, apparatus for measuring the optical characteristics of a banknote includes a reference body and means for moving the body from a first position within the apparatus but out of a banknote path to a second position, possibly within the banknote path, between an optical transmitter and an optical receiver, thereby to permit calibration by measuring the transmission and/or reflection characteristics of the reference body. Preferably, the reference body is used for calibrating the measurement of both transmittance and reflectance characteristics. Preferably, a control means is arranged automatically to move the reference body to the second position in response to particular conditions, for example each time a transaction has been completed using a banknote validator incorporating the apparatus of the invention.

[0014] An arrangement embodying the invention will

now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram to illustrate some of the principles of operation of an apparatus according to the invention;
Figure 2 is a schematic side view showing the operation of devices of the apparatus for measuring transmittance and reflectance characteristics of a banknote;
Figure 3 is a schematic end view of the device of Figure 2;
Figure 4 is a diagram of a banknote validator in accordance with the invention;
Figure 5 is a perspective view of an apparatus for measuring transmittance and reflectance characteristics of a banknote, the apparatus forming part of the validator of Figure 4;
Figure 6 is a plan view illustrating regions of a banknote which are scanned by the apparatus of Figure 5;
Figure 7 is a schematic side view showing the operation of a modified embodiment of the invention; and
Figure 8 is a side view of a further embodiment of the invention.

[0015] Referring to Figure 1, a banknote 2 lies in a plane P1. In an embodiment of the present invention, drive means are provided for conveying the banknote 2 in a scanning direction S which preferably lies in the plane P1 and more preferably is parallel to the length of the banknote 2. The direction shown at T is transverse, and particularly perpendicular, to the scanning direction S and also lies within the plane P1 of the banknote 2. The direction which is normal to the banknote 2 is shown at N.

[0016] The apparatus includes a first optical device 3 including a light transmitter 4 which is arranged to transmit light to the banknote 2 along a path which is parallel to a plane P2. The plane P2 contains the transverse direction T and is located at an angle, for example about 20°, to the normal direction N. The device 3 also includes two light receivers 6, 7 positioned in close proximity to, and on respective sides of, the transmitter 4 and displaced from each other in the transverse direction T.

[0017] Any light which is reflected from the banknote back in the direction which is substantially reverse to the direction of the transmitted light will be received by the receivers 6, 7 located near the transmitter 4. This will be diffusely reflected light. Any directly (i.e. specularly) reflected light will travel in a direction 8 away from the transmitter 4 and the receivers 6, 7.

[0018] A similar arrangement, involving a device 3' comprising a transmitter 4' and receivers 6', 7', is located diametrically opposite the device 3, on the opposite side of the path of the banknote 2, to measure the reflectance characteristics of the other side (in the drawing the underside) of the banknote. The receivers 6 and 7 are arranged to receive, in addition to light from the transmitter 4 reflected by the banknote, light from the transmitter 4' transmitted through the banknote. Similarly, the receivers 6', 7' can receive light from the transmitter 4 which has been transmitted through the banknote 2. Accordingly, each of the receivers 6, 6', 7, 7' can be used to detect both the reflectance and transmission characteristics of the banknote 2.

[0019] Figure 2 is a side view of the devices 3, 3', the plane of the drawing corresponding to a plane P3 (Figure 1) containing both the scanning direction S and the normal N. The light from the transmitter 4 forms a beam which illuminates an area 10 of the banknote. A lens 12 (see also Figure 3) collimates the light so that there is substantially no divergence of the beam when viewed in the plane P3. Accordingly, all the directly reflected light travelling in the direction 8 will avoid the receivers 6, 7.

[0020] In Figure 3, the plane of the drawing corresponds to a plane P4 (Figures 1 and 2) containing both the transverse direction T and the normal N. It will be noted that the light beam from the transmitter 4 diverges in order to illuminate the area 10. A lens 14, having a skewed optic axis, focuses approximately half the area 10, indicated at 10', on to the receiver 6. A lens 15, also having a skewed optic axis, focuses the other half of the area 10, indicated at 10", on to the receiver 7. The arrangement is symmetrical about the optic axis 16 of the transmitter 4.

[0021] Accordingly, a single transmitter 4 is used to illuminate the areas sensed by two separate receivers 6, 7, thus reducing the number of transmitters required. Furthermore, because the light diverges in the planes P2, P4 containing the transverse direction T, but not in the plane P3 containing the scanning direction S, a relatively large area can be illuminated while still avoiding the sensing of direct reflection by the receivers 6, 7. The light from the transmitter 4 incident on the banknote and the light from the banknote to the receivers 6, 7 travel in opposite directions in substantially the same path, the small path difference being as a result of the fact that the physical sizes of the transmitter and receivers cause a small angle to be subtended between the light paths at the banknote.

[0022] Figure 4 illustrates a banknote validator 20 in accordance with the invention. The validator has an inlet 22 arranged to receive banknotes which travel along a path 24 to an apparatus 30 which is arranged to test the optical transmission and reflectance characteristics of the banknote. A control means 26 is arranged to send signals to and receive signals from the apparatus 30 and to use the received signals to determine the authenticity and the denomination of the banknote. The control means 26 is also arranged to send control signals to the apparatus 30 to perform a calibration operation, as will be described below. The banknote travels from the apparatus 30 to a gate 28 which is controlled by the control means 26 in dependence upon the type of banknote received. The gate can direct the banknote either to a path 32 leading to an outlet 34, or to a path 36 leading to a banknote store 38.

[0023] The apparatus 30 for sensing the optical characteristics of banknotes is shown in more detail in the perspective view of Figure 5. Banknotes are conveyed in the scanning direction S by means of endless belts 40 and sets of rollers 42 at the inlet side 44 of the apparatus and endless belts 46 and sets of rollers 48 at the outlet side 50 of the apparatus. The belts 40 and rollers 42 at the inlet side 44 of the apparatus are disposed laterally between the belts 46 and rollers 48 at the outlet side 50 of the apparatus.

[0024] The optical devices 3 (which are identical to the devices 3') are arranged in modules, or units. A first unit 52 is disposed above the banknote path at the inlet side 44, and faces a second unit 54 below the banknote path. Each unit comprises four optical devices 3 arranged in a line extending in the transverse direction T, each device comprising a transmitter 4 and a pair of receivers 6, 7 arranged as shown in Figures 2 and 3 to sense the reflectance and transmission characteristics in a pair of adjacent areas 10', 10" of the banknotes. The units 52 and 54 are arranged for sensing the reflectance and transmittance characteristics of the banknotes in scanned areas which extend between the inlet belts 40.

