



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>7</sup> :  A61B 6/04		A1	(11) International Publication Number: <b>WO 00/32109</b>		
(21) International Application Number: PCT/FI99/00988		(43) International Publication Date: 8 June 2000 (08.06.00)			
(22) International Filing Date: 29 November 1999 (29.11.99)					
(30) Priority Data: 982580 27 November 1998 (27.11.98) FI					
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(54) Title: METHOD AND APPARATUS FOR TISSUE IMAGING					
(57) Abstract					
<p>The object of the invention is a method and apparatus used in tissue imaging, in particular for positioning the tissue to be imaged in the imaging area. For example, in mammography the tissue has generally been, among other things, compressed with compression plates and/or even physically pulled into the imaging area. In accordance with the invention, a tissue stretching solution is presented, whereby a tissue stretching means, which comprises a layer of flexible material that is translucent to the energy form, containing image information, used in imaging, is simply, quickly and effortlessly feedable and attachable to the tissue stretching device.</p>					

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## Method and apparatus for tissue imaging

This invention relates to a method and apparatuses for tissue imaging, especially for positioning tissue within the imaging space. Various positioning methods are utilized for example in 5 mammography, where it is known e.g. to compress the tissue to be imaged between compression plates and/or even to physically pull within the imaging space.

Currently, there is a multitude of known technologies used for tissue imaging, such as, for example x-ray, ultrasound, and magnetic imaging technologies. Imaging has become a proven 10 method for the detection of e.g. cancers and other abnormalities before they advance to a phase that is difficult to treat or incurable.

One of the problem areas associated with the imaging of tissue involves the positioning and retaining of tissue within the imaging space during the imaging process. The more successful 15 one is in positioning of the tissue within the imaging space, the less probable is the need for subsequent exposures in place for the unsuccessful ones. Problems encountered in positioning may also result in more images of a tissue area becoming taken than would be absolutely necessary. These problems are emphasized when x-rays are used, in which case the importance of radiation hygiene, i.e. the need to minimize exposure of the tissue to radiation, must always be 20 taken into consideration.

One of the methods utilized for the positioning of tissue, especially in mammography, is compression of the tissue to be imaged. The main reason for compressing tissue is to keep it in place during the imaging process. However, when the tissue layer to be imaged gets thinner, the 25 amount of radiation also gets smaller and the imaging time is shortened, which further reduces the inaccuracies caused by movement of the tissue under exposure. Furthermore, as a result of a thinner layer of tissue the contrast of the image improves as scattering is reduced, which simultaneously enables the use of lower imaging values (kV). Additionally, resolution improves, the film darkens more homogeneously, and the result is a diagnostically more valuable image, 30 since possible deviations of superimposed tissue layers are more effectively differentiated from each other.

In mammography, areas easily excluded from the imaging space are those close to the chest wall and armpits, where cancers and tissue abnormalities quite often occur. On the other hand, 35 the process of compression can even lead to part of the tissue under exposure being pushed out of the imaging space. Therefore, efforts have been made in this field to develop various solutions related to compression plates and compression methods that would make it possible to

pull or otherwise manipulate the tissue of the chest and breast areas in such a fashion that the imaging space created by the compression plates would retain as much tissue as possible. Even negative pressure has been used in an attempt to draw tissue into the imaging space by suction.

5 A rather new and interesting method for drawing the breast into the imaging space has been presented in U.S. patent publication No. 5.553.111. According to this procedure, a layer of radiolucent material is positioned between the compression plate and the tissue to be imaged, for instance a layer of plastic film. This film is positioned between the tissue to be imaged and the contact or compression surfaces of the compression plates, for example so that the film passes  
10 both over and under the breast. Thereafter, the film is pulled in the direction of the tip of the breast in order to pull more tissue within the imaging space. The publication proposes utilizing either one continuous layer of film to pull tissue from opposite sides, or separate bands of film that are fastened at both ends to their individual film conveyors in order to create substantially a ring-shaped stretching means, which passes around the compression paddle used for compressing  
15 the tissue to be imaged.

In principle, the technology described in U.S. patent publication No. 5.553.111 contains many advantageous features. However, in a practical application of these principles the solutions presented are in many respects problematic. Because of the modern demand for strict hygiene,  
20 among other things, it would be advisable to change the disposable film or the corresponding stretching means for every client. The solutions specified in the patent publication for pulling the film, and for fastening it to the traction device, etc., do not include a means for quickly changing the stretching means between customers. In addition, in the solutions presented, sanitizing the traction device in situ would be awkward and uncertain. For example, in mammography screening tests, the time factor is of such importance that it would appear that the technology described in the publication could not be utilized as such, except possibly for clinical imaging.  
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Therefore, the object of the invention presented here is to raise the level of technology in the field of positioning methods related to tissue imaging.  
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Specifically, the object of the invention presented herein is to develop the technology based on tissue stretching means so as to speed up the practical process of imaging.

