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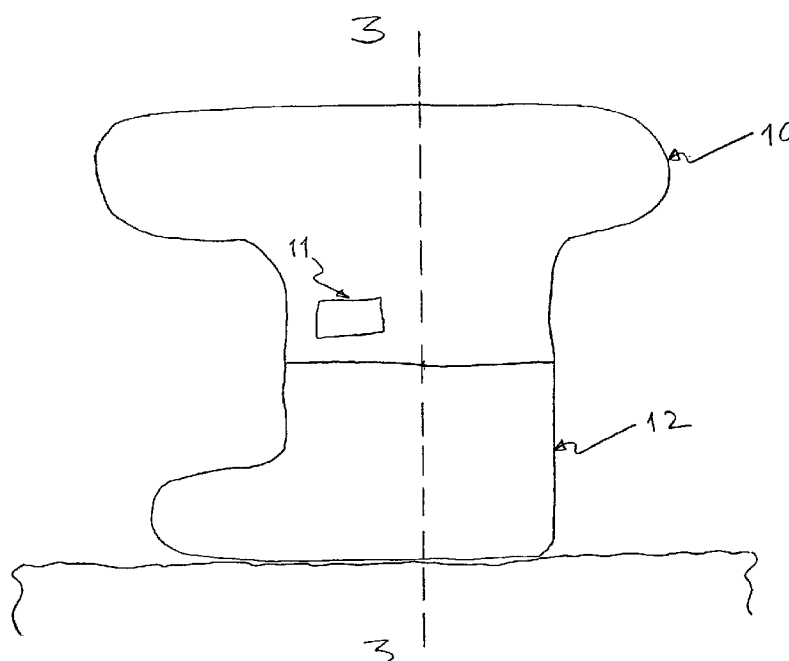
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))
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(54) Title: IMAGE ANALYSIS SYSTEM WITH INTERCHANGEABLE FUNCTIONALITIES



(57) Abstract: An electronic loupe having an electronic receptor/processing/communication portion and interchangeable light/lens portions.

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TITLE OF THE INVENTION

Image Analysis System With Interchangeable Functionalities

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CROSS REFERENCE TO RELATED APPLICATIONS

This application claims benefit under 35 U.S.C. §120 of U.S. Application No. 10/416,876 filed May 15, 2003, which claims the benefit under 35 U.S.C. §119(e) of U.S. Provisional Application Nos. 60/296,615 filed June 7, 2001; 60/287,947 filed May 1, 2001; and 60/248,897 filed November 15, 2000, the disclosures of which are hereby incorporated by reference.

Also, this application claims benefit under 35 U.S.C. §120 of 11/204,752 filed August 15, 2005, which claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Application Nos. 60/794,697 filed April 25, 2006; 60/678,460 filed on May 6, 2005; 60/674,360 filed on April 22, 2005; and 60/601,220 filed on August 24, 2004, the disclosures of which are incorporated by reference herein.

And, this application claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Application Nos. 60/794,697 filed April 25, 2006; 60/678,460 filed May 6, 2005; 60/674,360 filed April 22, 2005; 60/601,220 filed August 24, 2004; 60/296,615 filed June 7, 2001; 60/287,947 filed May 1, 2001; and 60/248,897 filed November 15, 2000, the disclosures of which are incorporated by reference herein.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

N/A

BACKGROUND OF THE INVENTION

5 In addition, the range of applications for which a portable instrument may be used is vast, placing great burdens on such a device.

 In one application in printing of documents and images from computer sources on laser and ink jet printers, the quality and resolution as well as consistency of the image becomes
10 increasingly important. This is particularly so in reproduction of images having fine detail or with small font size prints.

 The quality of the image is a function not only of the printer quality and characteristics including print head
15 characteristics but importantly of the quality of the actual paper, whether by not a normal soft surface fiber based paper or a more glossy paper designed for printing color images. Accordingly, it is important to be able to determine the ultimate print quality, or as used herein, "distinctness of image." This
20 is important both for quality control and the production of papers in production plants as well as for user selection and buying decisions in office, retail and wholesale environments.