[0025] Two further units, 56 and 58, are disposed respectively above and below the banknote path at the outlet side 50. These are of similar structure and orientation to the modules 52 and 54, except that they are arranged to scan the areas between the outlet belts 46. Accordingly, as indicated in the plan view of Figure 6, the units 52, 54, 56 and 58 can scan the entire width of the banknote, each pair of units scanning areas between the areas scanned by the other pair.

[0026] It will be seen from Figure 5 that the volume occupied by the units 52 to 58 can be relatively small, despite the fact that both transmittance and reflectance is measured right across the width the banknote. This is because (a) receivers are used for sensing both reflectance and transmittance characteristics, (b) each receiver is mounted in close proximity to the transmitter which emits the light which the receiver uses for sensing reflectance characteristics, (c) each transmitter illuminates sufficient area for two receivers, and (d) transmitters are used for both transmittance and reflectance measurements.

[0027] Within each of the devices 3, the transmitter 4 and the receivers 6 and 7 are mounted on a common circuit board. If desired, a single circuit board can be used for all the devices 3 within a single module.

[0028] In the preferred embodiment, each transmitter comprises an LED package which includes a plurality of dies each of a respective wavelength, for example red, green, blue and infra-red.

[0029] Figure 5 also shows a pair of calibration units 60, 62. Each unit carries four reference bodies 64 and is mounted for pivotal movement about an axis parallel to the transverse direction T so that the body can be pivoted from a non-operational position, as shown in Figure 5, to an operational position in which each reference body 64 is located between an optical device 3 of one of the units (52 or 56) and the corresponding optical device 3 in another of the units (54 or 58). In this position, the reference body is located in or near the banknote path, and is operable to transmit light from the transmitter 4 of one of the devices to the receivers 6,7 of the opposed device, and to reflect light from the transmitter 4 to its adjacent receivers 6,7. Each reference body has predetermined reflection and transmission characteristics, so that calibration of the apparatus can be performed by taking reflectance and transmission measurements while the reference members 60, 62 are in their operational positions.

[0030] The operation of the validator 20 of Figure 4 is as follows. A received banknote is delivered to the inlet side 44 of the apparatus 30. The reference members 60, 62 are in their non-operational positions at this time. The control means 26 continuously checks the light transmitted between the optical units 52, 54 in the inlet section 44 until it detects the significant change caused by the leading edge of the banknote. Further movement of the banknote in the scanning direction S is tracked using an encoder so that the subsequent transmission and reflectance measurements can be associated with respective positions on the banknote.

[0031] As the banknote continues to travel between the units 52, 54, various transmission and reflectance measurements are taken in sequence under the control of the control means 26 which activates the respective dies of different wavelengths, and enables the respective receivers, according to a stored programme. Preferably, the arrangement is such that: (a) dies of different wavelengths are not energised at the same time, (b) reflectance measurements made by each receiver take place when the opposed transmitter on the other side of the banknote path is de-energised, and (c) transmission measurements made by each receiver take place when its adjacent transmitter is de-energised.

[0032] The measurements are initially carried out using the units 52, 54, but similar measurements are also carried out by the units 56, 58 when the leading edge of the banknote has reached these units, as determined by the output of the encoder.

[0033] After the banknote has left the apparatus 30, the control means 26 moves the reference members 60, 62 to their operational positions and takes both transmission and reflection calibration measurements which are used to adjust the power supply to the dies of respective wavelengths so that the intensities of the outputs as measured by the receivers complies with a predetermined level, adjust the sensitivities of the receivers and/or alter the processing of the receiver outputs to achieve calibration of the apparatus.

[0034] Instead of performing the calibration each time a banknote has passed through the apparatus 30, the calibration operation may be performed only at the end of the transaction which may involve the measurement of one or more banknotes.

[0035] Various modifications of the described arrange-

ments are possible. For example, the reference members 60, 62 could be replaced by a sheet, made of for example plastics material, with predetermined reflection and/or transmission characteristics. This sheet could be fed along the banknote path, using the normal banknote feeding mechanism, and stored within the banknote apparatus, for example using a dedicated sheet store, so that the reference sheet can be discharged from the store to perform a calibration operation and then returned to the store.

[0036] A cleaning means such as a brush may be provided so that each reference body or the reference sheet is cleaned as it is moved to or from the position in which calibration takes place.

[0037] As explained above, it is important to use diffuse (i.e. not directly) reflected light so that a reliable measurement of the banknote's spectral characteristics can be obtained. However, and in accordance with a preferred aspect of this invention, it has been found that valuable information can be obtained by measuring direct (i.e. specular) reflection in addition to diffuse reflection. Furthermore, arrangements according to the present invention have a geometrical structure which relies upon light paths for transmissive and reflective measurements which avoid the path taken by direct light reflection. Accordingly, it is particularly simple to provide such structures with the means for additionally detecting directly-reflected light.

[0038] This can be appreciated by referring again to Figure 1. It is easy to place an additional sensor 9 in the path 8 of the directly-reflected light, and this is all that is required to obtain the additional measurement; the light is provided by the same transmitter 4 as is used for diffuse-reflection and transmission measurements. A further sensor could be placed below the banknote path to detect directly-reflected light from the transmitter 4'.

[0039] A modified embodiment could therefore be constructed as shown in Figure 7. This is similar to Figure 2, except for the provision of additional sensors 9, 9' and focussing lenses 19, 19' for focussing directly-reflected light onto these sensors.

[0040] By additionally measuring directly-reflected light, it is possible to sense the state of the surface of the banknote. This could be useful for detecting, for example, shiny areas caused by metal strips incorporated into the banknote or by adhesive tape on the banknote. Additionally, or alternatively, the paper quality or texture could be sensed, for example to test the fitness of the banknote to determine whether it should be dispensed. The directly-reflected light could also, or alternatively, be used (possibly in combination with a diffuse-reflection measurement) to distinguish between intaglio-printed ink and ink of uniform thickness. The provision of sensors for detecting reflected light at different angles (i.e. the diffuse-reflectivity sensors 6,7 and the direct-reflectivity sensor 9) could also be useful in detecting optically-variable ink.

[0041] Figure 8 shows another embodiment of the invention, similar to Figure 5. The features described with respect to Figure 5 also apply to the embodiment of Figure 8, and like reference numbers represent like parts, except as indicated below.

[0042] The embodiment of Figure 8 is shown in a different orientation from that of Figure 5, incorporates sensors for receiving directly-reflected light and additionally has a modified structure as compared with the arrangement of Figure 5 in order to make it more compact and easier to assemble.