35 The object of the invention is to provide a solution whereby the tissue stretching means could be simply, quickly and easily fed and fastened to a tissue pulling device, thereby resulting in a reduction of the total imaging time and eliminating difficult installation procedures.

The object of the invention is to provide a solution to feeding the stretching means into the traction device in such a way that a sheet-like stretching means, or stretching means of some other, in its principal dimensions essentially a rectangular configuration, could be fed into the traction device as easily as a bank card or a note is fed into an automatic cash dispenser, or the like.

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The object of the invention is also to provide a solution for fastening the tissue-stretching means to the tissue-stretching device so as to guarantee a rapid, secure and non-slip lockage of the stretching means to the traction device.

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Moreover, the aim of the invention is to provide such a solution for fastening the stretching means to the traction device, as well as to provide such a traction device, that the stretching means can be both pulled into the device as well as driven out of it.

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The object of the invention is also to provide an imaging system that utilizes tissue traction technology whereby the imaging methods and imaging sequences typically used in mammography can be applied simply, efficiently and, if so desired, to some degree automatically.

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The aim of the invention is also to enable the utilization of all those components generally used in mammography, such as the various compression paddles, image information receivers, grids, etc., in the same fashion as before.

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The invention and some of its advantageous applications are described below by referring to the enclosed figures. However, the invention is not exclusively limited to these solutions but essential features of it are presented in the enclosed patent claims, specifically in the characterizing parts of the independent patent claims.

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In the enclosed figures the invention is illustrated with reference to an x-ray application. To a professional in this field, it is self-evident which parts the structure of the ultrasound device adapted for the invention would deviate from the structure of the x-ray apparatus presented here.

Of the enclosed figures

figure 1 depicts a mammography x-ray apparatus,

35

figure 2 depicts the general principle of the traction of tissue to be imaged in accordance with typical prior art technology,

figure 3 depicts one stretching device according to the invention,

figures 4a-c depicts the operation of a stretching device as specified in figure 3 and

5 figure 5 shows an arrangement, according to the invention, of the stretching device for tissue to be imaged.

In accordance with figure 1, a typical mammography x-ray apparatus 1 comprises a body part 11 and a C-arm 12, or a corresponding part, connected to the body part 11, when typically a 10 radiation source 13 and a radiation receiver 14 (not actually shown in the figure) are situated at the opposite ends of the C-arm 12. Typically, C-arm 12 can be moved vertically and rotated in relation to the body part 11. Moreover, it is typical for compression paddles 15, 16 to be used in the apparatus, one of which is often structurally attached to the radiation receiver 14. The apparatus is typically equipped with means (not shown in the figure) for changing the height position 15 of the compression paddles 15, 16 in relation to C-arm 12.

Figure 2 depicts the general principle for traction of the tissue to be imaged in accordance with prior art in connection with a mammography apparatus utilizing compression technology. In this respect, it is emphasised that although compression is a beneficial method from the view- 20 point of applying the invention, the mere contact of the compression paddles with the stretching means and through it to the tissue to be imaged could in some applications of the invention be sufficient.

Before positioning the tissue to be imaged 20 in the imaging space created between the compression paddles 15, 16, a stretching means 21 made of elastic material is installed in the imaging device in accordance with figure 2. In accordance with the prior art, stretching means 21 can comprise, for example, a continuous band of film that is positioned to move along the contact or compression surfaces 22, 23 of compression paddles 15, 16 and through the traction device not shown in the figure. The traction device can be situated, for example, within the C-arm 30 12, in which case it is equipped with means for pulling the stretching means 21 approximately from its center towards the C-arm 12. In this case, the tissue to be imaged 20 could be placed in the pouch-shaped space open at the sides created by the stretching means 21. Alternatively, in accordance with prior art, the stretching device could comprise a ring-shaped stretching means 21 moving around either one or the other or around both individual compression paddles 15, 35 16, as well as being comprised of a transport device for either of such stretching means 21.

In accordance with figure 2, the tissue imaging process is initiated by moving, for example, the upper compression paddle 15 towards the lower compression paddle 16 (2a), such that the tissue to be imaged 20 gets evenly spread out over the imaging space (2b). The traction of tissue 20 within the imaging space is initiated by starting up the traction device or a separate conveyor device, not shown in the figure, which moves 25 the stretching means 21 in relation to the contact or compression surfaces 22, 23, whereby the tissue to be imaged 20 starts stretching in the direction of traction 26 and tissue located outside the space of contact or compression surfaces 22, 23 starts moving towards the imaging space (2c). Thus the image to be taken of tissue 20 will comprise such tissue that would normally remain outside the imaging space and where lesions 27 often occur (2d). The amount of the movement of tissue does not have to be at all large. For example, the transfer of a few millimeters can already be diagnostically significant.