BRIEF SUMMARY OF THE INVENTION

25 The present invention provides the flexibility of a portable image analyzer with the flexibility of adapting to many different analysis environments. This is accomplished with interchangeable parts which allow the more expensive equipment, such as CCD
30 substrate and processing electronics, to be provided in a common imaging head. The parts that need to accommodate different uses, such as illumination sources and lens design, and are at the same time less costly, to be of different design in a plurality of

differently configured light and/or lens (LL) housings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

5 These and other features of the present invention are described in the detailed description below and the accompanying drawing of which:

 Fig. 1 shows an image head with an LL housing attached;

 Fig. 2 shows an imaging head detached from a plurality of LL
10 housings;

 Fig. 3 shows a cross section of an imaging head with a typical LL housing;

 Fig. 4 shows an interconnection mechanism for reversibly attaching an imaging head to an LL housing;

15 Fig. 5 shows an application of the invention with an LL housing for analyzing the distinctness of image (DOI) as a figure of merit for printable paper characteristics;

 Figs. 6a and 6b show light distribution from the application of the invention to DOI analysis.

20

DETAILED DESCRIPTION OF THE INVENTION

 In furtherance of an understanding of the invention, the
25 disclosures of published US Applications Nos. 10/416,876 and 11/204,752 are incorporated herein by reference as examples of the processing range of applications to which the invention is adaptable.

 The invention can begun to be understood by reference first
30 to figs. 1 and 2. In Fig. 1 an image analyzer of the invention is shown with a image head 10, with an on/off switch/toggle 11 and LL housing 12 attached to each other. In Fig. 2 the units are shown apart with their attachment faces 14 and 16 respectively showing.

The image head 10 has an aperture 18 with lateral openings 20 to accommodate neck 22 and wings 24 of the LL housings in locking embrace. To provide electrical operating poser to the LL housings 12 contacts in areas 26 of the faces are provided.

5 The imaging head 10 and LL housing 12 are shown in section in Fig. 3 along the section lines shown in Fig. 2. The LL housing 12 is adapted to be placed over a substrate 30 having surface features to be analyzed. An aperture 32 allows light to pass into the LL housing and filter 34 may be secured therein for spectrum
10 specific analysis. The filter may be used in aperture 18, or in both, where return light for analysis only is to be filtered. Illumination sources 36 may be placed peripherally and out of the imaging light path within the housing 12 with their radiation directed through the aperture 32 onto the substrate. The sources
15 36 in some housings may be flash sources alone or in combination, under a control 37. In some analyses, the illumination originates below the LL housing from a source 36 and the light to be analyzed is that passing through the substrate 30.

A lens 38, with a zoom control in some housings, adapted to
20 the specific test such as by being telephoto or wide angle or anywhere in between is mounted in the housing. Light is focused through the aperture 40 in the collar 22 into the imaging head 10 and onto a 2D photo receptor such as a CCD array 42. For use in some applications, an auxiliary lens 44 may be included, or placed
25 through a slot, in the imaging head. The CCD detector may be high resolution, low res or have its center high res and the outer parts less high.

A processor 46 does some image analysis and displays it or the image on a screen 48. The raw or partially processed image
30 information can the be transmitted or a USB link 50 or by wi-fi, Bluetooth, or other technologies to a computer 52 for more robust processing as described below and in the art. Computer can have I?O connections 54 to printers, displays or the WEB 56

Electrical connections may be via the faces 14 and 16 in areas 26 as shown in contacts or via contacts 62 on the wings 24 and mating surfaces 64 within head 10 as shown in Fig. 4.

5 Among the processing and analyses provided in the invention and for which the LL housings 12 are particularly adapted are shown in the following table with the features of an LL housing specially adapted to that use:

TYPE OF ANALYSIS	LL HOUSING CONSIDERATONS
1. Dot analysis (area, diameter, perimeter, box ratio, circularity).	1. High lens magnification with low distortion and arreation.
2. Line edge uniformity analysis (blur, rag, width).	2. Low distortion with angular view appropriate for the line length. May use more than one housing.
3. Uniformity of area printing (grain, mottle, density, reflectivity).	3. Lens with uniform imaging intensity and low aberration or spacial distortion.
4. Fingerprint recording or analysis.	4. Conformance to local/federal standards which may change form time to time requiring new housing.
5. Color correctness.	5. Broad spectrum light and lens, possibly different filters in each housing.
6. Modulation transfer function	6. Per requirements
7. print image analysis, text analysis, barcode analysis, indicia analysis, watermark analysis, feature analysis, physical surface analysis, and forensic analysis.	7. Multi function with zoom lens.
8. transmitter light, e.g. through a semi transparent material	8. lens only, possibly with adjustable focus

Another application is for distinctness of image analysis which requires imaging a knife edge onto a printing paper to see how diffuse the paper or other substrate is as a measure of its printability. A LL housing for this application is illustrated at
5 Fig. 5 in which the light source 70 is a projected laser or other beam that has a sharp light to dark transition. The integral of that light pattern 74 is shown in Fig. 6a as a distribution 76 having a sharp peak 78. A very soft or fuzzy surface paper will have a correspondingly indistinct image 80 as shown in Fig. 6b
10 with a broad distribution 82 and spread peak 84.

