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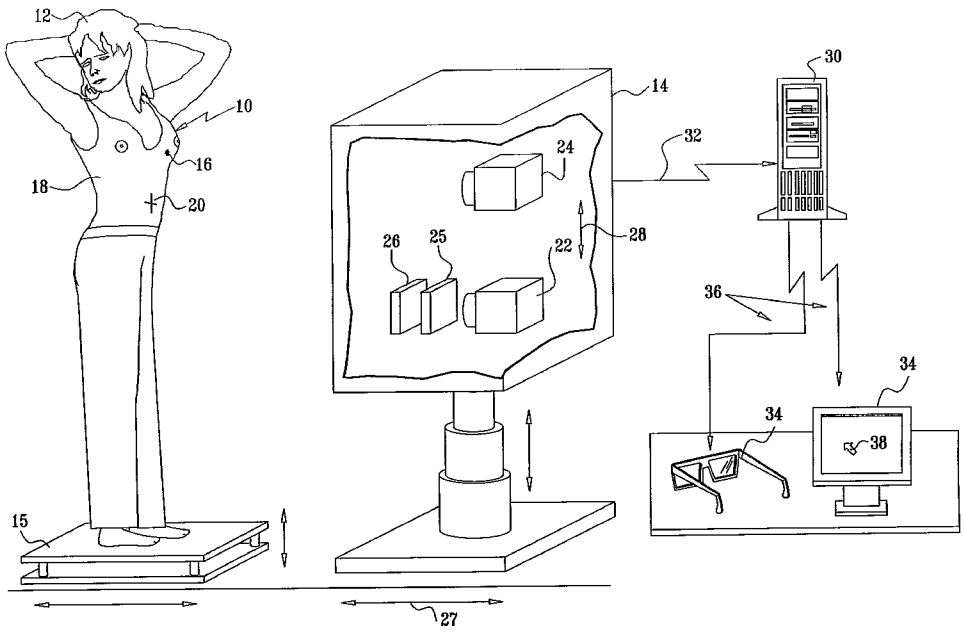
(54) **Title:** 3D THERMAL BREAST CANCER DETECTOR



(57) **Abstract:** A system for 3D thermographic imaging of a portion of a human body including non-thermographic image data acquisition functionality operative to acquire non-thermographic image data for at least a portion of a human body, thermographic image data acquisition functionality operative to acquire thermographic image data for at least a part of the at least one portion of the human body containing at least one object and a combined image generator operative to combine the non-thermographic and thermographic image data to provide a visually sensible three-dimensional output indicating the location and orientation of the at least one object within the at least a portion of the human body.

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3D THERMAL BREAST CANCER DETECTION

FIELD OF THE INVENTION

The present invention relates to a system and method for 3D imaging thermographic imaging, and more particularly to 3D thermographic imaging of a portion of a human body.

BACKGROUND OF THE INVENTION

U.S. Patent No. 6,442,419 is believed to represent the current state of the art.

SUMMARY OF THE INVENTION

The present invention seeks to provide a system and method for combination of 3D non-thermographic and thermographic imaging of a portion of a human body, preferably for medical diagnostic purposes.

There is thus provided in accordance with a preferred embodiment of the present invention a system for 3D thermographic imaging of a portion of a human body including non-thermographic image data acquisition functionality operative to acquire non-thermographic image data for at least a portion of a human body, thermographic image data acquisition functionality operative to acquire thermographic image data for at least a part of the at least one portion of the human body containing at least one object and a combined image generator operative to combine the non-thermographic and thermographic image data to provide a visually sensible three-dimensional output indicating the location and orientation of the at least one object within the at least a portion of the human body.

In accordance with a preferred embodiment of the present invention the system for 3D thermographic imaging of a portion of a human body also includes a housing containing the non-thermographic image data acquisition functionality and the thermographic image data acquisition functionality. Additionally or alternatively, the system for 3D thermographic imaging of a portion of a human body also includes a positioning device operative to reposition the housing.

In accordance with another preferred embodiment of the present invention the non-thermographic image data and the thermographic image data include at least one two-dimensional image. Additionally or alternatively, the non-thermographic image data and the thermographic image data include at least one three-dimensional image.

In accordance with yet another preferred embodiment of the present invention the non-thermographic image data acquisition functionality includes a stills camera or a digital camera. Optionally and preferably, the stills camera includes a black-and-white stills camera or a color stills camera. Additionally or alternatively, the digital camera includes CCD or CMOS. In accordance with a further preferred

embodiment of the present invention the non-thermographic image data acquisition functionality also includes a polarizer. Alternatively, the non-thermographic image data acquisition functionality may also include a color filter. In accordance with another further preferred embodiment of the present invention the thermographic image data acquisition functionality is sensitive to infra-red wavelengths.

In accordance with a still further preferred embodiment of the present invention the object in the portion of a human body includes a tumor. Preferably, the tumor includes cancerous tumor.

In accordance with a preferred embodiment of the present invention the combined image generator includes a computing device operative to combine the non-thermographic and thermographic image data to provide the visibly sensible three-dimensional output, a display for displaying the visibly sensible three-dimensional output and a communications network operative to connect the computing device to the display. Preferably, the system also includes a communications network operative to connect the non-thermographic image data acquisition functionality and the thermographic image data acquisition functionality to the combined image generator. Preferably, the computing device includes a PC or a PDA and the display includes of at least one LCD, at least one CRT or a plasma screen. As a further alternative, the display may include two LCDs or two CRTs packaged together in an eyeglasses structure. Preferably, the display is operative to display a pointer.

In accordance with another preferred embodiment of the present invention the communications networks include at least one of intranet, Internet, Blue-Tooth communications network, cellular communications network, infra-red communications network and radio frequency communications network.

In accordance with yet another preferred embodiment of the present invention the system for 3D thermographic imaging of a portion of a human body also includes a positioning device operative to reposition the non-thermographic image data acquisition functionality or the thermographic image data acquisition functionality. Additionally or alternatively, the system also includes a positioning device operative to reposition the human body.

There is also provided in accordance with another preferred embodiment of the present invention a method for 3D thermographic imaging of a portion of a

human body including acquiring non-thermographic image data for at least a portion of a human body, acquiring thermographic image data for at least a part of the at least one portion of the human body containing at least one object and combining the non-thermographic and thermographic image data to provide a visually sensible three-dimensional output indicating the location and orientation of the at least one object within the at least a portion of the human body.

In accordance with a preferred embodiment of the present invention the non-thermographic image data and the thermographic image data include at least one two-dimensional image. Additionally or alternatively, the non-thermographic image data and the thermographic image data include at least one three-dimensional image.

In accordance with another preferred embodiment of the present invention the acquiring non-thermographic image data includes acquiring first non-thermographic image data in a first relative position of the human body and at least one non-thermographic image data acquisition functionality and acquiring at least second non-thermograpic image data in at least a second relative position of the human body and at least one non-thermographic image data acquisition functionality.

In accordance with yet another preferred embodiment of the present invention the acquiring thermographic image data includes acquiring first thermographic image data in a first relative position of the human body and at least one thermographic image data acquisition functionality and acquiring at least second thermographic image data in at least a second relative position of the human body and at least one thermographic image data acquisition functionality.

In accordance with a further preferred embodiment of the present invention the at least second relative position is configured by repositioning the human body. Alternatively, the at least second relative position is configured by repositioning the at least one non-thermographic image data acquisition functionality or the at least one thermographic image data acquisition functionality. As a further alternative, the first relative position is configured by a first the non-thermographic image data acquisition functionality or by a first thermographic image data acquisition functionality and the at least second relative position is configured by at least a second the non-thermographic image data acquisition functionality or by at least a second thermographic image data acquisition functionality.

In accordance with another further preferred embodiment of the present invention the non-thermograpic image data acquisition functionality or the thermographic image data acquisition functionality is enclosed within a housing, and the at least second relative position is configured by repositioning the housing. Alternatively, the first relative position is configured by a first the non-thermograpic image data acquisition functionality or a first thermographic image data acquisition functionality enclosed within a first housing, and the at least second relative position is configured by at least a second the non-thermograpic image data acquisition functionality or at least a second thermographic image data acquisition functionality enclosed within at least a second housing.

In accordance with yet a further preferred embodiment of the present invention the combining includes computing a non-thermographic three-dimensional model of the non-thermographic image data, computing a thermographic three-dimensional model of the thermographic image data, combining the non-thermographic three-dimensional model and the thermographic three-dimensional model to provide the visually sensible three-dimensional output and displaying the visually sensible three-dimensional output.

In accordance with a still further preferred embodiment of the present invention the computing a non-thermographic three-dimensional model of the non-thermographic image data also includes computing spatial data of the non-thermographic three-dimensional model. Preferably, the computing spatial data of the non-thermographic three-dimensional model includes computing the X, Y and Z coordinates of the portion of the human body. Additionally or alternatively, the computing a non-thermographic three-dimensional model of the non-thermographic image data also includes obtaining information relating to the color, hue or tissue texture of the portion of the human body.

In accordance with another preferred embodiment of the present invention the computing a thermographic three-dimensional model of the non-thermographic image data also includes computing spatial temperature data of the non-thermographic three-dimensional model. Preferably, the computing spatial data of the non-thermographic three-dimensional model includes computing the temperature of the portion of the human body along the X, Y and Z coordinates.

In accordance with yet another preferred embodiment of the present invention the combining the non-thermographic three-dimensional model and the thermographic three-dimensional model includes substantially positioning the non-thermographic three-dimensional model and the thermographic three-dimensional model in parallel manner. Preferably, the substantially positioning the non-thermographic three-dimensional model and the thermographic three-dimensional model includes substantially positioning a marker. Additionally or alternatively the substantially positioning the non-thermographic three-dimensional model and the thermographic three-dimensional model includes substantially positioning X, Y and Z coordinates of the non-thermographic three-dimensional model and the thermographic three-dimensional model.

In accordance with still another preferred embodiment of the present invention the displaying the visually sensible three-dimensional output also includes displaying a pointer. Additionally or alternatively the displaying the visually sensible three-dimensional output also includes displaying sectional views of the visually sensible three-dimensional output.

In accordance with a further preferred embodiment of the present invention the method also includes extracting information from the visibly sensible three-dimensional output, and preferably also includes displaying the extracted information. Additionally or alternatively, the method also includes comparing the visibly sensible three-dimensional output to at least one visibly sensible three-dimensional model.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

Fig. 1 is a simplified pictorial illustration of a 3D non-thermographic and thermographic imaging system operative in accordance with a preferred embodiment of the present invention;

Figs. 2A-2E are simplified pictorial illustrations of five alternative embodiments of one stage of a method in accordance with a preferred embodiment of the present invention;

Figs. 3A-3E are simplified pictorial illustrations of five alternative embodiments of another stage of a method in accordance with a preferred embodiment of the present invention;

Fig. 4 is a flow chart illustration of the computing stage of a method in accordance with a preferred embodiment of the present invention;

Fig. 5 is a simplified pictorial illustration of an initial step of the computing stage of a method in accordance with a preferred embodiment of the present invention;

Fig. 6 is a simplified pictorial illustration of another step of the computing stage of a method in accordance with a preferred embodiment of the present invention; and

Fig. 7 is a simplified pictorial illustration of the final step of the computing stage of a method in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is now made to Fig. 1, which illustrates a system for 3D non-thermographic and thermographic imaging of a portion of a human body, in accordance with a preferred embodiment of the present invention. The system may be used as a diagnostic tool, for example for medical diagnosis such as diagnosis of tumors, and specifically in the diagnosis of cancerous breast tumors.