Figure 3 depicts one traction device 30 according to the invention that comprises a rotating axle, cylinder or drum 31, one or several means 32 for locking the stretching means 21, the operating part of which consists of, e.g., an eccentric wedge 33, a compressor spring 34 of the eccentric wedge 33, one or several guides 35 for the stretching means, and the release bar 36 of the eccentric wedge 33 or a corresponding component. Furthermore, the stretching device may comprise a receiver means for the stretching means, in figure 3 a wedge-shaped aperture 37 of the guide 35 of the stretching means 21. A motor 38 and power transmission means, not shown in the figure, drive the stretching device 30.

Figures 4a-c describe the functioning of the stretching device 30 as shown in figure 3. Stretching means 21, which is made of elastic material and is advantageously substantially rectangular in shape, is fed into the wedge-shaped receiving aperture 37 that directs stretching means 21 into a position between the cylinder 31, which can be rotated, and the eccentric wedge 33 (4a). The compressor spring 34 of the eccentric wedge 33 assists the engagement of the stretching means 21 between the wedge 33 and the cylinder 31, but the actual locking is based on the structure of the eccentric wedge 33 itself and the fixation of it to the stretching device 30. The eccentric wedge 33 tends to continuously adhere itself more closely to the cylinder 31, when the stretching means 21 that is fed into the space between the cylinder 31 and the eccentric wedge 33 is exposed to a force from the direction that extracts it from device 30. The stretching means 21 is pulled by the rotating cylinder 31. The dimensions and gear ratios between the stretching device 30 and the power transmission means can be such, for example, that rotation of cylinder 31 for half a cycle is sufficient to pull stretching means 21 to the supposed maximum distance, for example 50 mm (4b). Stretching means 21 is disengaged by rotating cylinder 31 in the opposite direction, whereby the sheath-like guide 35 that covers cylinder 31 feeds stretching means 21 from device 30 and the lock of stretching means 21 is released when the

eccentric wedge 33 comes into contact with the release bar 36 that turns the eccentric wedge 33 so that it disconnects with the surface of the cylinder 31 (4c).

Stretching device 30 may also comprise means, not shown in the figures, for identification of the feeding of the stretching means 21. For example, in connection with compressor spring 34 a micro switch can be installed that would react when coming into contact with stretching means 21. Alternatively, guide 35 can be equipped with components for the optical identification of the stretching means 21. Identification can also be specifically arranged so that the type of stretching means 21 fed into device 30 can be identified. In such case the control system may 10 include a signal route from identification means to traction or transport means, and the control system may be pre-programmed with typical imaging process parameters for each stretching means. Stretching device 30 can contain e.g. automatic control systems for locking the stretching means 21 based on an identification signal, e.g. by rotating cylinder 31 according to figures 15 3 and 4 or a corresponding device, a short distance. If desired, the whole imaging process can be automated according to the pre-programmed parameters of the apparatus, among other things when the compression ceases, the stretching means can be fed out of the device either to its initial position of imaging process, or entirely out of the device.

The arrangement can also comprise identification means for the traction force and traction distance of stretching means 21. In accordance with the invention, it is possible to arrange several stretching devices 30 that can be controlled independently of each other, thus making it possible to drive them, if so desired, by stretching the tissue only on one side or by stretching it from different sides for distances of variable length and/or by stretching tissue from different sides at different speeds. Device 30 can also be programmed to encompass different traction sequences 25 or traction-related security limit values such as, for example, the maximum traction force of the stretching means and/or limit values of the maximum stretching length, which can amount to e.g. 300 N for the traction force, 50 mm for the stretching length and 20 mm/s for the stretching speed, whereby typical values in use would be somewhat lower than these limit values.

30 Naturally, the traction components of stretching device 30 do not have to comply in all their details with the above-mentioned advantageous embodiments. The locking of stretching means 21 to the stretching device can also be implemented in other ways, for example with a locking device attached to some sort of gliding cradle. Thus one advantageous way of implementing the stretching movement would be to move the cradle along a suitable groove, or corresponding 35 element for controlling movement, advantageously in a linear fashion. It is also possible to utilize a solution whereby the traction means consists of two substantially parallel axles; both equipped essentially at their ends with intermeshing groove, gear or corresponding structures.

During rotation such axles fasten the stretching means between the axles by said intermeshing grooves or corresponding means, which axles while rotating further convey the stretching means through the transport device. Such a solution is especially advantageous, when one seeks to draw out the stretching means from the imaging device by other than the feeding route.