[0043] In Figure 5, the transmiters of the optical units 52 and 56 above the banknote path produce light paths which form an obtuse angle with respect to the direction of movement of the banknote; the transmitters of units 54 and 58 produce light paths which form an acute angle with respect to this direction. On the contrary, in Figure 8, the banknote path is bent and the angles formed by the light paths of the transmitters at the input side are opposite to the angles formed by the corresponding light paths at the output side. Thus, the transmitters of unit 52 on the left of the path at the inlet side produce light paths L52 which form an obtuse angle with respect to the direction S' of movement of the banknote, whereas the transmitters of the left unit 56 at the outlet produce light paths L56 which form an acute angle with respect to the direction S" of movement. Correspondingly, at the right side, the inlet unit 54 uses light paths L54 which are acute with respect to direction S' and the outlet unit 58 uses light paths L58 which are obtuse with respect to direction S".

[0044] The consequence of this is that all the units are mounted parallel to each other, with the upper units 52, 56 co-planar and the lower units 54, 58 also co-planar. This provides a more compact and conveniently assembled structure.

[0045] The direct-reflection light paths are shown in broken lines, with one of the direct-reflection sensors being shown at 9.

[0046] The arrangements described above all allow for particularly compact arrangements which scans the entire width of the banknote. However, other arrangements are possible. For example, the scanning direction could be different; in an alternative embodiment, banknotes are scanned in the direction T shown in Figures 1, 3 and 5, instead of the direction S. This might be appropriate if the banknote is to be scanned only along discrete tracks extending in the scanning direction, rather than completely across the banknote. In such an arrangement, it is less advantageous to have the light diverge in the plane containing the direction T.

Claims

1. Apparatus for sensing optical characteristics of a banknote, the apparatus comprising at least a first optical transmitter (4) located on one side of a path along which a banknote (2) can be moved in a scanning direction (S) in the plane (P1) of the banknote

for illuminating the banknote (2) by transmitting light in a direction which is inclined with respect to the normal (N) to the plane (P1) of the banknote (2), and at least a first optical receiver (6;7) for receiving light diffusely reflected from the banknote, **characterised by**:

the first transmitter (4) being arranged so that the light therefrom travels parallel to a sensing plane (P2) which contains a direction (T) that is substantially perpendicular to both the scanning direction (S) and the normal (N) to the plane (P1) of the banknote; the first receiver (6;7) being arranged to receive light from the first transmitter (4) which has been reflected by the banknote and which is also travelling in said sensing plane (P2), but in the opposite direction from the light emitted by the transmitter (4).

2. Apparatus as claimed in claim 1, further comprising a second optical transmitter (4') on the other side of the banknote path to the first optical transmitter (4), the first receiver (6;7) being arranged to sense light transmitted via the banknote (2) from the second transmitter (4').

3. Apparatus as claimed in claim 1, including a second optical receiver (6';7') arranged to sense light transmitted from the second transmitter (4') and diffusely reflected by the banknote (2).

4. Apparatus as claimed in claim 3, the second receiver (6';7') being arranged to sense light transmitted via the banknote (2) from the first transmitter (4).

5. Apparatus as claimed in claim 1', wherein the light from the first transmitter (4) diverges when viewed in said sensing plane (P2) as it travels to the banknote, so as to illuminate an area which is elongate and extends in a direction (T) traverse to the scanning direction (S).

6. Apparatus as claimed in claim 5, including first and second light receivers (6,7) both located on said one side of the path, each light receiver (6,7) being arranged to receive light from the first transmitter (4) which has been diffusely reflected by an area (10', 10") of the banknote, the areas (10',10") from which the first and second receivers (6,7) receive light being displaced in a direction (T) transverse to the scanning direction (S).

7. Apparatus as claimed in any preceding claim, including collimating means for preventing the light from the first transmitter (4) from diverging when viewed in a plane (P3) containing the scanning direction (S) and the normal (N) to the plane (P1) of the banknote (2).

8. Apparatus as claimed in any preceding claim, including a further optical receiver (9) arranged to sense light transmitted from the first transmitter (4) and specularly reflected by the banknote (2).

9. Apparatus as claimed in any preceding claim, wherein the first transmitter and the first receiver are mounted on a common circuit board.

10. Apparatus as claimed in any preceding claim, including a set of devices (3) each comprising a respective first receiver (6;7) and a respective first transmitter (4), each device (3) thereby being arranged to scan a respective area of one side of the banknote (2), the areas being displaced from each other in a direction (T) transverse to the scanning direction (S).

11. Apparatus as claimed in claim 10, including a further set of devices for scanning areas of said one side, each of which areas is located between areas scanned by the first set of devices.

12. Apparatus as claimed in claim 11, wherein the respective sets of devices are disposed in succession along a banknote path, one set of devices being adjacent a first part of the banknote path and defining a light path to the banknote at a first angle with respect to the direction of movement of the banknote and the other set of devices being adjacent a second part of the banknote path and defining a light path to the banknote at a second angle with respect to said direction of movement, the first and second banknote path parts being inclined with respect to each other, one of the first and second angles being acute and the other of the first and second angles being obtuse.

13. Apparatus as claimed in any one of claims 10 to 12, including a further set of devices for scanning areas of the opposite side of the banknote.

14. Apparatus as claimed in any preceding claim, further including a reference body (64) and means for moving the reference body between a first position located within the apparatus but out of the banknote path and a second position in any one of said light paths, and means for performing a calibration operation based on the output of at least one optical receiver (6; 7) when the reference body is in the second position.

15. Apparatus as claimed in claim 14, wherein the calibration operation calibrates transmission measurements.

16. Apparatus as claimed in claim 14 or claim 15, wherein the calibration operation calibrates reflectance measurements.

Patentansprüche

1. Vorrichtung zur Erfassung von optischen Eigenschaften eines Geldscheins, die Vorrichtung umfassend mindestens einen ersten optischen Sender (4), der auf einer Seite eines Pfades, entlang dem sich ein Geldschein (2) in einer Abtastrichtung (S) in der Ebene (P1) des Geldscheins bewegt werden kann, um den Geldschein (2) durch Aussenden von Licht in einer Richtung, die in Bezug auf die Normale (N) der Ebene (P1) der Banknote (2) geneigt ist, zu beleuchten, und mindestens einen ersten optischen Empfänger (6;7), zum Empfangen von Licht, das vom Geldschein diffus reflektiert wird, **dadurch gekennzeichnet, dass**:

   der erste Sender (4) so angeordnet ist, dass das Licht davon parallel zu einer Erfassungsebene (P2) läuft, die eine Richtung (T) beinhaltet, die im Wesentlichen rechtwinklig sowohl zu der Abtastrichtung (S) und der Normalen (N) der Ebene (P1) des Geldscheins ist; und der erste Empfänger (6;7) angeordnet ist, Licht des ersten Senders (4) zu empfangen, das durch den Geldschein reflektiert wurde und das auch in der Erfassungsebene (P2) läuft, aber in entgegengesetzter Richtung des Lichtes, das durch den Sender (4) ausgesendet wird.