CLAIMS

What is claimed is:

- 5 1. A device for analyzing a characteristic of a surface comprising:
- a first and a second selectively attachable and detachable housing portion, the first housing portion housing a source and a lens, said second housing portion housing processing
- 10 electronics;
- a detector being housed in one of said first and second housing portions;
- the source configured to illuminate a first plane, to which said surface can be placed, with an electromagnetic radiation;
- 15 said lens configured to image a surface at said first plane onto a second plane;
- the detector arranged to receive electromagnetic radiation from said surface over an area at said second plane and configured to provide an output representative of said electromagnetic
- 20 radiation; and
- processing electronics configured to process said output into an information representative of characteristics of light at said surface.
- 25 2. The device of claim 1 wherein a connection/disconnection mechanism is provided in said first and second housing portions to allow a secure attachment of said first and second housing portions together.
- 30 3. The device of claim 1 or 2 further comprising a plurality of first housing portions each having one said source and one said

lens wherein at least one of said lens and said source is different between each of the plurality of first housing portions.

4. The device of claim 3 wherein one of said housing portions
5 contains only a lens and said processing electronics is configured to analyze electromagnetic radiation transmitted through said second plane.

5. The device of claim 1 wherein said surface includes an
10 image.

6. The device of any of claims 1-4 wherein said processing electronics is configured to analyze an image reflected to said second plane.

15 7. The device of any of claims 1-6 wherein said processing electronics is configured to analyze a plurality of dimensions of said surface.

20 8. The device of any of claims 1-7 including means for adjusting a focal length of the lens.

9. The device of any one of claims 1-8 further including a filter for said electromagnetic radiation.

25 10. The device of any of claims 1-9 wherein the device comprises a switch for activating the source and processing electronics.

11. The device of any of claims 1-10 wherein the source
30 comprises a flash source.

12. The device of any of claims 1-11 further comprising a communication link in said second housing portion.

13. The device of claim 12 wherein said processing electronics shares its processing function over said communication link with a remote processing capability.

5

14. The device of any of claims 1-13 wherein the information includes at least one of print image analysis, text analysis, barcode analysis, indicia analysis, watermark analysis, feature analysis, physical surface analysis, and forensic analysis.

10

15. The device of any of claims 1-13 wherein the information includes the result of an analysis selected from the group consisting of:

dot analysis,
line analysis,
area analysis,
distinctness of image,
modulation transfer function, and
tone reproduction analysis.

15

20

16. The device of any of claims 1-13 wherein said information includes information on at least one of a display, a food item, a biological specimen, electronic paper with or without printing, paper with or with printing, a security feature, a dermatological feature, reproduction tone, spectrum of said radiation; and intensity distribution.

25

30

17. The device of any of claims 1-13 wherein said processing electronics is adapted for analyzing at least one of a dot property, a line property, an edge property, and an area property.

18. The device of any of claims 1-13 wherein said processing electronics is adapted for calibrating a density.

19. The device of any of claims 1-13 wherein said processing electronics is adapted for analyzing a spatial frequency response.

5 20. The device of any of claims 1-13 wherein said processing electronics is adapted for analyzing a color registration.

21. The device of any of claims 1-13 wherein said processing electronics is adapted for analyzing a tone reproduction.

10

22. A method for analyzing a characteristic of a surface, the method comprising the steps of:

15 illuminating a subject from radiation emitted from a first selectively attachable and detachable housing portion, the first housing portion housing a source and a lens;

detecting in a second housing portion, selectively attachable and detachable with said first portion, radiation from said subject to provide an output representative of said subject.

20 23. The method of claim 22 further including the a step of analyzing said the radiation for one or more subject characteristics.

25 24. The method of any of claims 23 wherein the step of analyzing further includes a step of analyzing a plurality of subject characteristics and changing said first portions one or more of times to accommodate one or more of the analyzing steps.

30 25. The method of any of claims 24 wherein the method further includes a step of adjusting a focal length of the lens in said first portion.