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Figure 5 shows how a stretching device 30, in accordance with the invention, can be integrated, for example, in a C-arm structure 12 typical to a mammography apparatus 1 in order to form a tissue positioning apparatus 50 according to the invention. In the arrangement shown in figure 5, the C-arm 12 includes the upper and lower compression paddles 15, 16, which are movable in relation to the C-arm, a cassette tunnel 51 coupled to the lower compression paddle 16, a movable grid 52, the so-called bucky, and the upper and lower stretching devices 30 in an essential vicinity of the compression paddles. A radiation receiver 14 of the desired type can be attached to the cassette tunnel 51, while the radiation source 13 is located on the opposite frame of the C-arm structure 12.

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In the arrangement depicted in figure 5, it is possible to position a stretching means 21 for both of the compression paddles 15, 16 by engaging them, for example, to the stretching devices 30 shown in figure 3 and 4. Otherwise, the imaging process can be executed, for example, in the way referred to in the description which refers to figure 2.

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On the other hand, one advantageous way to execute the imaging process, according to the invention, as, for example, in an arrangement according to figure 5, consists of stages wherein two stretching means 21 are fed into stretching devices 30 of their own, are then locked or engaged to the traction or transportation means of the stretching device 30, and the tissue to be imaged 20 is alternately first compressed and then pulled, possibly several times if necessary, provided the patient's ability to tolerate pain does not restrict the process. Thereafter, the picture is taken, the compression is released and the stretching means 21 are moved to their starting position, i.e. to the position they were in when locked or engaged to the traction or transportation means, after which the same phases are repeated in order to take a picture of the same object, but from a different angle and/or e.g. taking an image of the same object but of a different place in the tissue, i.e., taking an image first of one breast or breast tissue and then taking an image of the other breast or breast tissue.

The imaging process can be speeded up by simultaneously making the compression and stretching movements, as well as their counter movements. This type of simultaneous stretching and compression method can also be automated as a function of the increase of compression force and the decrease of compression thickness. The optimal compression force and pull-

ing-speed/pulling-distance interdependence for various tissue types to be imaged can be determined by clinical tests. The tissue type can be identified, for example, by compression thickness and force, in which case e.g. a tissue with a great starting thickness, and with which a relatively small force is needed for compression, can be drawn in greater volume to the imaging area than a tissue with the opposite qualities. Automation can be done for example by first compressing for a short distance, e.g. until a specific compression force is reached, after which the tissue is both pulled and compressed and possibly separately pulled or compressed at the end.

When using the imaging technology, which makes possible a real-time or a near real-time imaging or allows for the movement of the tissue, it can be advantageous, in a diagnostic sense, to stretch the tissue while imaging.

One of the advantages of the technique according to the invention is that it makes it possible to use all of the imaging practices typically used in mammography without requiring any special arrangements due to the application of the invention. For example, it would be difficult to apply the magnification imaging typical in mammography to at least some of the prior art solutions, since the stretching device arrangement would make changing the distance between the receiver and the imaging area difficult or even impossible. A stretching device in accordance with the invention can also be attached to an existing mammography apparatus with relatively small alterations.

Breast tissues, in particular, vary considerably in terms of size. Because of this, in mammography there has generally been used image information receivers of different sizes, compression plates of different sizes and types etc., for objects of different sizes. In the tissue stretching device of the arrangement according to the invention, the advantage is that it does not in any way limit the possibilities for utilization of these different size and/or otherwise different equipment. Image information can also be received in the same way as with all known techniques, such as on film or digitally.

Although the invention has been described above in connection with the use of two compression plates closing on tissue from opposite sides, it can also naturally be used in connection with applications using just one or more than two compression plates or with the compression structure surrounding the tissue being imaged. When utilizing several compression paddles, it is often beneficial that they are made to approach the tissue being imaged in an essentially symmetrical fashion.

In accordance with the invention, the stretching material itself can be of any flexible material that is translucent to the energy form utilized in imaging. Potential materials include e.g. various types of plastics, fabrics, cellulose-based materials and even appropriate metals. The stretching means can be made so that it comprises areas with varying tensile stress, thus making 5 it possible to regulate the degree of stretching of tissue even in this manner.

Furthermore, it is not necessary that the actual form of the stretching means be that of a genuine rectangle. What is essential is that the stretching means can easily be fed into the stretching device from one end. However, from the point of view of locking the stretching means, it may be 10 advantageous to design some kind of projection or projections at the feeding end of it, in order that the stretching device can easily grasp and lock the stretching means. Projections of this kind can e.g. be in the form of a rectangle or a triangle, either pointed or blunt, and they can form the whole group of projections covering the feeding end of the stretching means. The appropriate form of the feeding end can also be used as an implement according to which the 15 stretching device specifically identifies the stretching means.

Identifying the stretching means can, of course, be based on many other characteristics as well, such as the colour of the stretching means, a colour sticker or a bar code attached to the stretching means.

20 The invention also makes it possible to optimize the form of the stretching means as well as its structure, such as its length, width, thickness and material to be applicable with various compression paddles. For example, with the upper and lower compression paddles one can use a specific stretching means, one can use specific stretching means for compression paddles of 25 differing widths, as well as a specific stretching means with various, so called spot-compression paddles etc.