2. Vorrichtung nach Anspruch 1, weiter umfassend einen zweiten optischen Sender (4') auf der anderen Seite des Geldscheinpfades zu dem ersten optischen Sender (4), wobei der erste Empfänger (6;7) angeordnet ist, um Licht zu erfassen, das von dem zweiten Sender (4') über den Geldschein (2) ausgesendet wird.

3. Vorrichtung nach Anspruch 1, beinhaltend einen zweiten optischen Empfänger (6';7'), angeordnet, um Licht zu erfassen, das von dem zweiten Sender (4') ausgesendet und durch den Geldschein diffus reflektiert wird.

4. Vorrichtung nach Anspruch 3, wobei der zweite Empfänger (6';7') angeordnet ist, um Licht zu erfassen, das von dem ersten Sender (4) über die Banknote (2) ausgesendet wird.

5. Vorrichtung nach Anspruch 1, wobei das Licht des ersten Senders (4) auseinander läuft, während es zu dem Geldschein läuft, wenn besehen in der Erfassungsebene (P2), um eine Fläche zu beleuchten, die länglich ist und sich in einer Richtung (T) erstreckt, die quer zu der Abtastrichtung (S) ist.

6. Vorrichtung nach Anspruch 5, beinhaltend erste und zweite Lichtempfänger (6,7), beide befindlich auf der einen Seite des Pfades, wobei jeder Lichtempfänger (6,7) angeordnet ist, um Licht von dem ersten Sender (4) zu empfangen, das von einer Fläche (10',10") des Geldscheins diffus reflektiert wurde, wobei die Flächen (10',10"), von denen die ersten und zweiten Empfänger (6,7) Licht empfangen, in einer Richtung (T), die quer zu der Abtastrichtung (S) verläuft, versetzt sind.

7. Vorrichtung nach einem der vorhergehenden Ansprüche, beinhaltend Kollimierungsmittel, um das Licht des ersten Senders (4) davon abzuhalten, auseinander zu laufen, wenn besehen in einer Ebene (P3), die die die Abtastrichtung (S) und die Normale (N) zur Ebene (P1) des Geldscheins (2) enthält.

8. Vorrichtung nach einem der vorhergehenden Ansprüche, beinhaltend einen weiteren optischen Empfänger (9), angeordnet, um Licht zu erfassen, das von dem ersten Sender (4) ausgesendet und von dem Geldschein (2) spiegelnd reflektiert wird.

9. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei der erste Sender und der erste Empfänger auf einer gemeinsamen Platine befestigt sind.

10. Vorrichtung nach einem der vorhergehenden Ansprüche, beinhaltend eine Menge von Vorrichtungen (3), jede umfassend einen entsprechenden ersten Empfänger (6;7) und einen entsprechenden ersten Sender (4), wobei jede Vorrichtung (3) **dadurch** angeordnet ist, um eine entsprechende Fläche von einer Seite des Geldscheins (2) abzutasten, wobei die Flächen zueinander in einer Richtung (T), quer zur Abtastrichtung (S), versetzt sind.

11. Vorrichtung nach Anspruch 10, beinhaltend eine weitere Menge von Vorrichtungen zum Abtasten von Flächen der einen Seite, wobei jede der Flächen sich zwischen Flächen befindet, die von der ersten Menge an Vorrichtungen abgetastet werden.

12. Vorrichtung nach Anspruch 11, wobei die entsprechenden Mengen von Vorrichtungen nacheinander entlang einem Geldscheinpfad angeordnet sind, wobei eine Menge von Vorrichtungen neben einem ersten Teil des Geldscheinpfades ist und einen Lichtpfad auf den Geldschein in einem ersten Winkel in Bezug auf die Bewegungsrichtung des Geldscheins definiert und die andere Menge von Vorrichtungen benachbart zu einem zweiten Teil des Geldscheinpfades ist und einen Lichtpfad auf den Geldschein in einem zweiten Winkel in Bezug auf die Bewegungsrichtung definiert, wobei die ersten und zweiten Geldscheinpfadteile in Bezug aufeinander geneigt sind, wobei einer der ersten und zweiten Winkel spitz und der andere der ersten und zweiten Winkel stumpf ist.

13. Vorrichtung nach einem der Ansprüche 10 bis 12, beinhaltend eine weitere Menge von Vorrichtungen zum Abtasten von Flächen der gegenüberliegenden Seite des Geldscheins.

14. Vorrichtung nach einem der vorhergehenden Ansprüche, weiter beinhaltend einen Referenzkörper (64) und Mittel zum Bewegen des Referenzkörpers zwischen einer ersten Position, die sich innerhalb der Vorrichtung aber außerhalb des Geldscheinpfades befindet, und einer zweiten Position in irgendeinem der Lichtpfade, und Mittel zum Durchführen einer Kalibrierungsoperation, basierend auf der Ausgabe von mindestens einem optischen Empfänger (6;7), wenn der Referenzkörper in der zweiten Position ist.

15. Vorrichtung nach Anspruch 14, wobei die Kalibrierungsoperation Transmissionsmessungen kalibriert.

16. Vorrichtung nach Anspruch 14 oder 15, wobei die Kalibrierungsoperation Reflektierungsmessungen kalibriert.

Revendications

1. Appareil pour détecter les caractéristiques optiques d'un billet de banque, l'appareil comportant au moins un premier transmetteur optique (4) situé d'un côté d'un trajet le long duquel un billet de banque (2) peut être déplacé selon une direction de scannage (S) dans le plan (P1) du billet de banque pour illuminer le billet de banque (2) en transmettant de la lumière dans une direction qui est inclinée par rapport à la normale (N) au plan (P1) du billet de banque (2), et au moins un premier récepteur optique (6 ; 7) pour recevoir de la lumière réfléchie de manière diffuse depuis le billet de banque, **caractérisé par** :

le premier transmetteur (4) étant agencé de façon que la lumière, depuis celui-ci, est transmise parallèlement à un plan de détection (P2) qui contient une direction (T) qui est sensiblement perpendiculaire à la fois à la direction de scannage (S) et à la normale (N) au plan (P1) du billet de banque ; le premier récepteur (6 ;7) étant agencé de façon à recevoir la lumière depuis le premier transmetteur (4) qui a été réfléchie par le billet de banque et qui est transmise aussi dans ledit plan de détection (P2), mais dans la direction opposé à celle de la lumière émise par le transmetteur (4).