26. The method of claim 22 further including a step of filtering said electromagnetic radiation.

27. The method of any of claims 22 wherein the step of
5 illuminating further comprises a step of flash illuminating.

28. The method of any of claims 22-27 wherein the method further includes a step of communicating said output representation to a remote processing capability.

10 29. The method of claim 28 further including processing the communicated output representation at said remote capability.

30. The method of any of claims 22-29 wherein the output
15 representation includes information reflecting one or more of:
print image analysis, text analysis, barcode analysis,
indicia analysis, watermark analysis, feature analysis, physical
surface analysis, and forensic analysis.

20 31. The method of any of claims 22-30 wherein the output representation includes information reflecting one or more of:
dot analysis,
line analysis,
area analysis,
25 distinctness of image,
modulation transfer function, and
tone reproduction analysis.

32. The method of any of claims 22-31 wherein the step of
30 illuminating includes illuminating at least one of a display, a food item, a biological specimen, electronic paper with or without printing, paper with or with printing, a security feature, a

dermatological feature, reproduction tone, spectrum of said radiation; and intensity distribution.

5 33. The method of any of claims 22-32 wherein the output representation includes information reflecting one or more of a dot property, a line property, an edge property, a color registration, a tone reproduction, a density property, and an area property.

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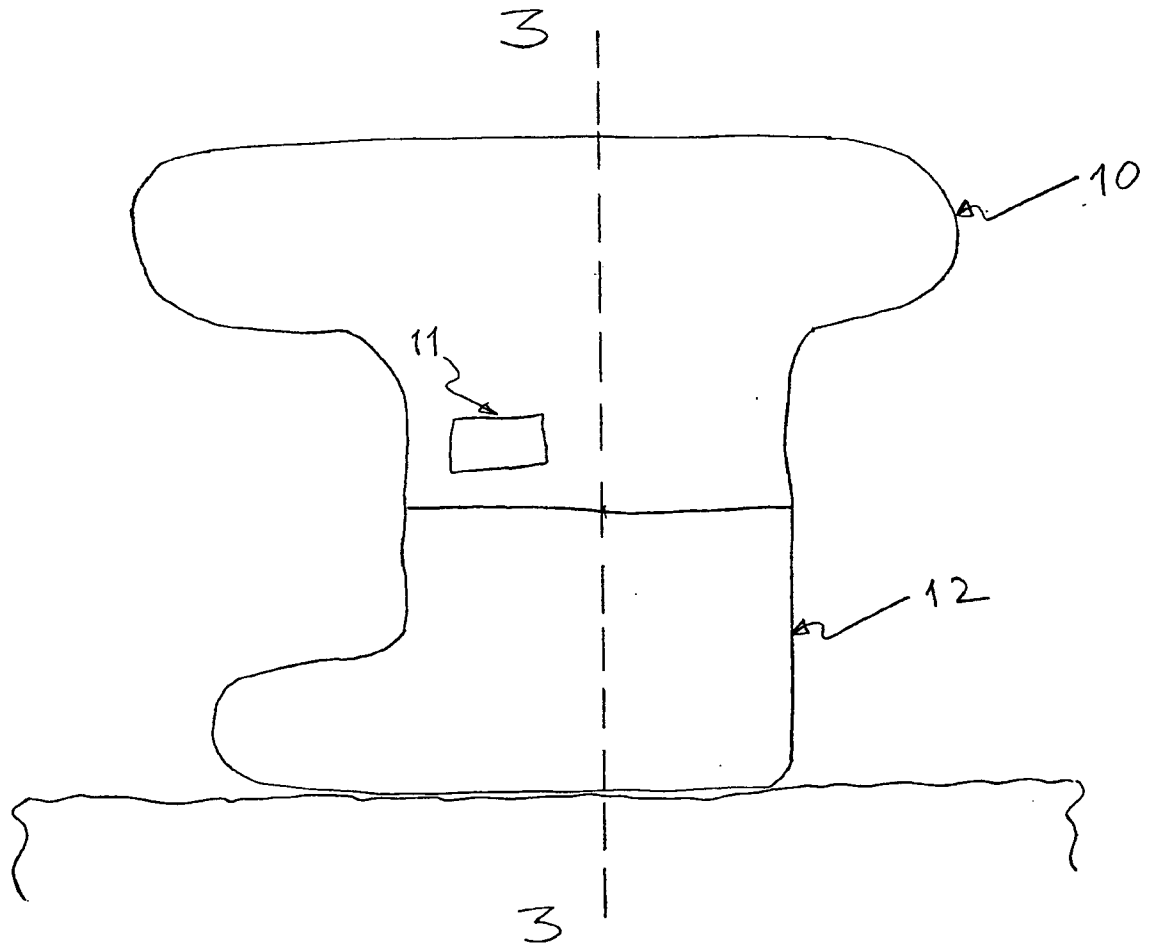