The applications outlined above represent favourable and potential embodiments of the invention to which it is in no way intended to be limited. The following patent claims define the 30 scope of the invention, within the idea according to which many details may vary.

## Claims

1. An arrangement in a stretching device for tissue to be imagined, which stretching device (30) includes traction or transportation means for stretching means (21) and means for receiving the stretching means (21), which stretching means (21) in turn has a layer of flexible material that is translucent to the energy form used in imaging, and means to engage the stretching means (21) to the traction or transportation means of the stretching device (30), characterized in that means for receiving the stretching means (21) have been arranged to receive, as for its predominant shape essentially a rectangular or otherwise elongated sheet like or band like, or the like, stretching means (21) from the direction of one of its end sides, or from the corresponding direction in view of the predominant shape of the stretching means (21).  
5
2. An arrangement in a stretching device according to claim 1, characterized in that it includes means to lock the stretching means (21) to the traction or transportation means from the one side it is adjusted to be fed into the stretching device (30), or to engage the stretching means (21) to the traction or transportation means at the sides adjacent to the side from which it is adapted to be fed into the stretching device (30).  
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3. An arrangement in a stretching device according to claim 1 or 2, characterized in that means for receiving the stretching means (21) comprise a guide or some other structure (37), which endeavors to guide the stretching means (21) fed into the stretching device (30) around a drum, cylinder, bar, pipe, axle, or the like, that belongs to the traction or transportation means.  
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4. An arrangement in a stretching device according to claim 3, characterized in that the means to engage the stretching means (21) to the stretching device (30) include a locking device (32) that is operatively connected to the aforementioned cylinder (31), or the like.  
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5. An arrangement in a stretching device according to claim 4, characterized in that the locking device (32) includes an eccentric (33), which eccentric, when in contact with the aforementioned cylinder (31), or the like, forms such a locking device (32) that the eccentric (33) attempts to wedge against the casing of the cylinder (31), or the like, when the stretching means (21) being fed between them is under the influence of a force acting counter to the feeding direction of it.  
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- 35 6. An arrangement in a stretching device according to any of the claims 2-5, characterized in that means for locking the stretching means (21) include, for facilitating the engaging of it, a spring (34) that presses the eccentric against a cylinder (31), or the like.

7. An arrangement in a stretching device according to any of the claims 1-6, characterized in that it includes means to operate the traction or transportation means in both the pulling direction of the stretching means (21) as well as in the opposite direction.

5 8. An arrangement in a stretching device according to claim 7, characterized in that it includes a release bar (36), or a corresponding equipment, for releasing the locking of the stretching device (30), which release bar has been set to contact the eccentric (33) in such a way that when the cylinder (31), or the like, is rotated against the feed direction of the stretching means (21) it turns the eccentric (33) such that the eccentric (33) breaks off contact with the surface of  
10 the cylinder (31), or the like.

9. An arrangement in a stretching device according to claim 1 or 2, characterized in that it includes implements to convey the stretching means (21) through the stretching device (30).

15 10. An arrangement in a stretching device according to any of the claims 1-9, characterized in that it includes sensor means to ascertain if the stretching means (21) has been fed in the stretching device (30).

20 11. An arrangement in a stretching device according to claim 10, characterized in that it includes a control system which has a signal route from the sensor means to the traction or transportation means in order to transmit the information of the reception of the stretching means (21).

25 12. An arrangement in a stretching device according to claim 11, characterized in that it includes means to lock or engage the stretching means (21) to the traction or transportation means according to the identification signal transmitted through the aforementioned signal route.

30 13. An arrangement in a stretching device according to any of the claims 2-12, characterized in that implements (32) for engaging or locking the stretching means (21) include an arrangement to drive the traction or transportation means a short distance.

35 14. An arrangement in a stretching device according to any of the claims 10-13, characterized in that the sensor means include the implements to identify what kind of stretching means (21) has been fed into the receiving means (37) and the implements to control the stretching device (30) on the basis of this identification information.

15. An arrangement in a stretching device according to any of the claims 1-14, characterized in that it includes means for measuring the stretching force exerted on the stretching means (21), for measuring the distance that has been pulled, for adjusting the traction force, the distance pulled and the traction speed, and for setting maximum values for these parameters.

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16. An arrangement in a stretching device according to any of the claims 1-15, characterized in that it has been adjusted, together with the contact or compression device (11, 15, 16) of the tissue to be imaged, to form a positioning device (50) of the tissue to be imaged, whereby the contact or compression device (11, 15, 16) includes one or several contact or compression surfaces (22, 23) approaching the tissue to be imaged, or a contact or compression surface (22, 23) encircling the tissue to be imaged, whereby the stretching means (21) has been arranged to be adjusted between the tissue to be imaged (20) and the contact or compression surface (22, 23) - in order to form contact surface or surfaces for the tissue to be imaged (20) and for the stretching implement (21).