As seen in Fig. 1, a body part 10 of a person 12 is located in front of an imaging device 14. The person 12, may be standing, sitting or in any other suitable position relative to imaging device 14. Person 12 may initially be positioned or later be repositioned relative to imaging device 14 by positioning device 15, which typically comprises a platform moving on a rail, by force of an engine, or by any other suitable force. Additionally, a tumor 16 may exist in body part 10 of person 12. Typically, body part 10 comprises a breast, and tumor 16 comprises a breast tumor such as a cancerous tumor.

In accordance with a preferred embodiment of the present invention, person 12 may be wearing a clothing garment 18, such as a shirt. Preferably, clothing garment 18 may be non-penetrable or partially penetrable to visible wavelengths such as 400-700 nanometers, and may be penetrable to wavelengths that are longer than visible wavelengths, such as IR wavelengths. Additionally, a reference mark 20 may be located close to person 12, preferably directly on the body of person 12 and in close proximity to body part 10. Optionally and preferably, reference mark 20 is directly attached to body part 10. Reference mark 20 may typically comprise a piece of material, a mark drawn on person 12 or any other suitable mark, as described hereinbelow.

Imaging device 14 typically comprises at least one non-thermographic imaging system 22 that can sense at least visible wavelengths and at least one thermographic imaging system 24 which is sensitive to infra-red (IR) wavelengths, typically in the range of as 3-5 micrometer and/or 8-12 micrometer. Typically imaging systems 22 and 24 are capable of sensing reference mark 20 described hereinabove.

Optionally, a polarizer 25 may be placed in front of non-thermographic imaging system 22. As a further alternative, a color filter 26, which may block at least a

portion of the visible wavelengths, may be placed in front of non-thermographic imaging system 22.

Typically, at least one non-thermographic imaging system 22 may comprise a black-and-white or color stills camera, or a digital camera such as CCD or CMOS. Additionally, at least one non-thermographic imaging system 22 may comprise a plurality of imaging elements, each of which may be a three-dimensional imaging element.

Optionally, imaging device 14 may be repositioned relative to person 12 by positioning device 27. As a further alternative, each of imaging systems 22 and 24 may also be repositioned relative to person 12 by at least one positioning device 28. Positioning device 27 may comprise an engine, a lever or any other suitable force, and may also comprise a rail for moving imaging device 14 thereon. Preferably, repositioning device 28 may be similarly structured.

Data acquired by non-thermographic imaging system 22 and thermographic imaging system 24 is output to a computing device 30 via a communications network 32, and is typically analyzed and processed by an algorithm running on the computing device. The resulting data may be displayed on at least one display device 34, which is preferably connected to computing device 30 via a communications network 36. Computing device 30 typically comprises a PC, a PDA or any other suitable computing device. Communications networks 32 and 36 typically comprise a physical communications network such as an internet or intranet, or may alternatively comprise a wireless network such as a cellular network, IR communication network, a radio frequency (RF) communications network, a blue-tooth (BT) communications network or any other suitable communications network.

In accordance with a preferred embodiment of the present invention display 34 typically comprises a screen, such as an LCD screen, a CRT screen or a plasma screen. As a further alternative display 34 may comprise at least one visualizing device comprising two LCDs or two CRTs, located in front of a user's eyes and packaged in a structure similar to that of eye-glasses. Preferably, display 34 also displays a pointer 38, which is typically movable along the X, Y and Z axes of the displayed model and may be used to point to different locations or elements in the displayed data.

Reference is now made to Figs. 2A-4, which illustrate various stages in method of 3D non-thermographic and thermographic imaging of a portion of a human body, in accordance with a preferred embodiment of the present invention.

As seen in Fig. 2A, person 12 comprising body part 10 is located on a positioning device 15 in front of an imaging device 14, in a first position 40 relative to the imaging device. First image data of body part 10 is acquired by at least one non-thermographic imaging system 22, optionally through polarizer 25 or as an alternative option through color filter 26. Additionally, at least second image data of body part 10 is acquired by at least one non-thermographic imaging system 22, such that body part 10 is positioned in at least a second position 42 relative to imaging device 14.

The second relative position 42 may be configured by repositioning person 12 using positioning device 15 as seen in Fig. 2A, by repositioning imaging device 14 using positioning device 27 as seen in Fig. 2B or by repositioning non-thermographic imaging system 22 using positioning device 28 as seen in Fig. 2C. As a further alternative, the second relative position 42 may be configured by using two separate imaging devices 14 as seen in Fig. 2D or two separate non-thermographic imaging systems 22 as seen in Fig. 2E.

In a further stage of the method in accordance with a preferred embodiment of the present invention, person 12 comprising body part 10 is located on a positioning device 15 in front of an imaging device 14, in a first position 44 relative to the imaging device. First thermographic image data of body part 10 is acquired by at least one thermographic imaging system 24. Additionally, at least second thermographic image data of body part 10 is acquired by at least one thermographic imaging system 24, such that body part 10 is positioned in at least a second position 42 relative to imaging device 14.

The second relative position 46 may be configured by repositioning person 12 using positioning device 15 as seen in Fig. 3A, by repositioning imaging device 14 using positioning device 27 as seen in Fig. 3B, or by repositioning thermographic imaging system 24 using positioning device 28 as seen in Fig. 3C. As a further alternative, the second relative position 46 may be configured by using two separate imaging devices 14 as seen in Fig. 3D or two separate thermographic imaging systems 24 as seen in Fig. 3E.

It will be appreciated that the non-thermographic image data acquisition described in Figs. 2A-2E may be performed before, after or concurrently with the thermographic image data acquisition described in Figs. 3A-3E.

Image data of body part 10 may be acquired by thermographic imaging system 24, by separately imaging a plurality of narrow strips of the complete image of body part 10. Alternatively, the complete image of body part 10 is acquired by thermographic imaging system, and the image is sampled in a plurality of narrow strips or otherwise shaped portions for processing. As a further alternative, the imaging of body part 10 may be performed using different exposure times.

The thermographic and non-thermographic image data obtained from imaging device 14 is analyzed and processed by computing device 30 as illustrated in Fig. 4.

In stage 50, image data acquired from non-thermographic imaging system 22 is processed by computing device 30 to build a non-thermographic three-dimensional model of body part 10 of person 12, using algorithms and methods that are well known in the art, such as the method described in U.S. Patent No. 6,442,419 which is hereby incorporated by reference as if fully set forth herein. The non-thermographic three-dimensional model, preferably includes spatial information, typically the X, Y and Z coordinates of the body part 10, as well as the location of reference marker 20. Additionally, the non-thermographic three-dimensional model preferably includes information relating to the color, hue and tissue texture of body part 10. An exemplary non-thermographic three-dimensional model and the process of building such a model are illustrated in Fig. 5.

Thermographic image data acquired from thermographic imaging system 24 is processed by computing device 30 in stage 52 to build a thermographic three-dimensional model of body part 10 of person 12, using algorithms and methods that are well known in the art, such as the method described in U.S. Patent No. 6,442,419 which is hereby incorporated by reference as if fully set forth herein. The thermographic three-dimensional model preferably includes spatial temperature information, typically the X, Y and Z coordinates of the temperature of body part 10 and of reference marker 20. An exemplary thermographic three-dimensional model and the process of building such a model are illustrated in Fig. 6.

It is appreciated that the thermographic three-dimensional model may be built before, after or concurrently with the non-thermographic three-dimensional model.

The three-dimensional models built in stages 50 and 52 as described hereinabove are combined into a single three-dimensional model in stage 54. Correct positioning of the two models in the combined three-dimensional model may be achieved by accurately positioning reference marker 20 in the two models, by comparing X, Y and Z coordinates or using any other suitable method. An exemplary combined three-dimensional model as built in stage 54 is illustrated in Fig. 7.

In stage 56, computing device 30 extracts information included in the combined three-dimensional model, such as information regarding temperature, temperature changes in a certain point and a comparison of temperatures in different points in body part 10. Additionally, computing device 30 may extract, compute and display a comparison of size or temperature between body part 10 and another body part of person 12, such as the two breasts of person 12.

In an additional or alternative stage 58, the computing device 30 may compare and display differences between a plurality of three-dimensional models of the same body part 10 of a person 12, the plurality of models being based on data acquired at a plurality of different time points. Typically, the information compared, computed and displayed includes information about temperature, dimensions such as length, width, height and depth, shape, volume, color, hue and tissue texture. The information may be displayed graphically or textually, and may be described as a change in percentage or in absolute value.

As shown in stage 60, the output of any of stages 54, 56 and 58 is displayed on display 34. Pointer 38 is also displayed, and may be used to point to sections or elements of the displayed model, along any of the X, Y and Z coordinates. Optionally and preferably, an algorithm is provided to facilitate the display of sectional views of the three-dimensional model or of specific tissue layers of the modeled body part 10.

It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of the various features described hereinabove as well as modifications

and variations thereof as would occur to a person of skill in the art upon reading the foregoing specification and which are not in the prior art.

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CLAIMS

1. A system for 3D thermographic imaging of a portion of a human body comprising:

non-thermographic image data acquisition functionality operative to acquire non-thermographic image data for at least a portion of a human body;

thermographic image data acquisition functionality operative to acquire thermographic image data for at least a part of said at least one portion of said human body containing at least one object; and

a combined image generator operative to combine said non-thermographic and thermographic image data to provide a visually sensible three-dimensional output indicating the location and orientation of said at least one object within said at least a portion of said human body.

2. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and also comprising a housing containing said non-thermographic image data acquisition functionality and said thermographic image data acquisition functionality.

3. A system for 3D thermographic imaging of a portion of a human body according to claim 2 and also comprising a positioning device operative to reposition said housing.

4. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and wherein said non-thermographic image data comprises at least one two-dimensional image.

5. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and wherein said non-thermographic image data comprises at least one three-dimensional image.

6. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and wherein said non-thermographic image data acquisition functionality comprises a stills camera or a digital camera.

7. A system for 3D thermographic imaging of a portion of a human body according to claim 6 and wherein said stills camera comprises a black-and-white stills camera or a color stills camera.

8. A system for 3D thermographic imaging of a portion of a human body according to claim 6 and wherein said digital camera comprises CCD or CMOS.

9. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and wherein said non-thermographic image data acquisition functionality also comprises a polarizer.

10. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and wherein said non-thermographic image data acquisition functionality also comprises a color filter.

11. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and wherein said thermographic image data comprises at least one two-dimensional image.

12. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and wherein said thermographic image data comprises at least one three-dimensional image.

13. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and wherein said thermographic image data acquisition functionality is sensitive to infra-red wavelengths.

14. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and wherein said object comprises a tumor.

15. A system for 3D thermographic imaging of a portion of a human body according to claim 14 and wherein said tumor comprises a cancerous tumor.

16. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and wherein said combined image generator comprises:

a computing device operative to combine said non-thermographic and thermographic image data to provide said visibly sensible three-dimensional output;

a display for displaying said visibly sensible three-dimensional output; and

a communications network operative to connect said computing device to said display.