2. Appareil selon la revendication 1, comportant de plus un deuxième transmetteur optique (4') de l'autre côté du trajet du billet de banque au premier transmetteur optique (4), le premier récepteur (6 ; 7) étant agencé pour détecter la lumière transmise via le billet de banque (2) depuis le deuxième transmetteur (4').

3. Appareil selon la revendication 1, comportant un deuxième récepteur optique (6' ; 7') disposé pour détecter la lumière transmise par le deuxième transmetteur (4') et réfléchie de manière diffuse par le billet de banque (2).

4. Appareil selon la revendication 3, le deuxième récepteur (6' ; 7') étant disposé pour détecter la lumière transmise via le billet de banque (2) depuis le premier transmetteur (4).

5. Appareil selon la revendication 1, dans lequel la lumière depuis le premier transmetteur (4) diverge lorsqu'elle est vue dans ledit plan de détection (P2) lorsqu'elle est transmise vers le billet de banque (2), de façon à illuminer une zone qui est allongée et qui s'étend dans la direction (T) transverse à la direction de scannage (S).

6. Appareil selon la revendication 5, comportant un premier et un deuxième récepteurs de lumière (6 ; 7), tous les deux situés sur ledit un côté du trajet, chaque récepteur de lumière (6 ; 7) étant disposé pour recevoir de la lumière depuis le premier transmetteur (4) qui a été réfléchie de manière diffuse par une zone (10', 10") du billet de banque, les zones (10', 10") à partir desquelles les premier et deuxième récepteurs (6 ; 7) reçoivent de la lumière étant déplacées dans une direction (T) transverse à la direction de scannage (S).

7. Appareil selon l'une quelconque des revendications précédentes, comportant des moyens de collimatage pour éviter que la lumière provenant du premier transmetteur (4) ne diverge lorsqu'elle est vue dans un plan (P3) contenant la direction de scannage (S) et la normale (N) au plan (P1) du billet de banque (2).

8. Appareil selon l'une quelconque des revendications précédentes, comportant un récepteur optique supplémentaire (9) disposé pour détecter la lumière transmise depuis le premier transmetteur (4) et réfléchie de manière spéculaire par le billet de banque (2).

9. Appareil selon l'une quelconque des revendications précédentes, dans lequel le premier transmetteur et le premier récepteur sont montés sur une plaque à circuits imprimés commune.

10. Appareil selon l'une quelconque des revendications précédentes, comportant un jeu de dispositifs (3) comportant chacun respectivement un premier récepteur (6 ; 7) et un premier transmetteur (4), chaque

dispositif (3) étant ainsi disposé pour scanner une zone respective d'un côté du billet de banque (2), les zones étant déplacées l'une par rapport à l'autre dans la direction (T) transverse à la direction de scannage (S).

11. Appareil selon la revendication 10, comportant un jeu supplémentaire de dispositifs pour des zones de scannage dudit un côté, chacune desdites zones étant située entre des zones scannées par le premier jeu de dispositifs.

12. Appareil selon la revendication 11, dans lequel les jeux respectifs de dispositifs sont disposés en succession le long du trajet d'un billet de banque, un jeu de dispositifs étant adjacent à une première partie du trajet du billet de banque et définissant un trajet de lumière au billet de banque selon un premier angle par rapport à la direction de déplacement du billet de banque et l'autre jeu de dispositifs étant adjacent à une seconde partie du trajet du billet de banque et définissant un trajet de lumière au billet de banque selon un deuxième angle par rapport à ladite direction de déplacement, les première et deuxième parties du trajet du billet de banque étant inclinées l'une par rapport à l'autre, un des premier et deuxième angles étant aigu et l'autre des premier et deuxième angle étant obtus.

13. Appareil selon l'une quelconque des revendications 10 à 12, comportant un jeu supplémentaire de dispositifs pour scanner des zones du côté opposé du billet de banque.

14. Appareil selon l'une quelconque des revendications précédentes, comportant de plus un corps (64) de référence et des moyens pour déplacer le corps de référence entre une première position située à l'intérieur de l'appareil, mais en dehors du trajet du billet de banque et une deuxième position dans n'importe lequel desdits trajets de lumière, et des moyens pour réaliser une opération de calibrage sur la base de la sortie d'au moins un récepteur optique (6 ; 7) lorsque le corps de référence est dans la deuxième position.