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17. An arrangement in a stretching device according to claim 16, characterized in that the positioning device (50) made up of the stretching device (30) and the contact or compression device (11, 15, 16) has means for operating the stretching device (30) and the contact or compression device (11, 15, 16) alternately and/or simultaneously.

15

18. An arrangement in a stretching device according to claim 16 or 17, characterized in that in an arrangement with more than one stretching device (30) there are means for pulling the stretching means (21) for distances of differing lengths on various sides of the tissue and/or for pulling the tissue from just one side.

20

19. An arrangement in a stretching device according to any of the claims 15-18, characterized in that the positioning device (50), which is made up of the stretching device (30) and the contact or compression device (11, 15, 16), has two stretching devices (30) that have been adjusted in respect of the tissue to be imaged (20), so that the contact surfaces of the stretching means (21) and of the tissue to be imaged (20) are situated on different sides of the tissue to be imaged (20).

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20. An arrangement in a stretching device according to any of the claims 16-19, characterized in that said contact or compression device (11, 15, 16) has connector means for the receiver (14) of the energy form, containing the image information, generated in the imaging process.

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21. An arrangement in a stretching device according to any of the claims 1-15, characterized in that the means for attaching the aforementioned receiver (14) allow for various sized receivers (14), receivers based on different imaging techniques and/or different receiving techniques, to be attached to the contact or compression device.

5 22. An arrangement in a stretching device according to claim 20 or 21, characterized in that it includes means for adjusting the distance between the image information receiver (14) and the imaging area.

10 23. An arrangement in a stretching device according to any of the claims 16-22, characterized in that it includes control means for automatically driving the traction and compression devices on the basis of a pre-determined program and/or, e.g., thickness and compression force information received from the compression of the tissue to be imaged.

15 24. An apparatus for imaging tissues, in particular an apparatus for imaging breast tissue and tissue of the breast area, which apparatus includes a body part (11), a source of energy (13) used in the tissue (20) imaging and a receiver (14) for the energy form, containing image information of the tissue to be imaged, received from this source (13), a control system of the imaging apparatus (1) and a positioning apparatus (50) for the tissue to be imaged (20), which positioning apparatus (50) includes a contact or compression device (11, 15, 16) which includes a contact surface approaching the tissue to be imaged (20), or the contact or compression surfaces (22, 23), or a continuous contact or compression surface encircling the whole tissue to be imaged (20), and a stretching device (30) for the tissue to be imaged, which includes a traction or transportation means of the stretching means, means (37) for receiving the stretching means (21), which stretching means (21) contain a layer of flexible material that is translucent to the energy form used in the imaging, and means for engaging the stretching means (21) to the traction or transportation means of the stretching device (30), characterized in that means (37) for receiving the stretching means (21) have been arranged to receive - as for it's predominant shape essentially a rectangular or otherwise elongated sheet like or band like, or the like - stretching means (21) from the direction of one of it's end sides, or from the corresponding direction in view of the predominant shape of it.

20 25. An imaging apparatus according to claim 24, characterized in that the stretching device (30) of the tissue to be imaged (20) is in accordance with any of the claims 2-23.

25

26. An imaging apparatus according to claim 24 or 25, characterized in that it has means for driving the stretching means (21) out of the imaging apparatus (1) through implements that are separate from the receiving means (37) of the stretching means (21).

5 27. An imaging apparatus according to claim 24, 25 or 26, characterized in that the source of energy (13) used in imaging the tissue (20) is an x-ray tube.

28. A tissue stretching means, which is especially used in the imaging of breast tissue and tissue of the breast area, which stretching means (21) has a layer of flexible material that is translucent to the energy form utilized in imaging, which stretching means (21) is intended to be engaged to the traction or transportation means of a stretching device (30) that stretches the tissue to be imaged, characterized in that stretching means (21) is, as for its predominant dimensions, essentially a rectangular or of otherwise elongated sheet like or band like, or the like, shape, and that one of the sides corresponding the end side of it can be brought into to any arrangement as per claims 1-23 or to any receiving elements (37) of a stretching device (30) of an imaging apparatus as per claims 24-27 in such a way that it is able to be locked or engaged to the traction or transportation devices of the said stretching device (30).

10 15 29. A stretching means according to claim 28, characterized in that it contains areas with various grades of tensile stress.

30. A stretching means according to claim 28 or 29, characterized in that it is a plastic film, a strip of cloth, a cellulose based band or sheet, or a thin metal plate.

25 31. A stretching means according to any of the claims 28-30, characterized in that it includes means that make possible the identification of the specific characteristics of the stretching means (21), such as a certain colour of the stretching means (21), a colour sticker, a bar code, or the shape of the feed end of the stretching means (21).