17. A system for 3D thermographic imaging of a portion of a human body according to claim 16 and wherein said computing device comprises a PC or a PDA.

18. A system for 3D thermographic imaging of a portion of a human body according to claim 16 and wherein said display comprises at least one LCD, at least one CRT or a plasma screen.

19. A system for 3D thermographic imaging of a portion of a human body according to claim 18 and wherein said display comprises two LCDs or two CRTs packaged together in an eye-glasses structure.

20. A system for 3D thermographic imaging of a portion of a human body according to claim 16 wherein said display is operative to display a pointer.

21. A system for 3D thermographic imaging of a portion of a human body according to claim 16 wherein said communications network comprises at least one of intranet, internet, Blue-Tooth communications network, cellular communications

network, infra-red communications network and radio frequency communications network.

22. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and also comprising a positioning device operative to reposition said non-thermographic image data acquisition functionality or said thermographic image data acquisition functionality.

23. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and also comprising a communications network operative to connect said non-thermographic image data acquisition functionality and said thermographic image data acquisition functionality to said combined image generator.

24. A system for 3D thermographic imaging of a portion of a human body according to claim 23 wherein said communications network is selected from a group consisting of intranet, internet, Blue-Tooth communications network, cellular communications network, infra-red communications network and radio frequency communications network.

25. A system for 3D thermographic imaging of a portion of a human body according to claim 1 and also comprising a positioning device operative to reposition said human body.

26. A method for 3D thermographic imaging of a portion of a human body comprising:

acquiring non-thermographic image data for at least a portion of a human body;

acquiring thermographic image data for at least a part of said at least one portion of said human body containing at least one object; and

combining said non-thermographic and thermographic image data to provide a visually sensible three-dimensional output indicating the location and orientation of said at least one object within said at least a portion of said human body.

27. A method for 3D thermographic imaging of a portion of a human body according to claim 26 and wherein said non-thermographic image data comprises at least one two-dimensional image.

28. A method for 3D thermographic imaging of a portion of a human body according to claim 26 and wherein said non-thermographic image data comprises at least one three-dimensional image.

29. A method for 3D thermographic imaging of a portion of a human body according to claim 26 and wherein said acquiring non-thermographic image data comprises:

acquiring first non-thermographic image data in a first relative position of said human body and at least one non-thermographic image data acquisition functionality; and

acquiring at least second non-thermographic image data in at least a second relative position of said human body and at least one non-thermographic image data acquisition functionality.

30. A method for 3D thermographic imaging of a portion of a human body according to claim 29 and wherein said at least second relative position is configured by repositioning said human body.

31. A method for 3D thermographic imaging of a portion of a human body according to claim 29 and wherein said at least second relative position is configured by repositioning said at least one non-thermographic image data acquisition functionality.

32. A method for 3D thermographic imaging of a portion of a human body according to claim 29 and wherein said first relative position is configured by a first said non-thermographic image data acquisition functionality and said at least second relative position is configured by at least a second said non-thermographic image data acquisition functionality.

33. A method for 3D thermographic imaging of a portion of a human body according to claim 29 and wherein said non-thermographic image data acquisition functionality is enclosed within a housing, and said at least second relative position is configured by repositioning said housing.

34. A method for 3D thermographic imaging of a portion of a human body according to claim 29 and wherein said first relative position is configured by a first said non-thermographic image data acquisition functionality enclosed within a first housing, and said at least second relative position is configured by at least a second said non-thermographic image data acquisition functionality enclosed within at least a second housing.

35. A method for 3D thermographic imaging of a portion of a human body according to claim 26 and wherein said thermographic image data comprises at least one two-dimensional image.

36. A method for 3D thermographic imaging of a portion of a human body according to claim 26 and wherein said thermographic image data comprises at least one three-dimensional image.

37. A method for 3D thermographic imaging of a portion of a human body according to claim 26 and wherein said acquiring thermographic image data comprises:

acquiring first thermographic image in a first relative position of said human body and at least one thermographic image data acquisition functionality; and

acquiring at least a second thermographic image in at least a second relative position of said human body and at least one thermographic image data acquisition functionality.

38. A method for 3D thermographic imaging of a portion of a human body according to claim 37 and wherein said at least second relative position is configured by repositioning said human body.

39. A method for 3D thermographic imaging of a portion of a human body according to claim 37 and wherein said at least second relative position is configured by repositioning a thermographic image data acquisition functionality.

40. A method for 3D thermographic imaging of a portion of a human body according to claim 37 and wherein said first relative position is configured by a first thermographic image data acquisition functionality and said at least second relative position is configured by a second thermographic image data acquisition functionality.

41. A method for 3D thermographic imaging of a portion of a human body according to claim 37 and wherein said thermographic image data acquisition functionality is enclosed within a housing, and said at least second relative position is configured by repositioning said housing.

42. A method for 3D thermographic imaging of a portion of a human body according to claim 37 and wherein said first relative position is configured by a first said thermographic image data acquisition functionality enclosed within a first housing, and said at least second relative position is configured by at least a second said thermographic image data acquisition functionality enclosed within at least a second housing.

43. A method for 3D thermographic imaging of a portion of a human body according to claim 26 and wherein said combining comprises:

computing a non-thermographic three-dimensional model of said non-thermographic image data;

computing a thermographic three-dimensional model of said thermographic image data;

combining said non-thermographic three-dimensional model and said thermographic three-dimensional model to provide said visually sensible three-dimensional output; and

displaying said visually sensible three-dimensional output.

44. A method for 3D thermographic imaging of a portion of a human body according to claim 43 and wherein said computing a non-thermographic three-dimensional model of said non-thermographic image data also comprises computing spatial data of said non-thermographic three-dimensional model.

45. A method for 3D thermographic imaging of a portion of a human body according to claim 44 and wherein said computing spatial data of said non-thermographic three-dimensional model comprises computing the X, Y and Z coordinates of said portion of said human body.

46. A method for 3D thermographic imaging of a portion of a human body according to claim 43 and wherein said computing a non-thermographic three-dimensional model of said non-thermographic image data also comprises obtaining information relating to the color of said portion of said human body.

47. A method for 3D thermographic imaging of a portion of a human body according to claim 43 and wherein said computing a non-thermographic three-dimensional model of said non-thermographic image data also comprises obtaining information relating to the hue of said portion of said human body.

48. A method for 3D thermographic imaging of a portion of a human body according to claim 43 and wherein said computing a non-thermographic three-dimensional model of said non-thermographic image data also comprises obtaining information relating to the tissue texture of said portion of said human body.

49. A method for 3D thermographic imaging of a portion of a human body according to claim 43 and wherein said computing a thermographic three-dimensional model of said non-thermographic image data also comprises computing spatial temperature data of said non-thermographic three-dimensional model.

50. A method for 3D thermographic imaging of a portion of a human body according to claim 49 and wherein said computing spatial data of said non-thermographic three-dimensional model comprises computing the temperature of said portion of said human body along the X, Y and Z coordinates.

51. A method for 3D thermographic imaging of a portion of a human body according to claim 43 and wherein said combining said non-thermographic three-dimensional model and said thermographic three-dimensional model comprises substantially positioning said non-thermographic three-dimensional model and said thermographic three-dimensional model in parallel manner.

52. A method for 3D thermographic imaging of a portion of a human body according to claim 51 and wherein said substantially positioning said non-thermographic three-dimensional model and said thermographic three-dimensional model comprises substantially positioning a marker.

53. A method for 3D thermographic imaging of a portion of a human body according to claim 51 and wherein said substantially positioning said non-thermographic three-dimensional model and said thermographic three-dimensional model comprises substantially positioning X, Y and Z coordinates of said non-thermographic three-dimensional model and said thermographic three-dimensional model.

54. A method for 3D thermographic imaging of a portion of a human body according to claim 43 and wherein said displaying said visually sensible three-dimensional output also comprises displaying a pointer.

55. A method for 3D thermographic imaging of a portion of a human body according to claim 43 and wherein said displaying said visually sensible three-dimensional output also comprises displaying sectional views of said visually sensible three-dimensional output.

56. A method for 3D thermographic imaging of a portion of a human body according to claim 43 and also comprising extracting information from said visibly sensible three-dimensional output.

57. A method for 3D thermographic imaging of a portion of a human body according to claim 56 and also comprising displaying said extracted information.

58. A method for 3D thermographic imaging of a portion of a human body according to claim 43 and also comprising comparing said visibly sensible three-dimensional output to at least one visibly sensible three-dimensional model.