FIG. 1

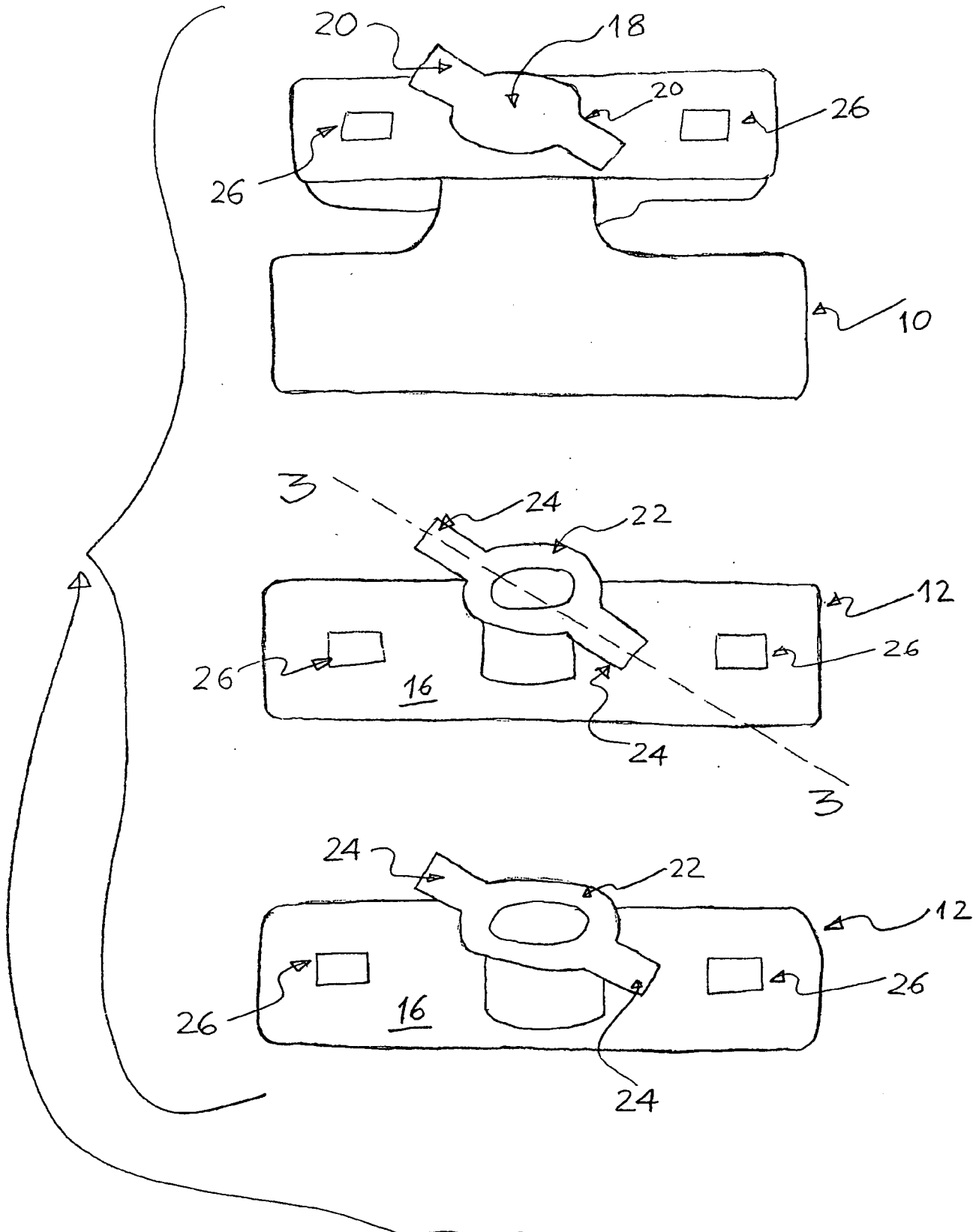


FIG. 2