30 32. A stretching means according to any of the claims 28-31, characterized in that the side of it which corresponds to the end side in its predominant form, and which is fed into the receiving elements (37) of the stretching device (30), has been designed to have a tapering projection, or to have a symmetrical or asymmetrical blunt or pointed triangle, or to have a feeding edge comprised of several such triangle- or rectangle-shaped or other forms.

35 33. A method in tissue imaging, in particular, imaging the tissues of the breast and the breast area, in which method the energy emanating from an energy source of an energy form used in

the imaging, which energy source is part of an imaging apparatus, is directed to the object to be imaged and further onto the receiver of the form of energy, containing the image information, and in which the tissue to be imaged is positioned in the imaging area with the help of a contact or compression surface of a positioning apparatus belonging to the imaging apparatus, and in 5 which the tissue being imaged is put into contact with the surface of a stretching means used in a stretching device belonging to the imaging apparatus, to form a contact surface between them, when the tissue to be imaged is stretched by using the aforementioned stretching means, which stretching means comprises a layer of flexible material that is translucent to the energy form, containing image information, used in the imaging, characterized in that the stretching 10 means, being as for it's predominant form essentially a rectangular or of otherwise elongated sheet like or band like, or the like, shape, is put in contact with the receiving means belonging to the stretching device, at one of it's end sides, or from the corresponding direction in view of the predominant shape of the stretching means.

15 34. A method according to claim 33, characterized in that the stretching means is placed in contact with the traction or transportation means of the stretching device belonging to the imaging apparatus, and whereby the stretching means is locked into fixed contact with the traction or transportation means at that one side which was fed into the stretching device, or the stretching means is engaged to the traction or transportation means at the side adjacent to the side which 20 was fed into the stretching device.

35. A method according to claim 33 or 34, characterized in that the locking or engaging is achieved by driving the stretching means a short distance into the traction device.

25 36. A method according to any of the claims 33-35, characterized in that the stretching means is driven around a drum, cylinder, bar, pipe, axle or the like which belongs to the traction or transportation means.

30 37. A method according to any of the claims 33-36, characterized in that the stretching means is identified as being fed into the traction device with the help of the identification means that constitute a part of the traction device.

38. A method according to claim 37, characterized in that the identification means send an identification signal to the control system of the imaging apparatus.

39. A method according to claim 38, characterized in that the control system sends a signal to the traction or transportation device of the stretching means, whereupon it locks or engages the stretching means to the traction or transportation device.

5 40. A method according to any of the claims 33-39, characterized in that with the help of the identification means, the type of the stretching means fed into the receiving means is identified and the stretching device is controlled based on this identification information.

10 41. A method according to any of the claims 33-40, characterized in that the stretching device is driven both in the pulling direction and in the opposite direction of the stretching means.

42. A method according to claims 33-34, characterized in that the stretching means is driven through the stretching device.

15 43. A method according to any of the claims 33-42, characterized in that the stretching means is driven out of the imaging apparatus via a different route than it was fed in, advantageously through means separate from the receiving means of the stretching device.

20 44. A method according to any of the claims 33-43, characterized in that in order to position the tissue to be imaged, more than one contact or compression surface approaching the tissue or a contact or compression surface completely encircling the tissue to be imaged is utilised, when the stretching means is placed in between one or more of these surfaces and the tissue to be imaged before they come into contact with each other.

25 45. A method according to claim 44, characterized in that the tissue to be imaged is stretched only at one point or at different points at differing lengths.

30 46. A method according to claim 44 or 45, characterized in that the tissue to be imaged is essentially stretched symmetrically from different sides, for example, in essence from opposite sides.

47. A method according to any of the claims 44-46, characterized in that the tissue to be imaged is compressed and stretched simultaneously.

48. A method according to any of the claims 44-47, characterized in that the object to be imaged is compressed and stretched alternately, possibly several times, before imaging and/or between different imaging operations.

5 49. A method according to any of the claims 44-48, characterized in that an image of the same tissue is taken from two or several different angles, while between the previous and the next image the stretching means is driven back to the starting position of the imaging sequence, i.e. to the position where it was after becoming locked or engaged to the traction or transportation means of the stretching device.

10 50. A method according to any of the claims 33-49, characterized in that the tissue is stretched during the imaging process.

15 51. A method according to any of the claims 33-50, characterized in that different images are taken of the same tissue by changing the distance between the receiver in relation to the tissue to be imaged.

20 52. A method according to any of the claims 44-51, characterized in that the traction and compression means are driven automatically with the help of control means on the basis of a pre-determined program and/or, for example, on the basis of the information on thickness and compression force received from compression of the tissue to be imaged.