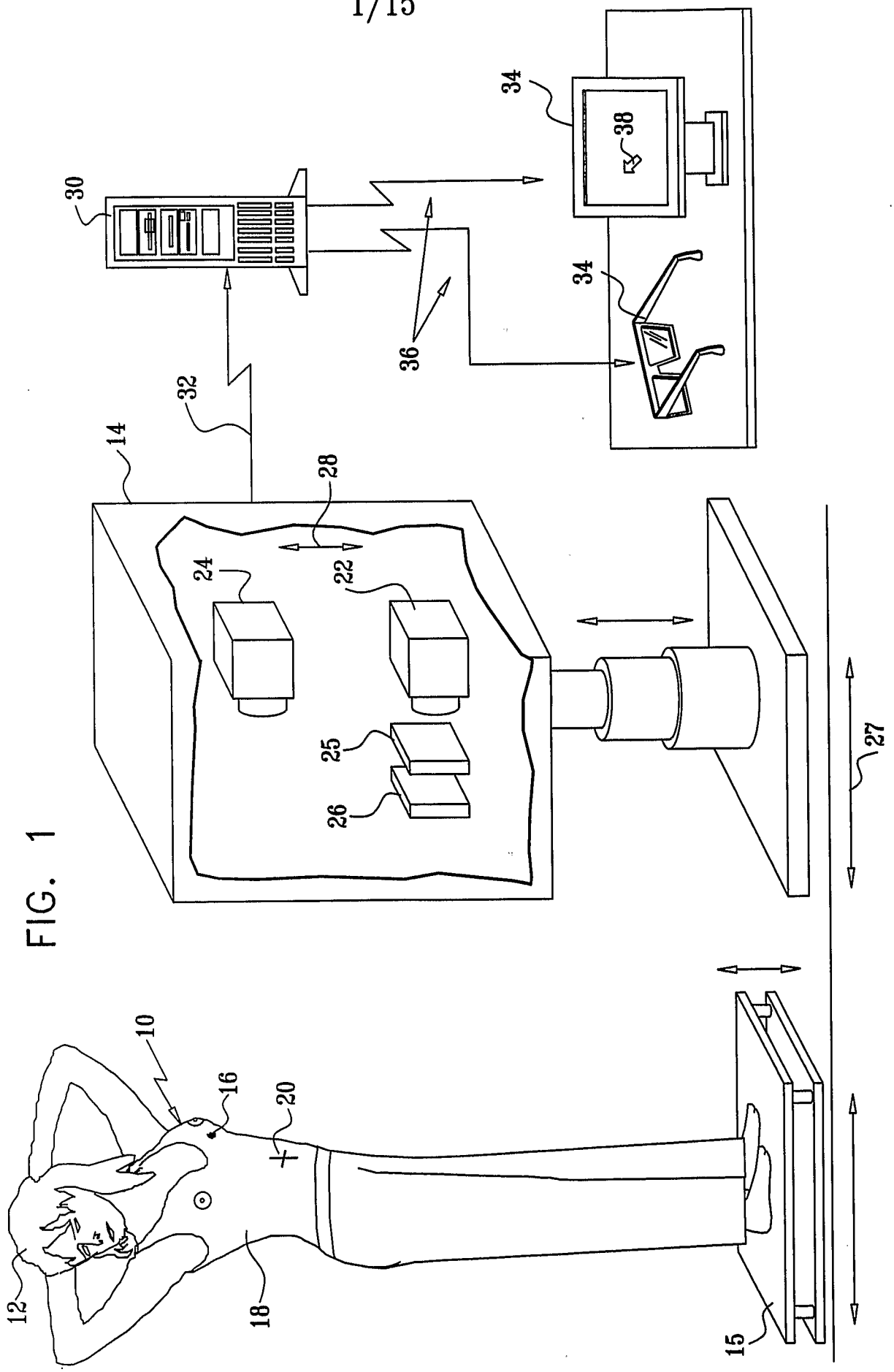


FIG. 1

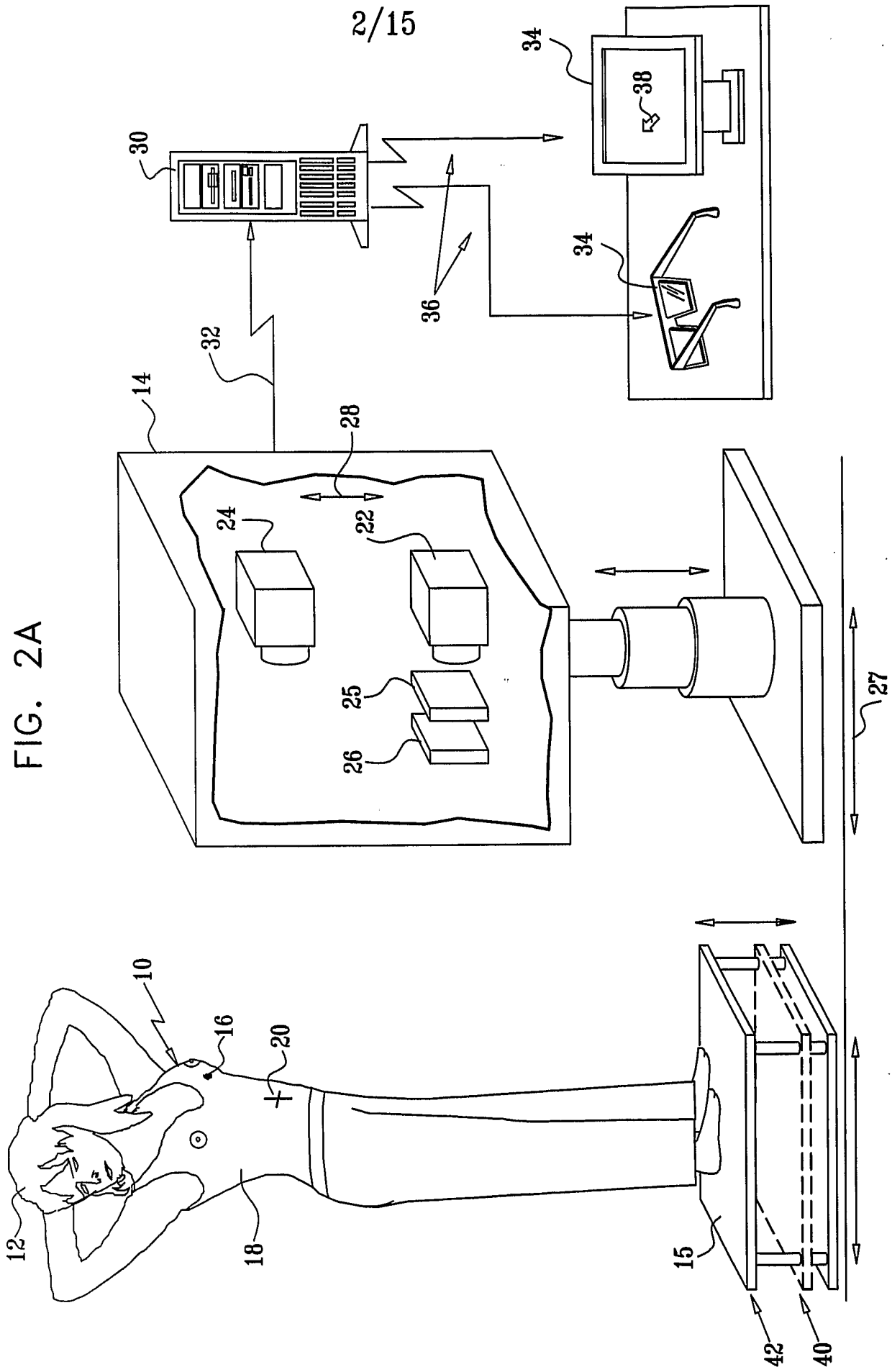
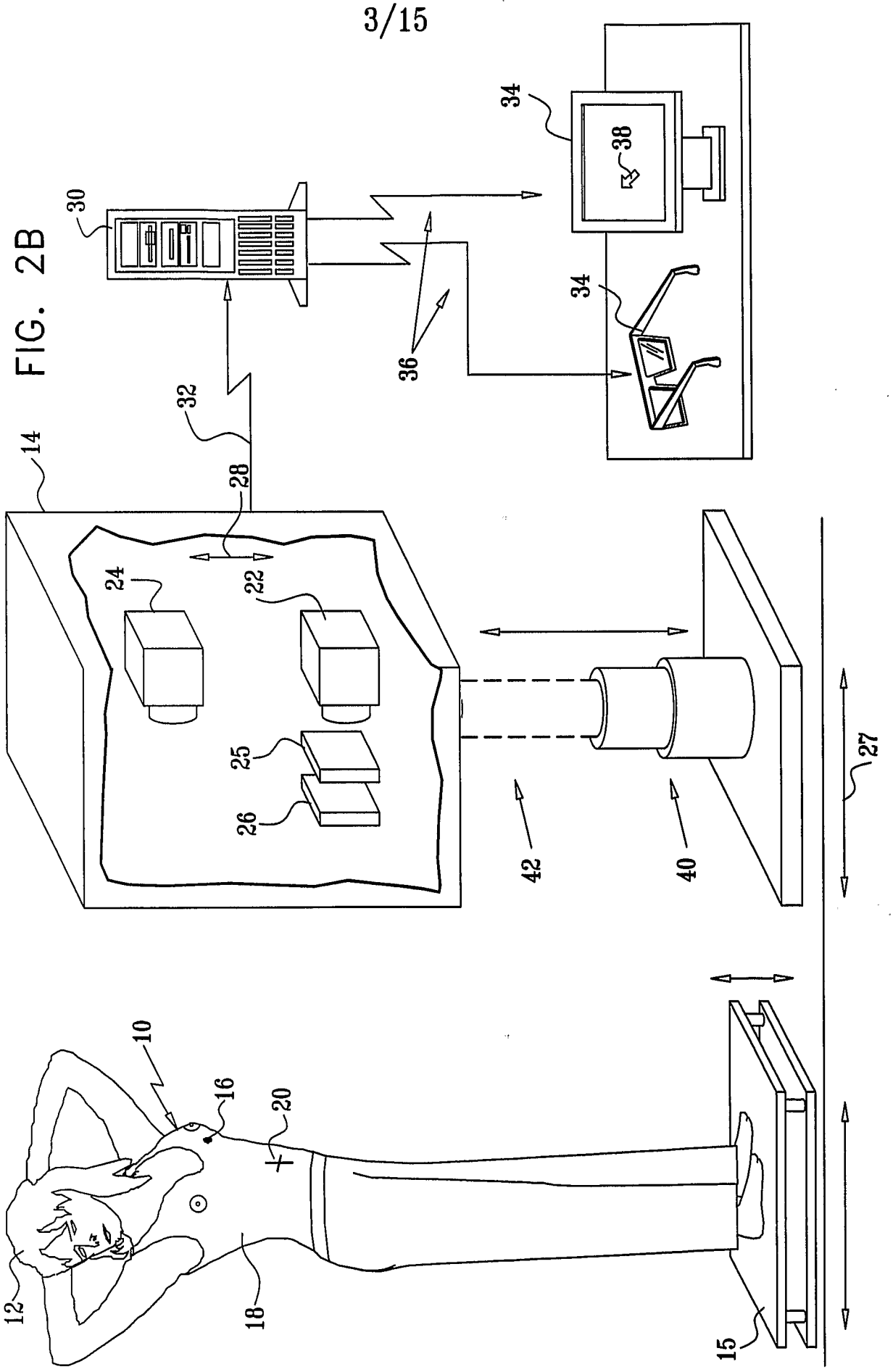