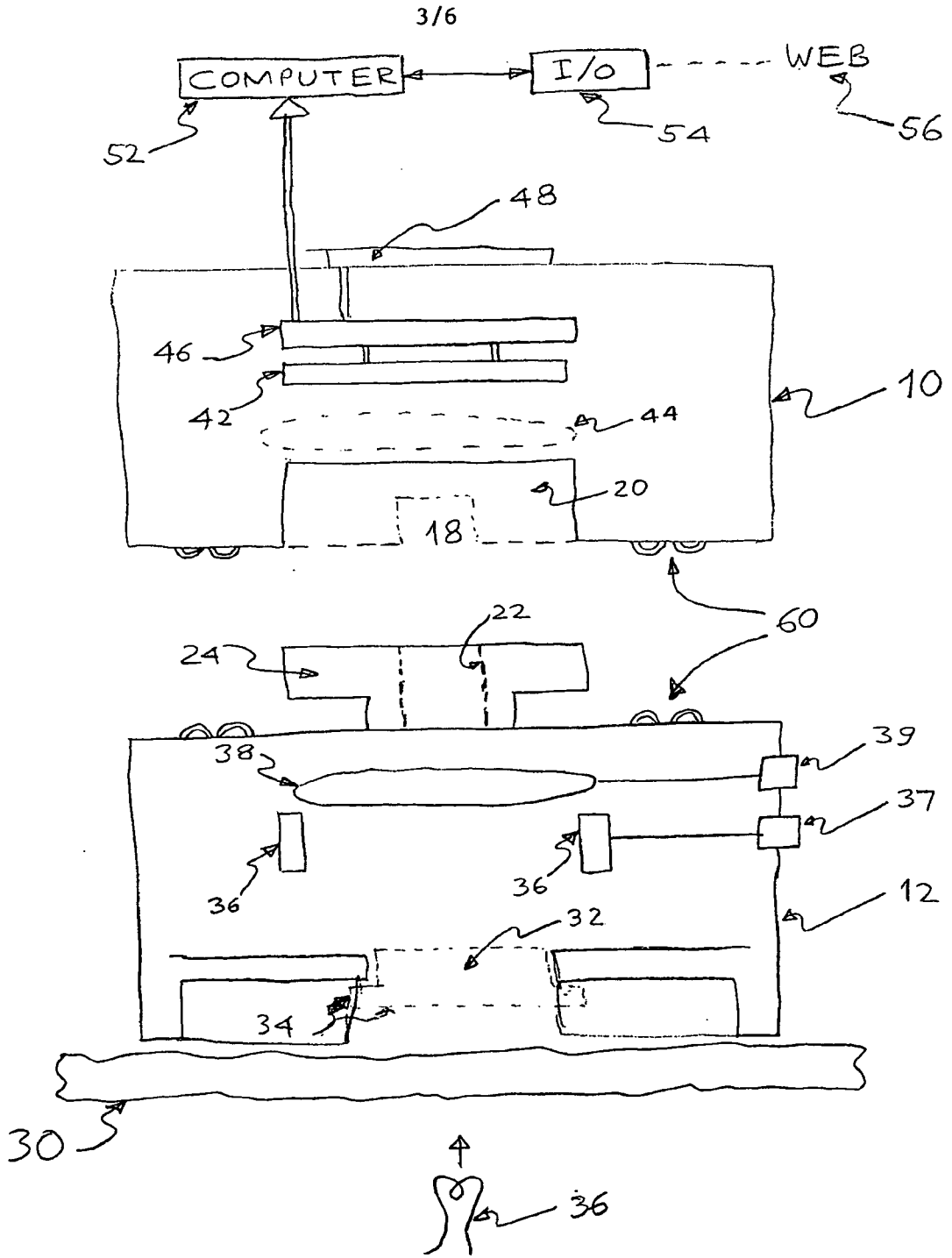


FIG. 3

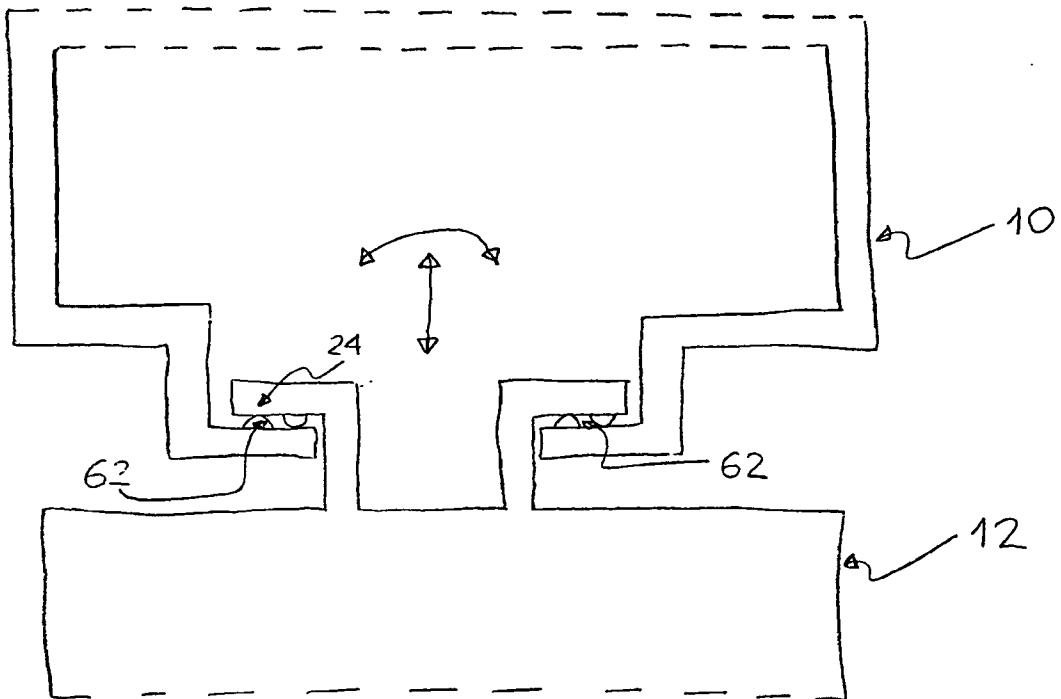