15. Appareil selon la revendication 14, dans lequel l'opération de calibrage calibre des mesures de transmission.

16. Appareil selon la revendication 14 ou 15, dans lequel l'opération de calibrage calibre des mesures de réflectance.

FIGURE 1

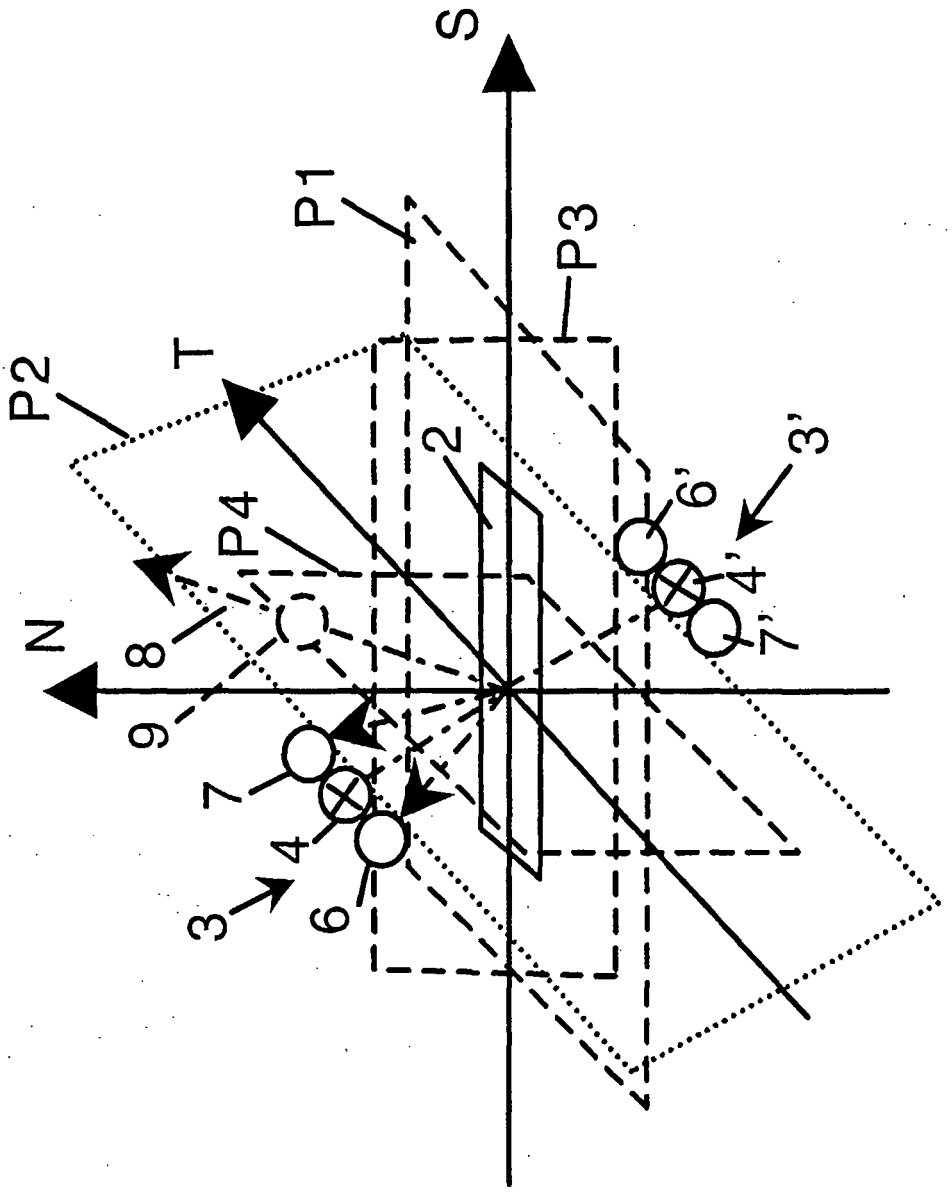


FIGURE 2

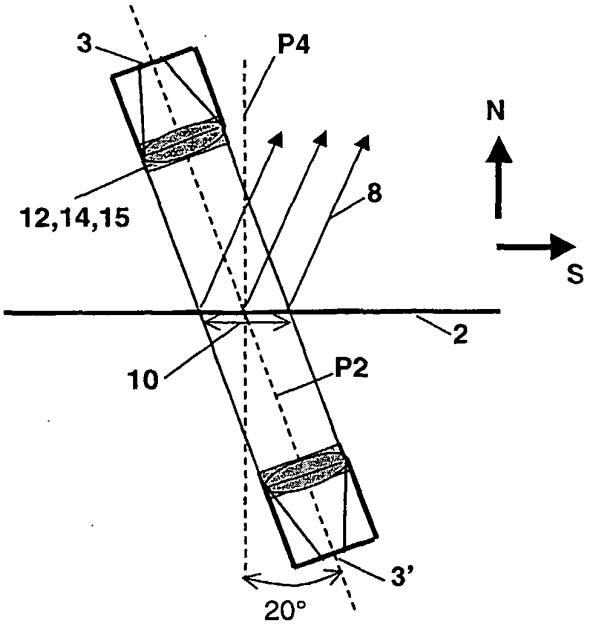


FIGURE 3

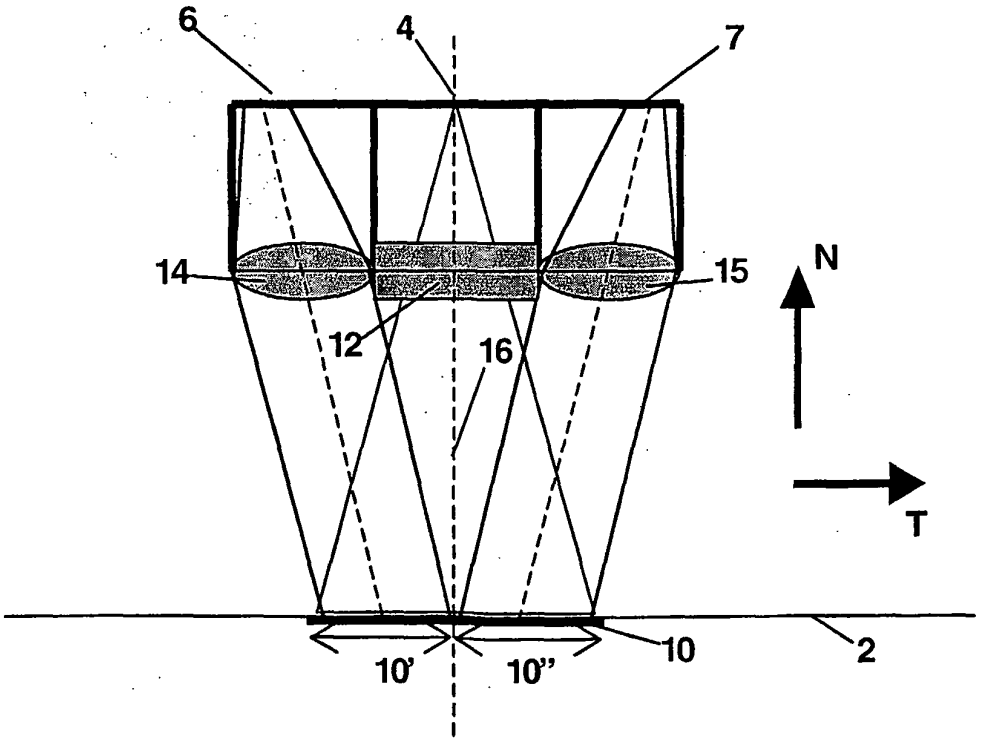


FIGURE 4

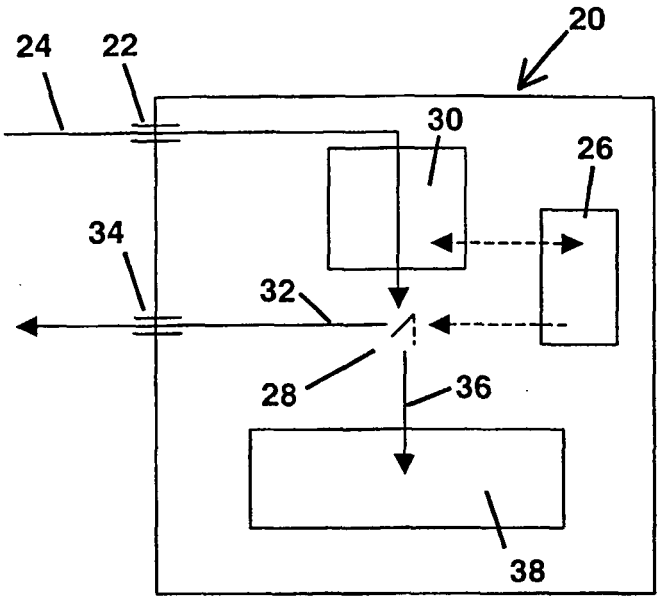
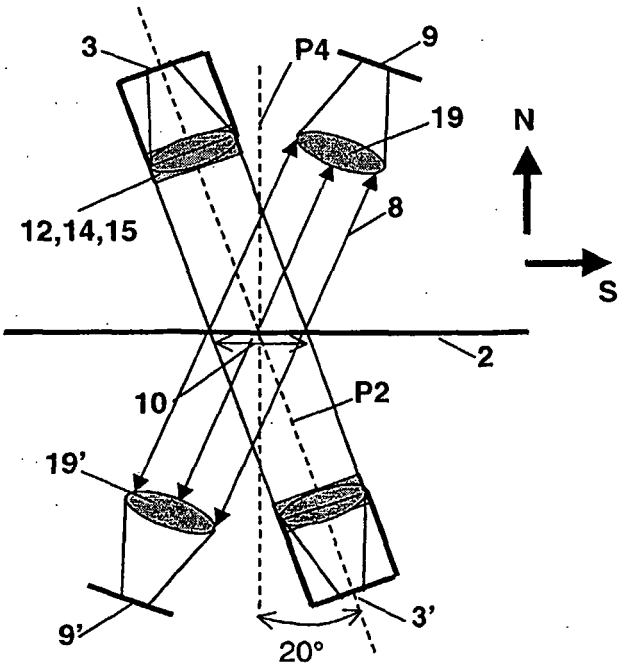