FIG. 2A

FIG. 2B



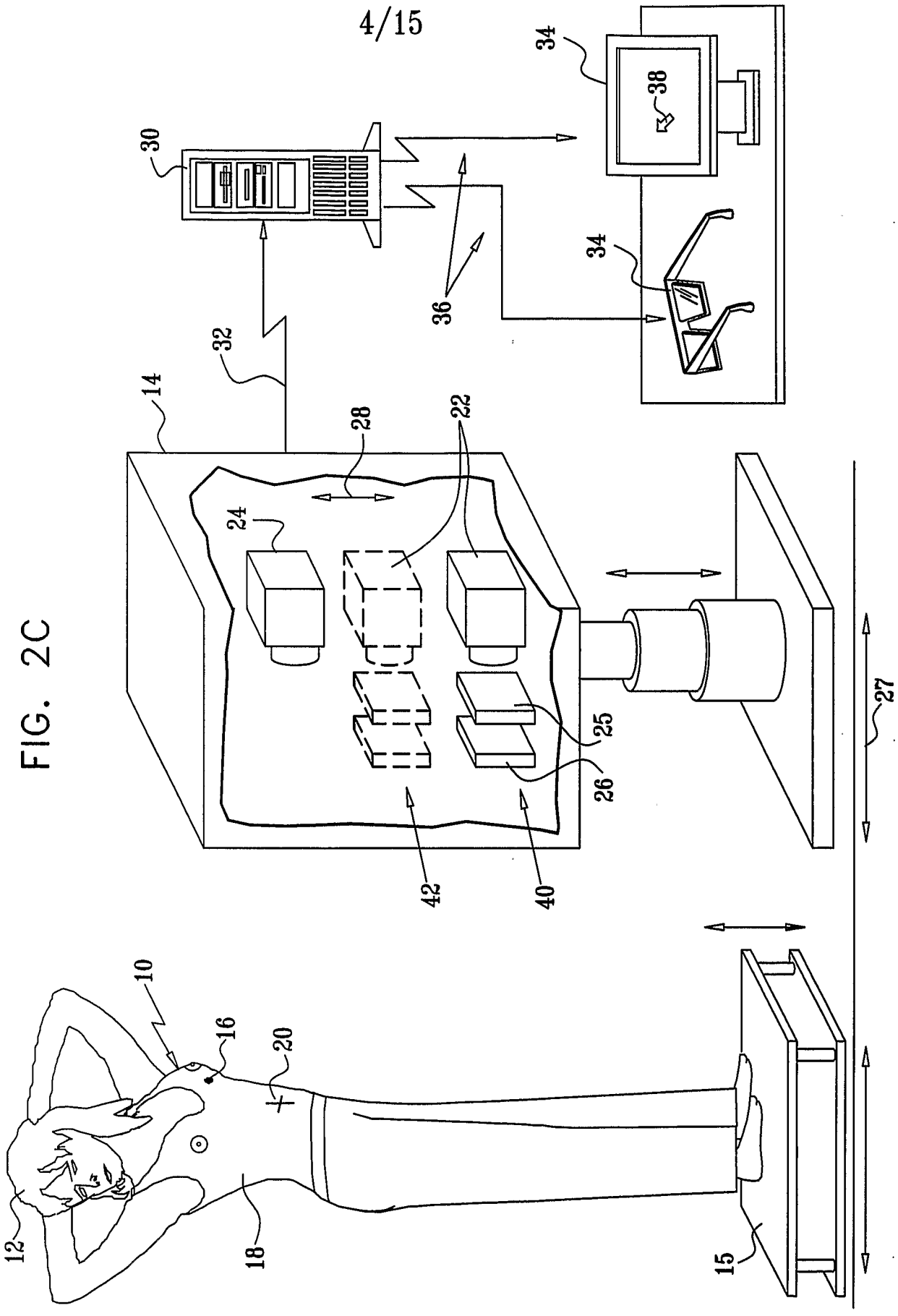
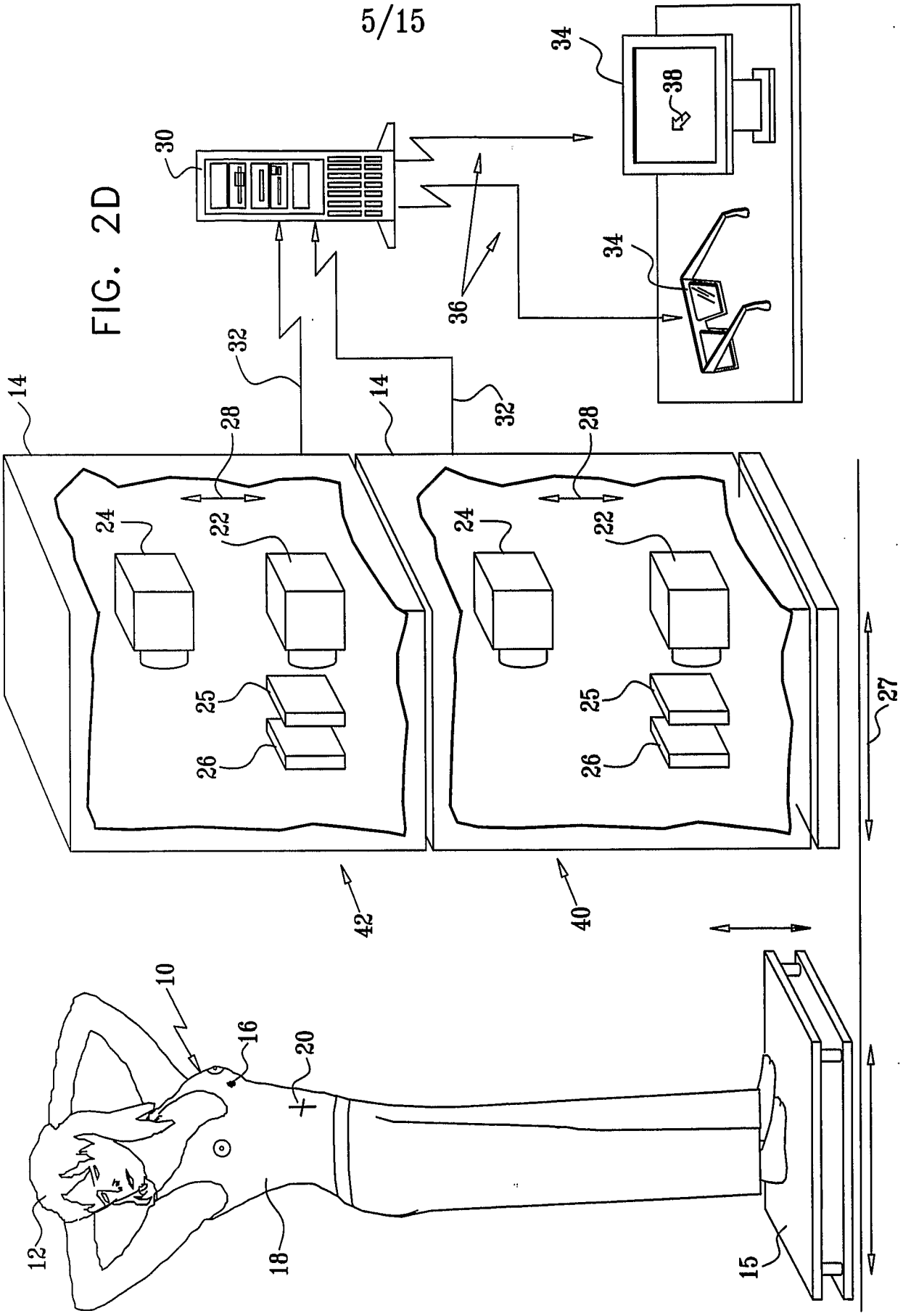


FIG. 2C

FIG. 2D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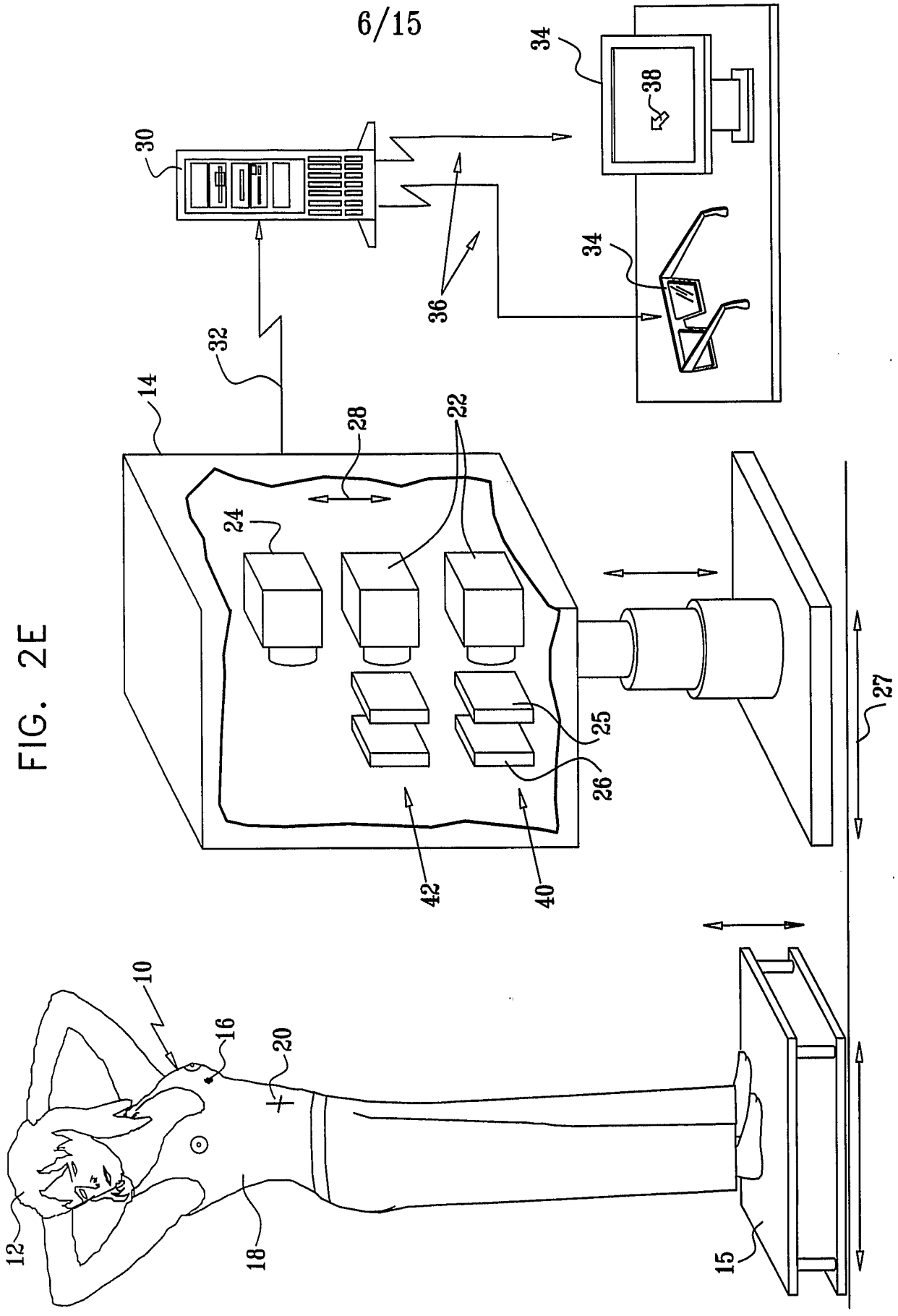