FIG. 4

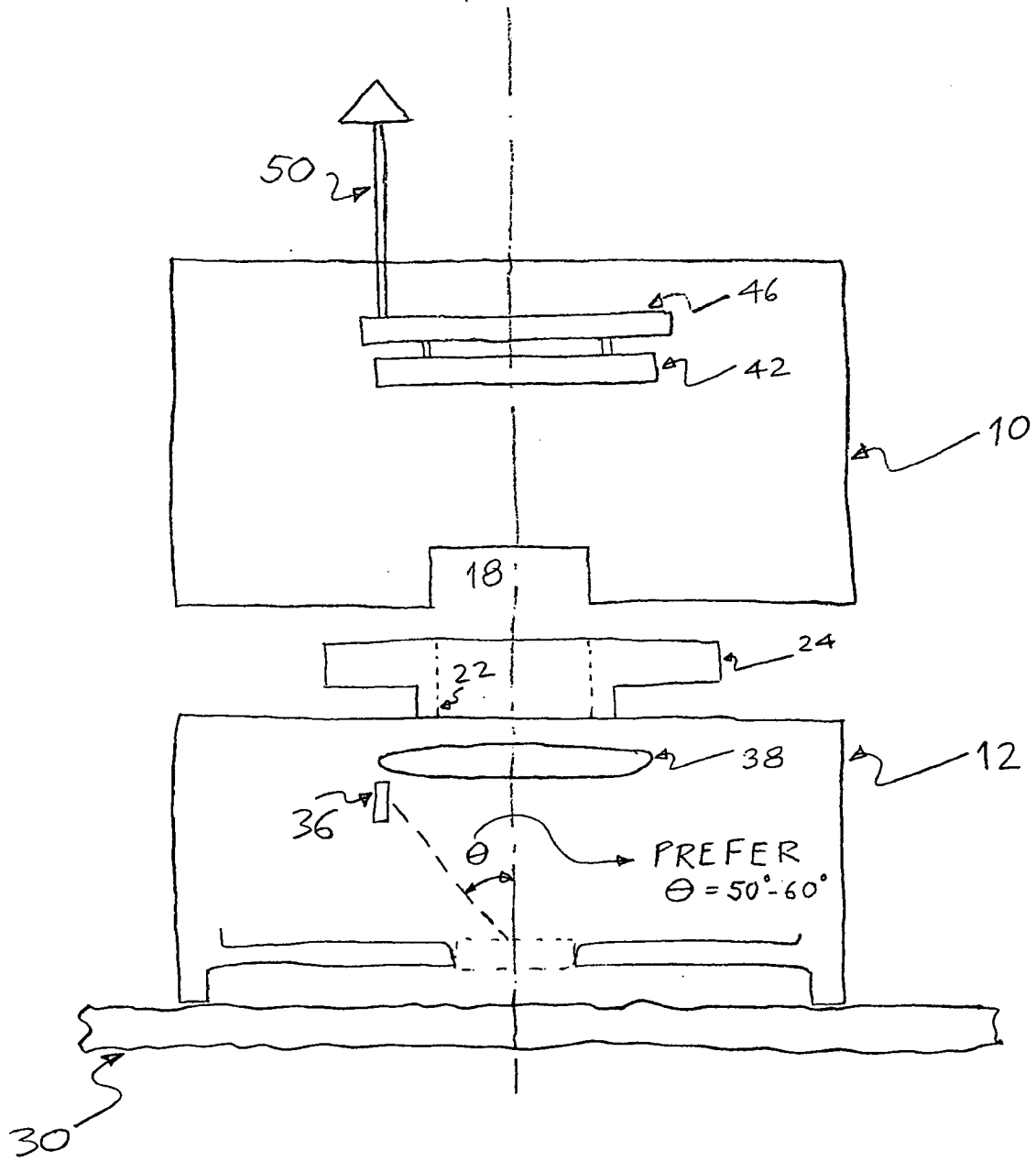


FIG. 5

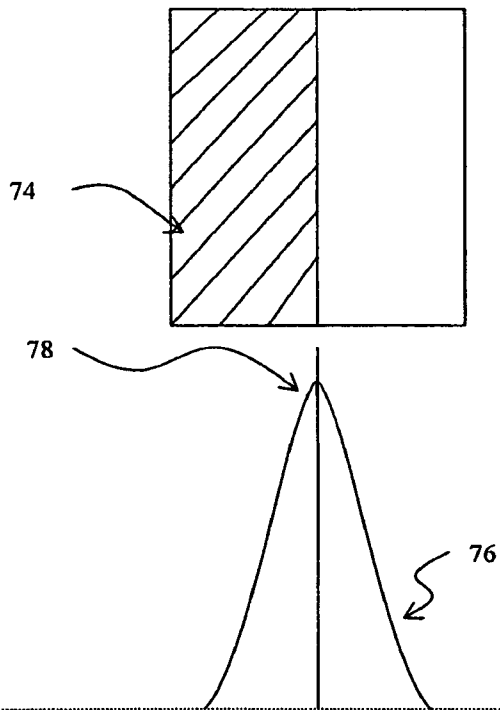