FIGURE 7



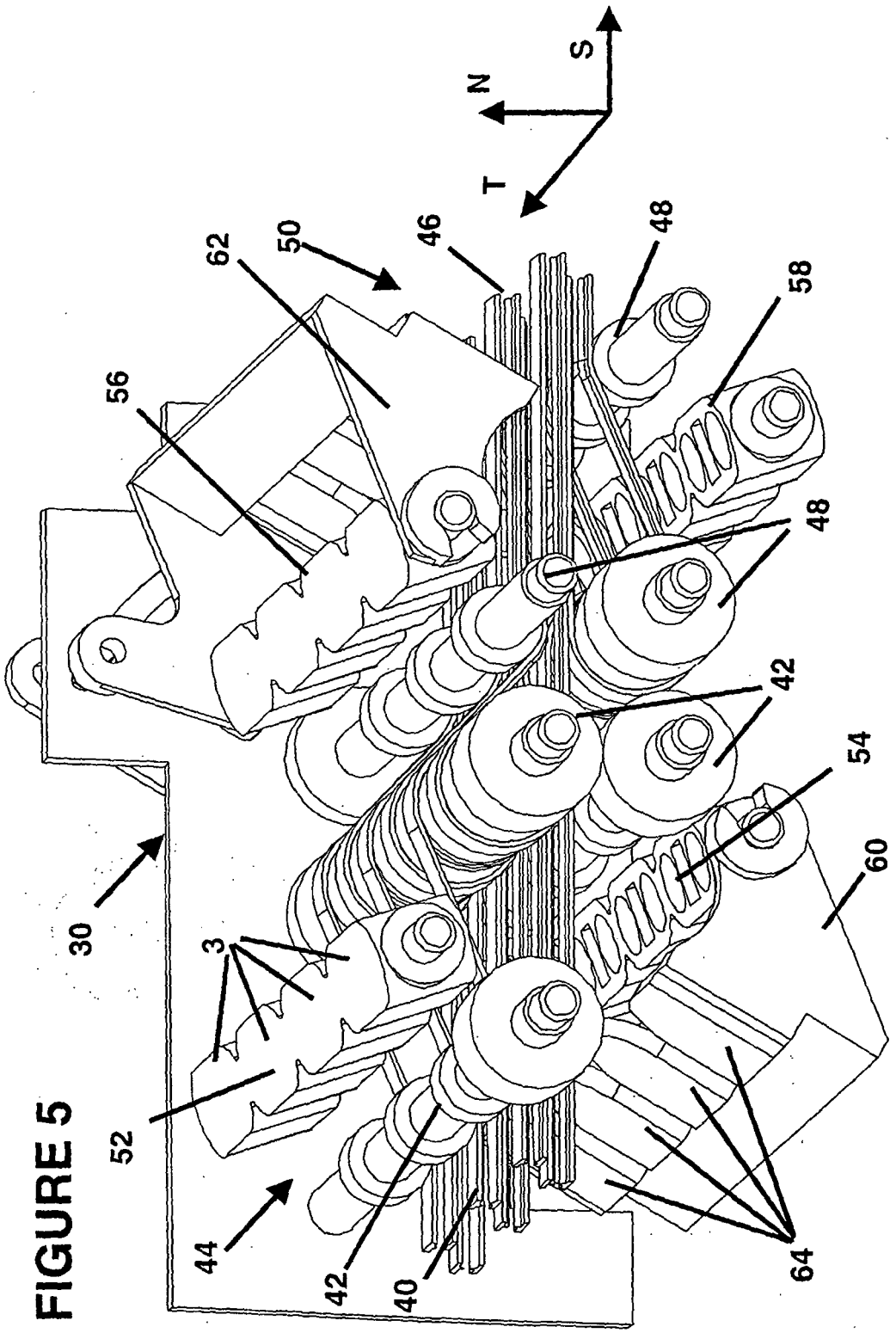


FIGURE 5

FIGURE 6

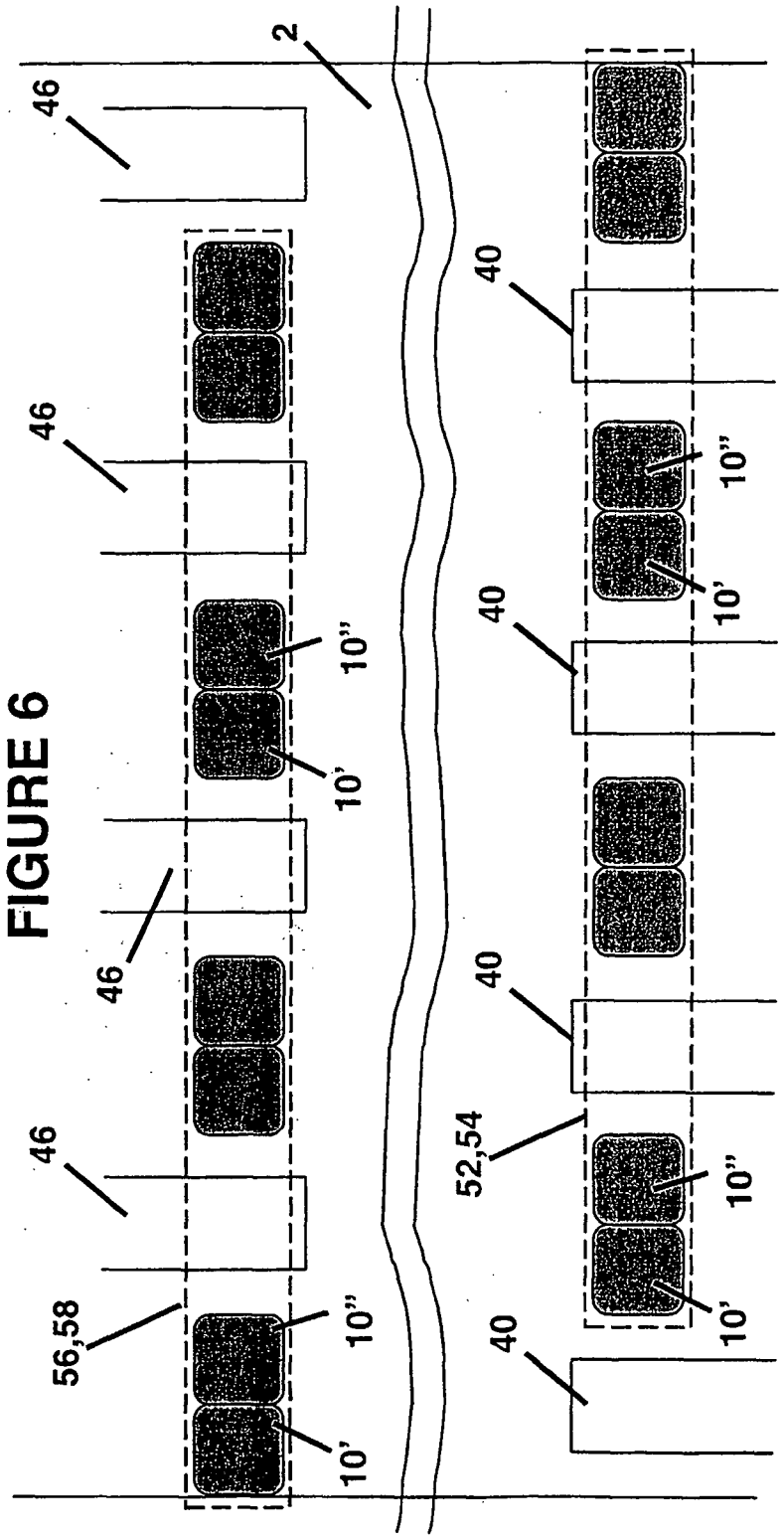
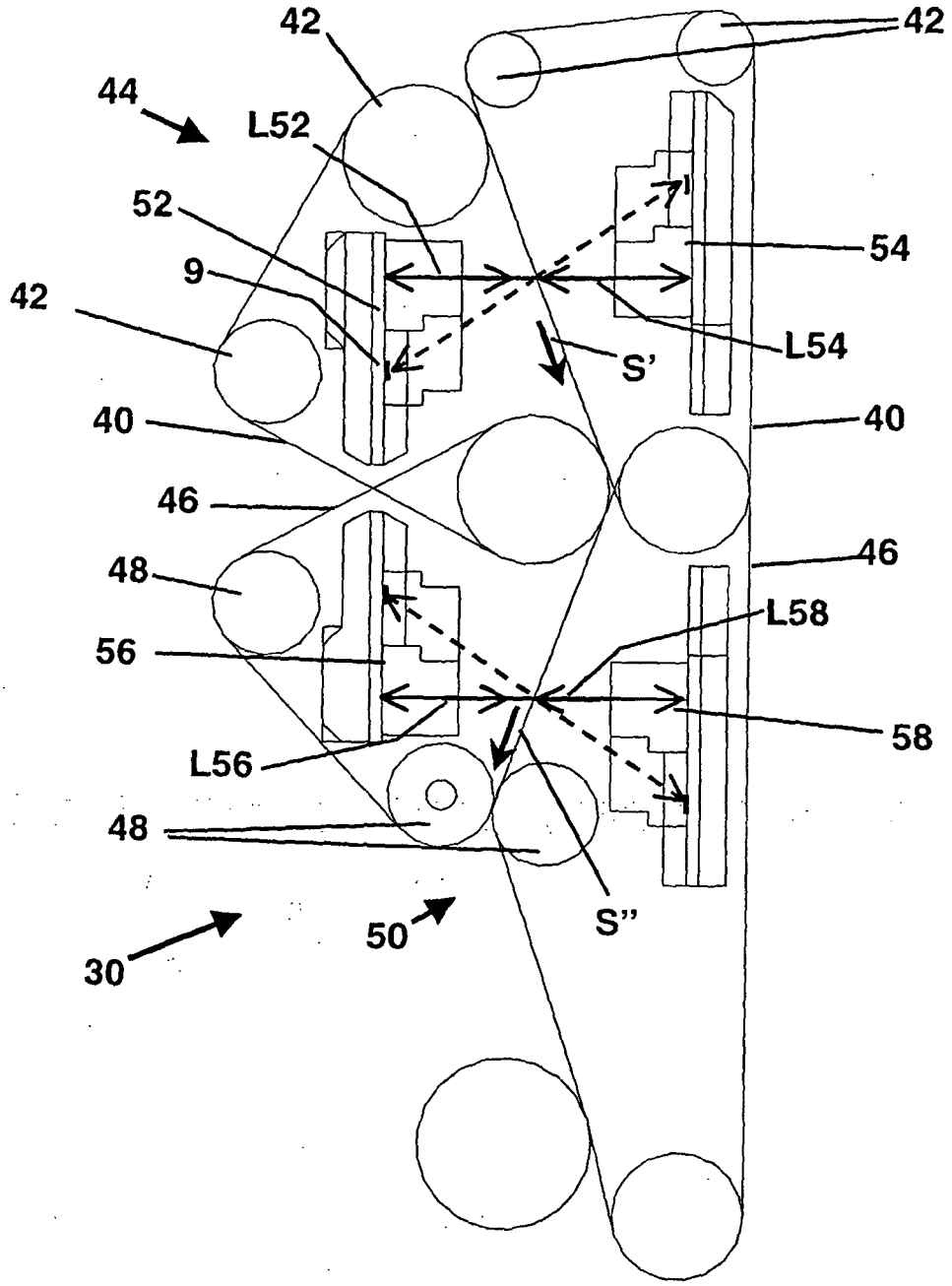


FIGURE 8



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 0537513 A **[0003]**
- EP 0718809 A **[0004]**
- US 6061121 A **[0006]**
- EP 0731737 A **[0011]**