FIG. 2E

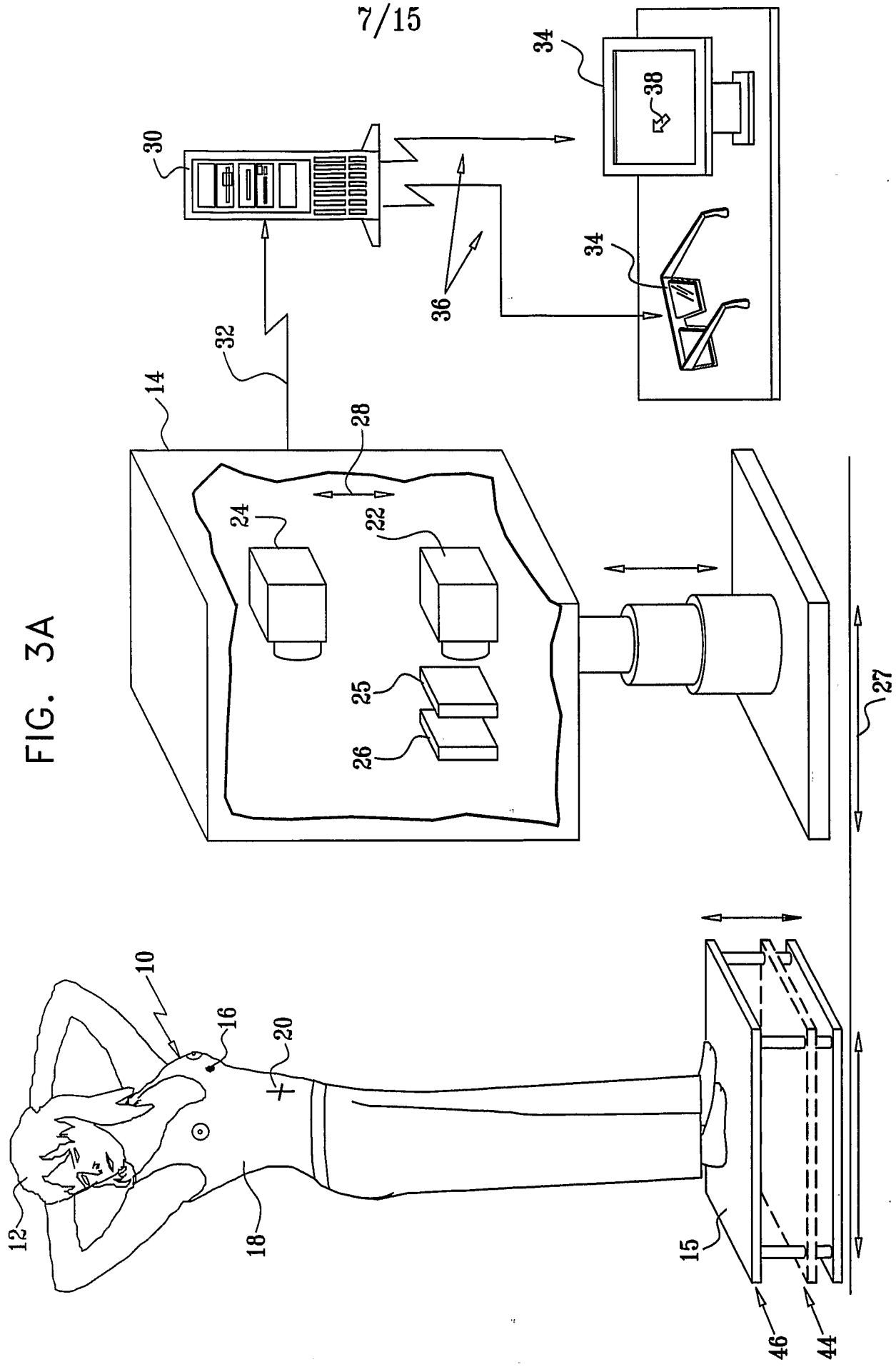
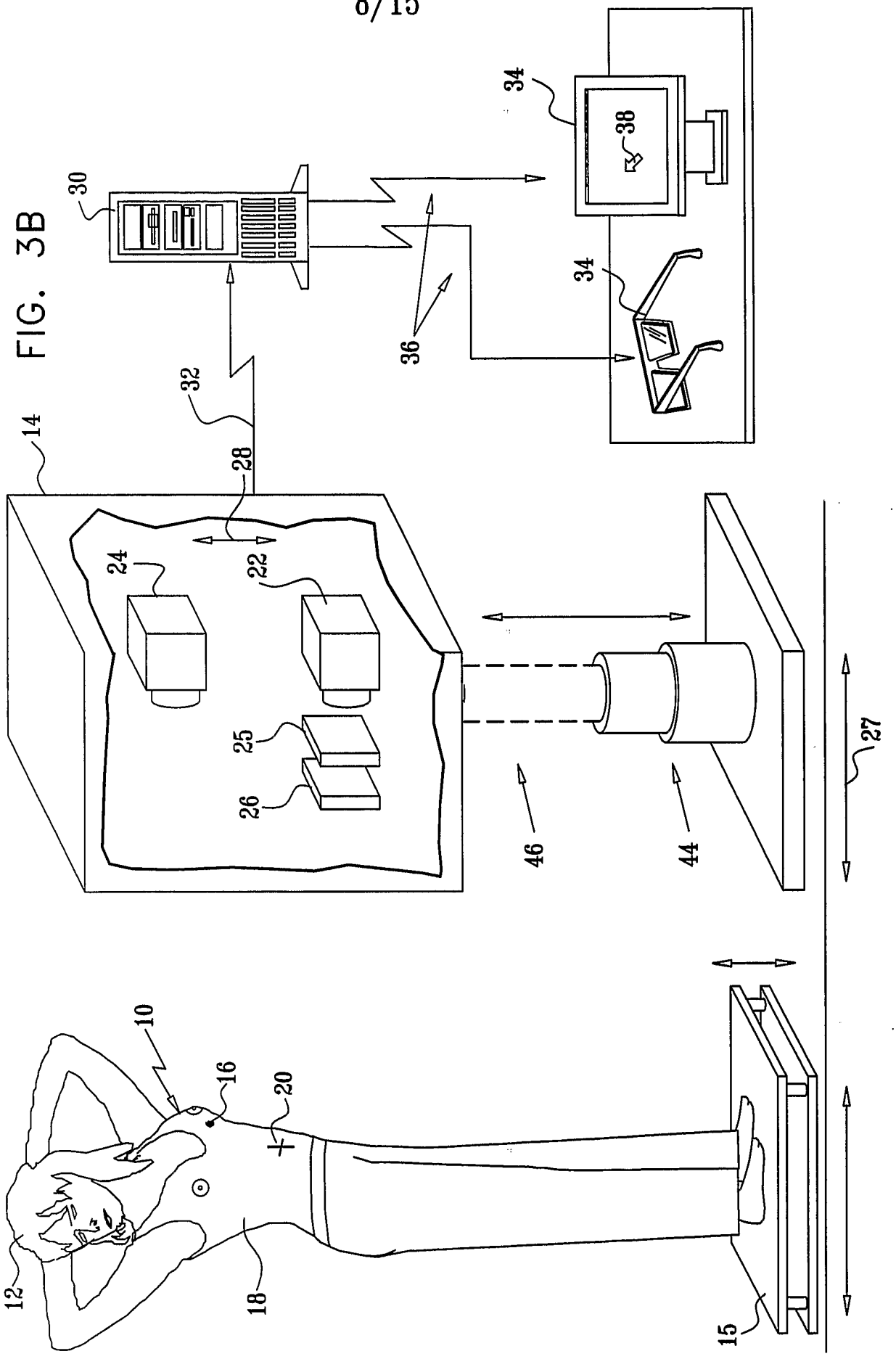


FIG. 3A

FIG. 3B



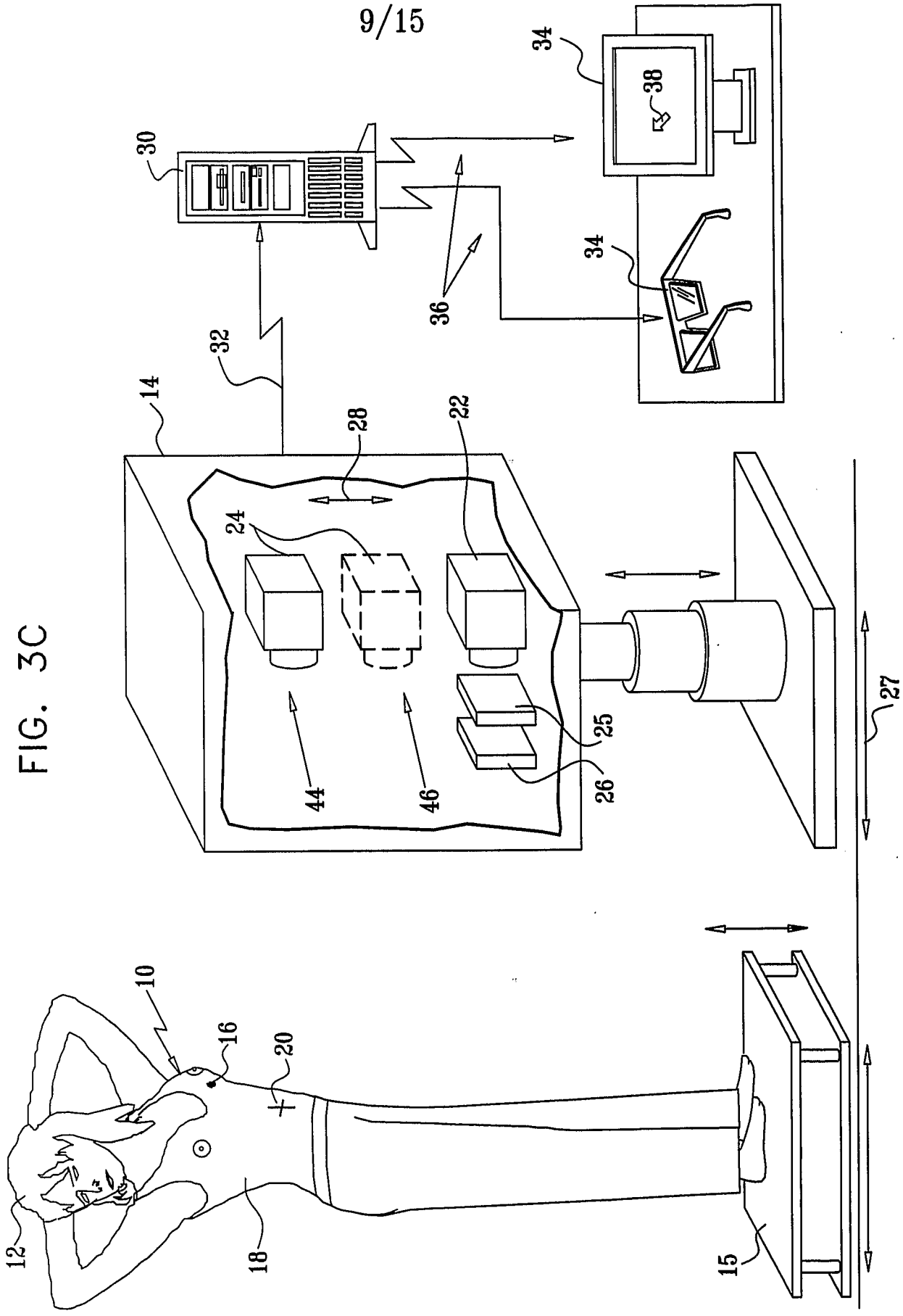
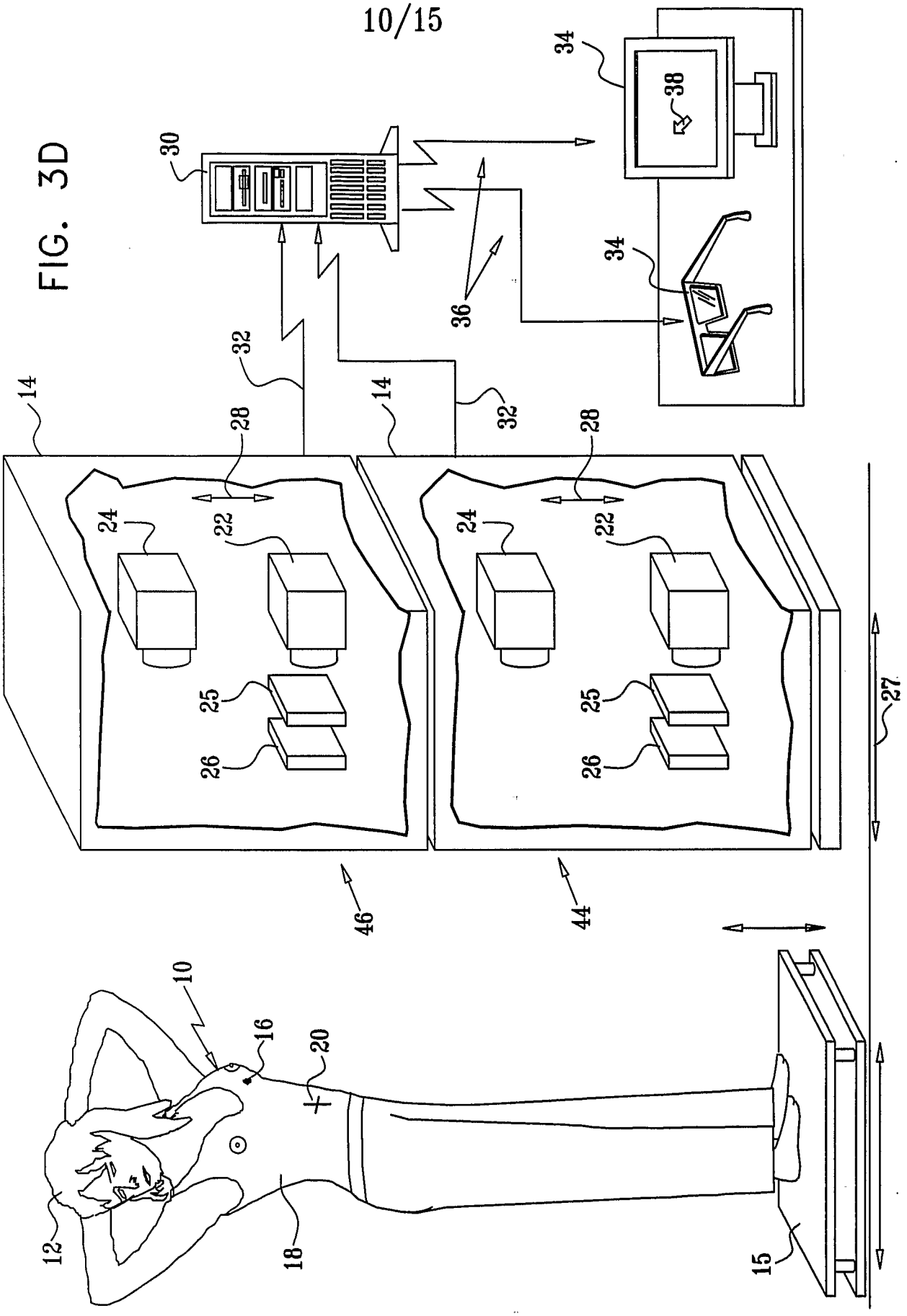