FIG. 6a

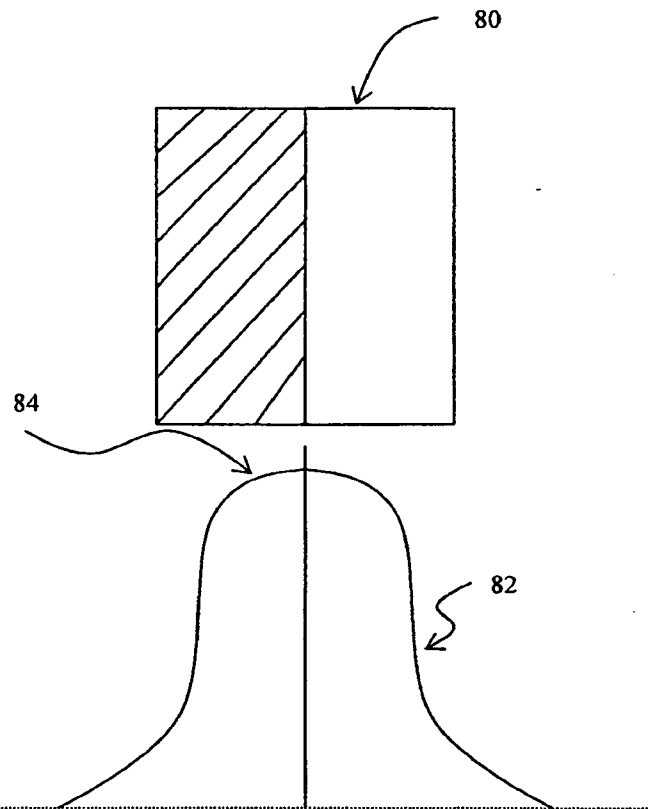


FIG. 6b