FIG. 3C

FIG. 3D



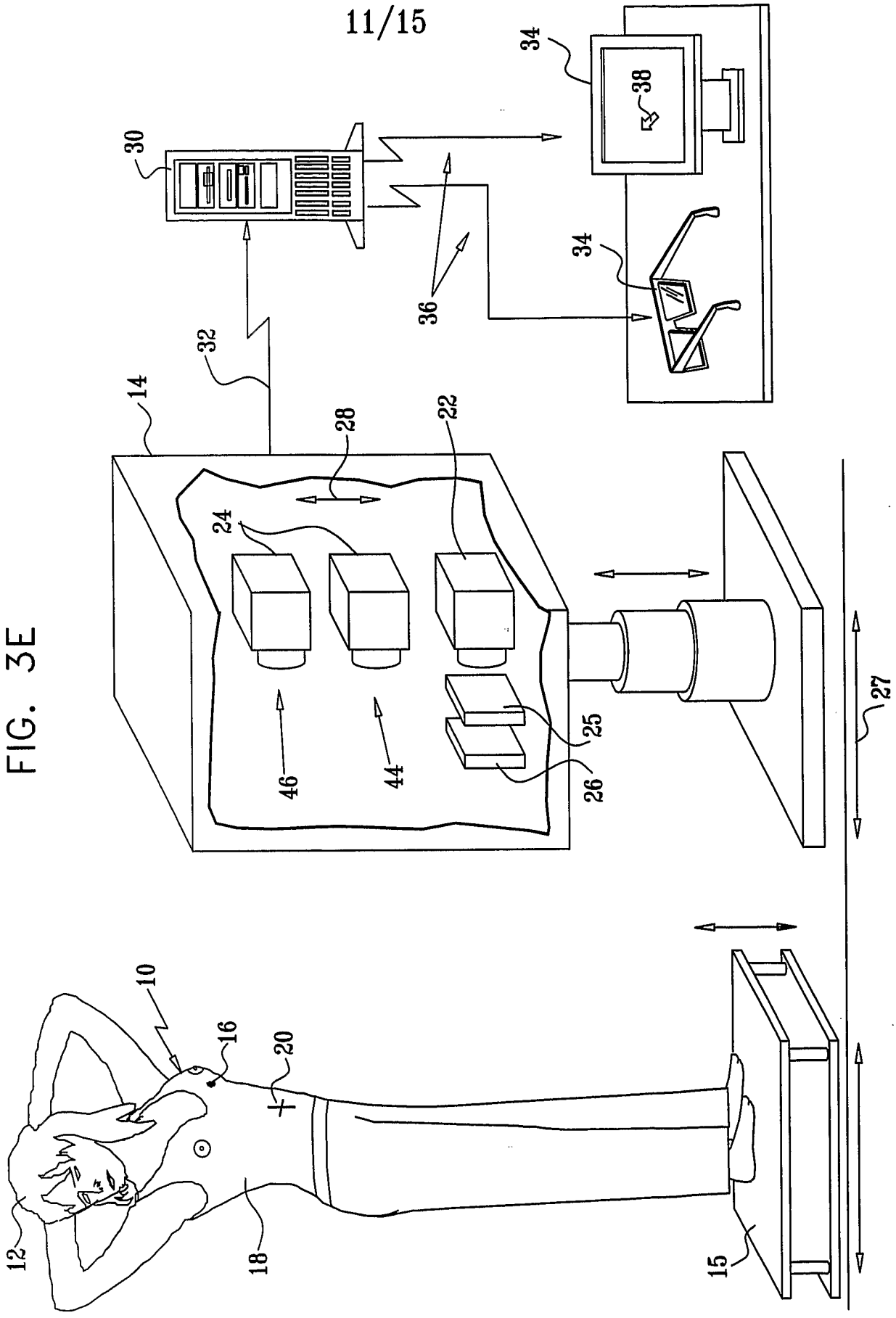
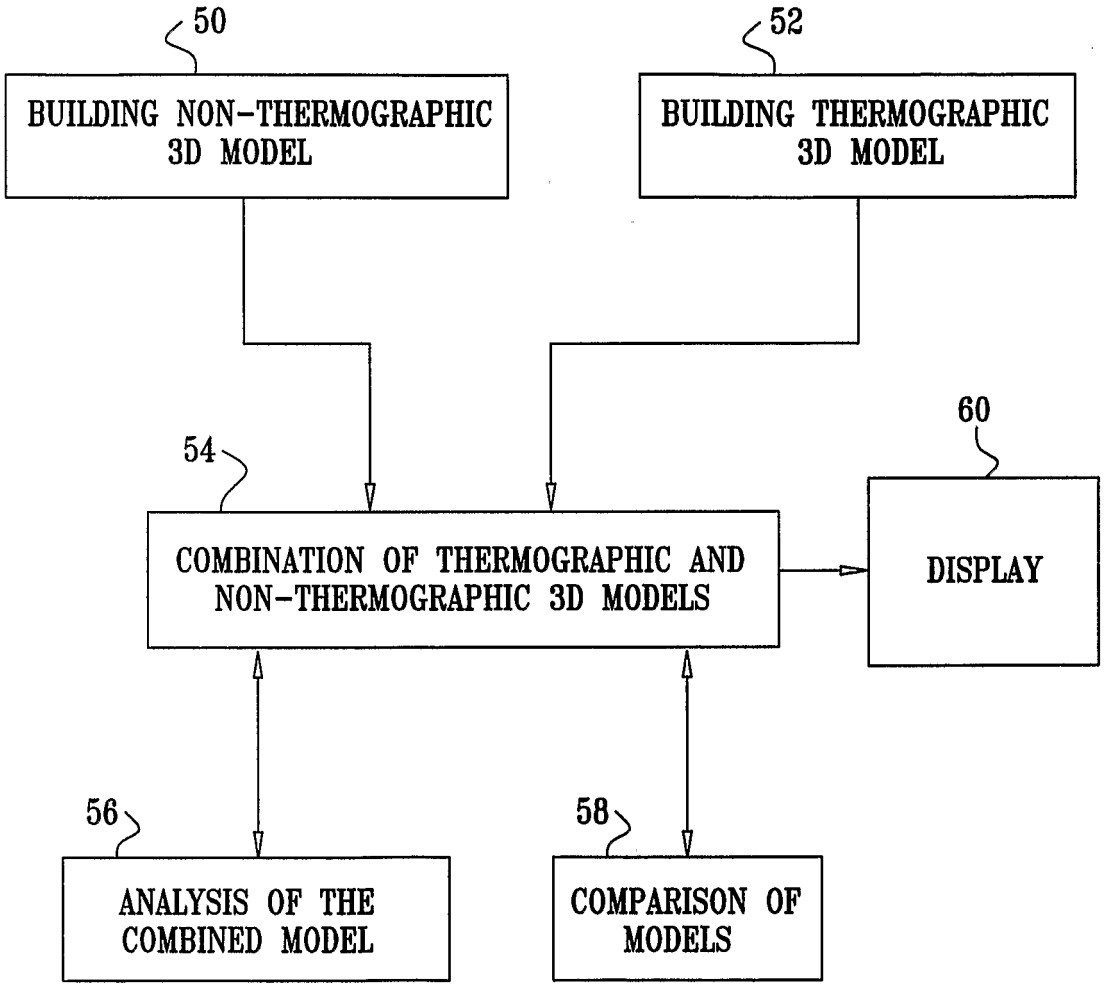


FIG. 3E

FIG. 4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BUILDING NON-THERMOGRAPHIC 3D MODEL
52
BUILDING THERMOGRAPHIC 3D MODEL
54
COMBINATION OF THERMOGRAPHIC AND NON-THERMOGRAPHIC 3D MODELS
60
DISPLAY
56
ANALYSIS OF THE COMBINED MODEL
58
COMPARISON OF MODELS

FIG. 5

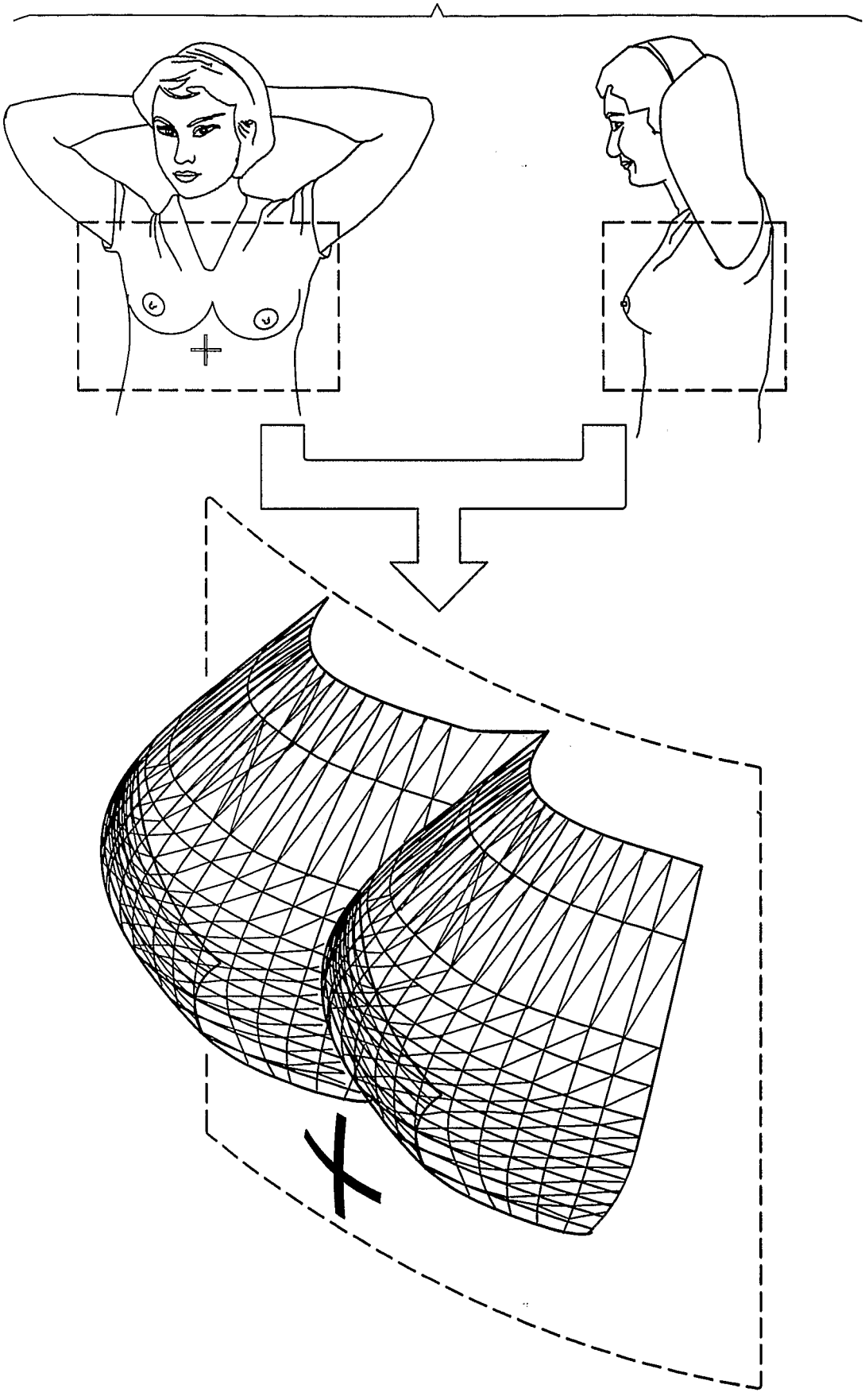
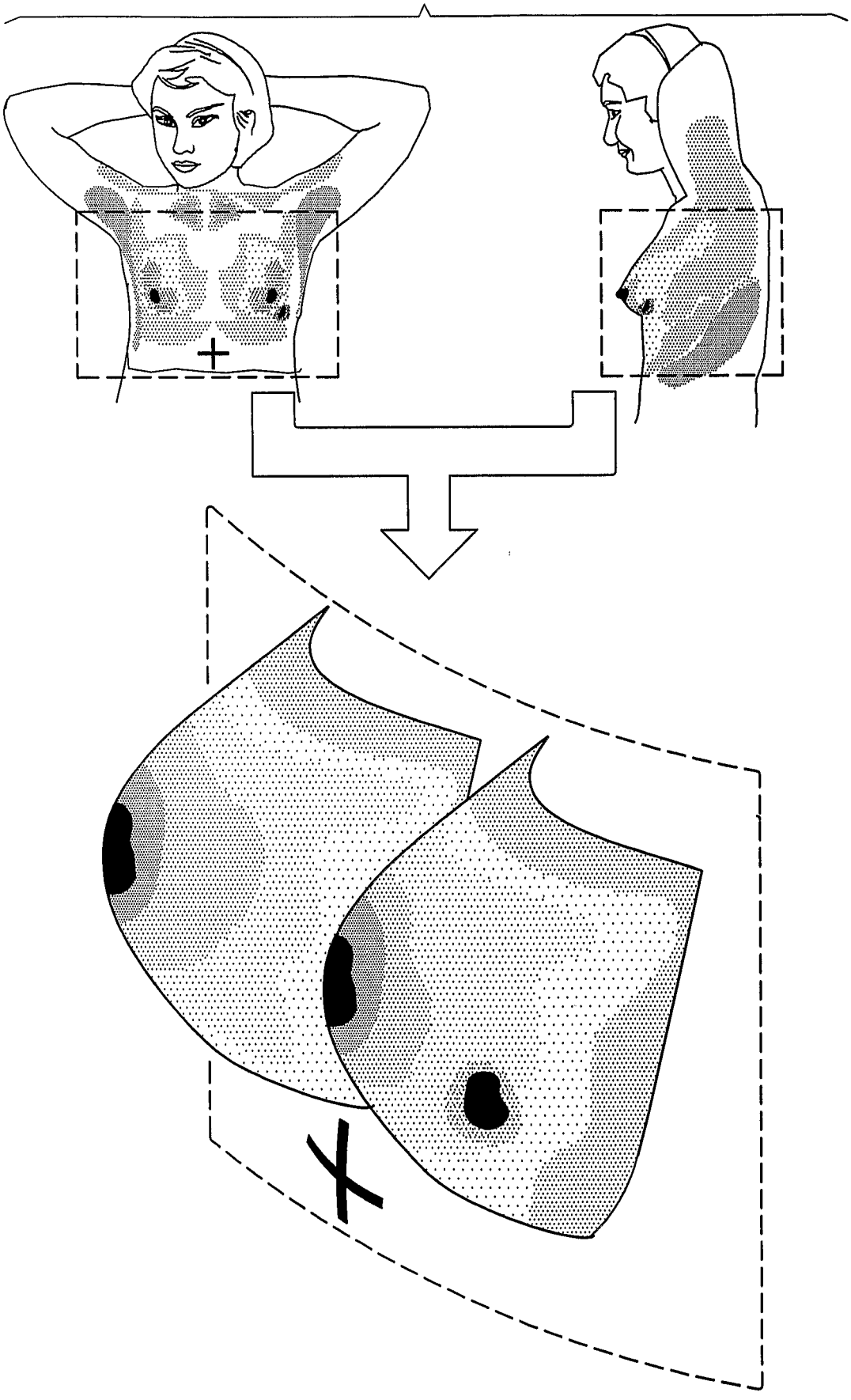


FIG. 6



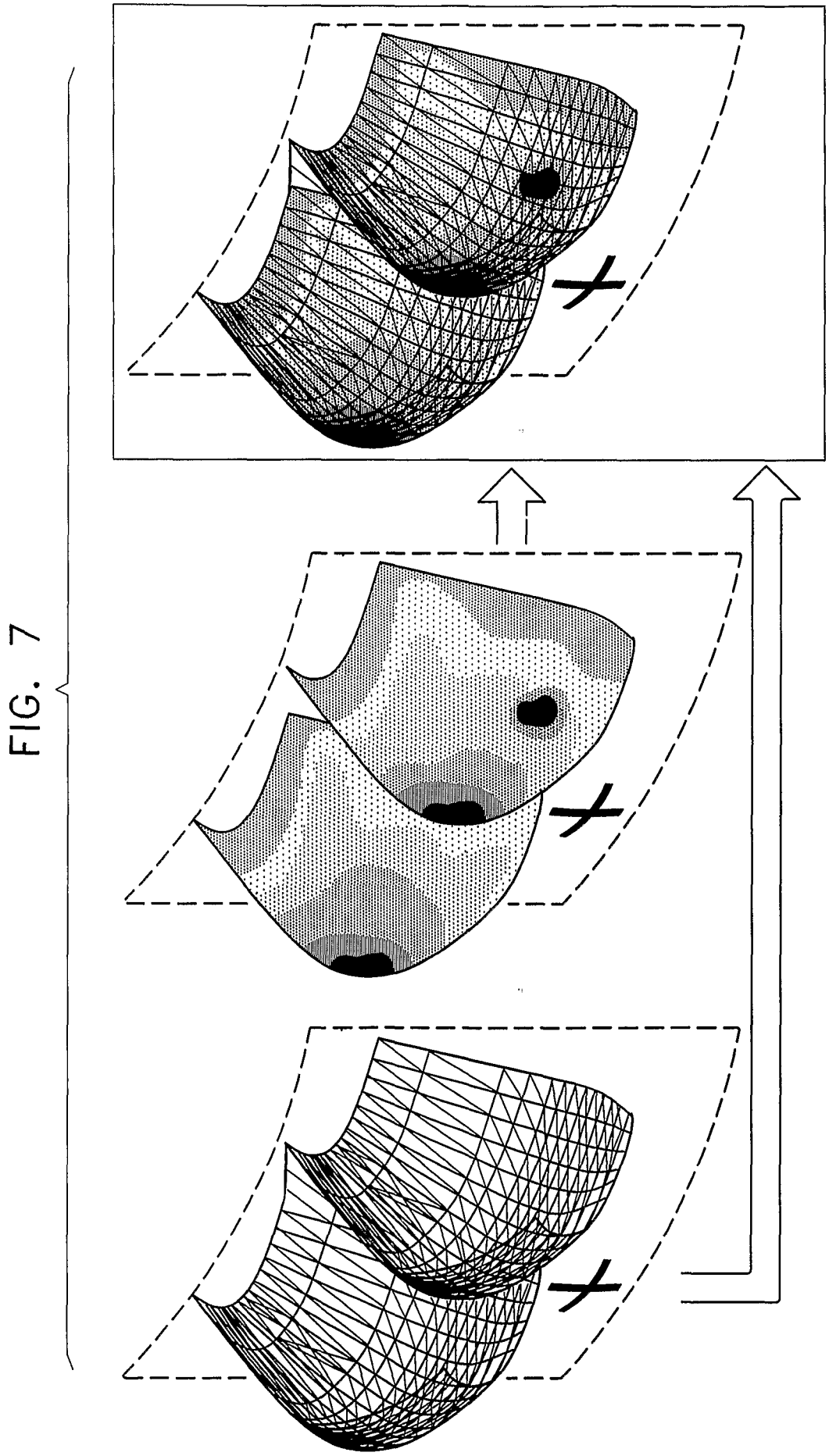


FIG. 7

专利名称(译)	3D热乳腺癌检测仪		
公开(公告)号	EP1766551A2	公开(公告)日	2007-03-28
申请号	EP2005756911	申请日	2005-07-04
[标]申请(专利权)人(译)	真实成像有限公司		
申请(专利权)人(译)	真实影像		
当前申请(专利权)人(译)	真实影像		
[标]发明人	ARNON BOAZ		
发明人	ARNON, BOAZ		
IPC分类号	G06K9/00 B01D61/00 G06T7/00 A61B5/00		
CPC分类号	G06K9/00208 A61B5/0091 A61B5/015 A61B5/4312 A61B5/444 G06K9/00362 G06K9/209 G06K2209/05 G06T7/0012 G06T2207/10048 G06T2207/30068 Y10S128/922		
优先权	60/586162 2004-07-07 US		
其他公开文献	EP1766551B1 EP1766551A4		
外部链接	Espacenet		

摘要(译)

一种用于人体的一部分（10,12,16,18和20）的3D热成像系统，包括用于人体的至少一部分的非热成像图像数据（22），热成像图像数据采集（24）用于获取包含至少一个物体的人体的至少一部分的至少一部分的热成像图像数据的功能和用于组合非热成像和热成像图像数据（30）以提供视觉的组合图像生成器的功能可感知的三维输出，指示至少一个物体在人体的至少一部分内的位置和取向。