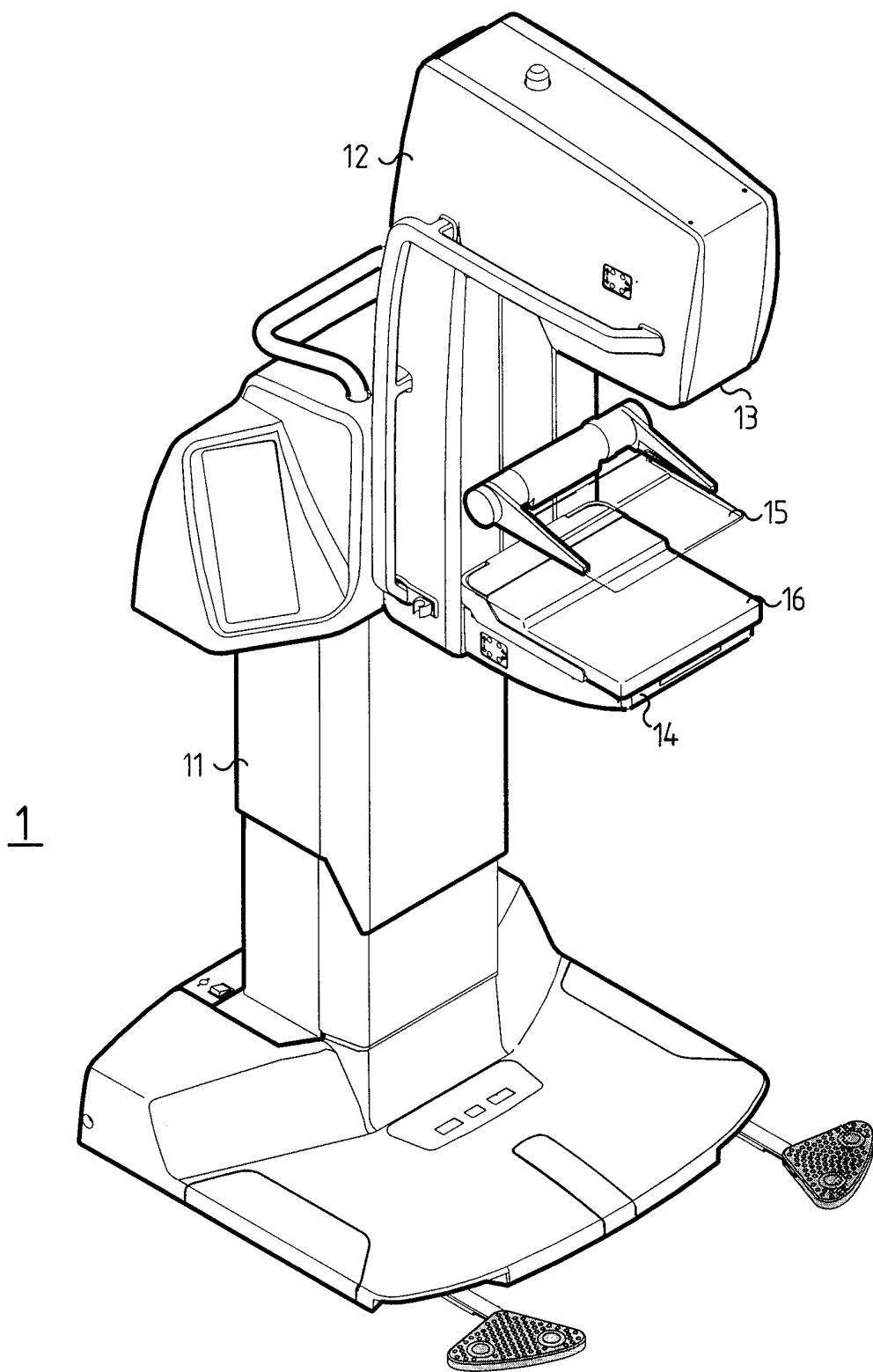


FIG.1

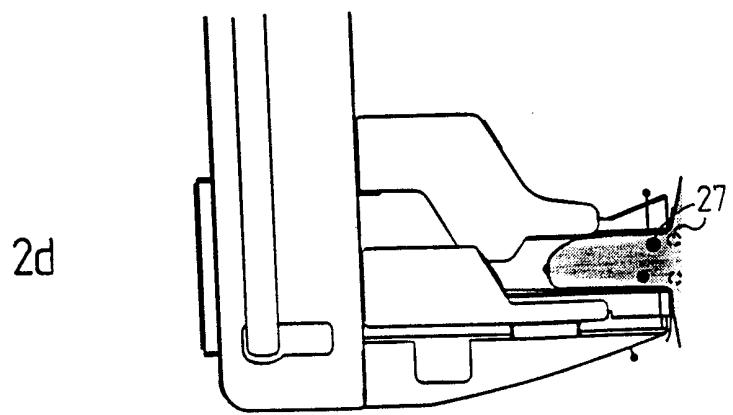
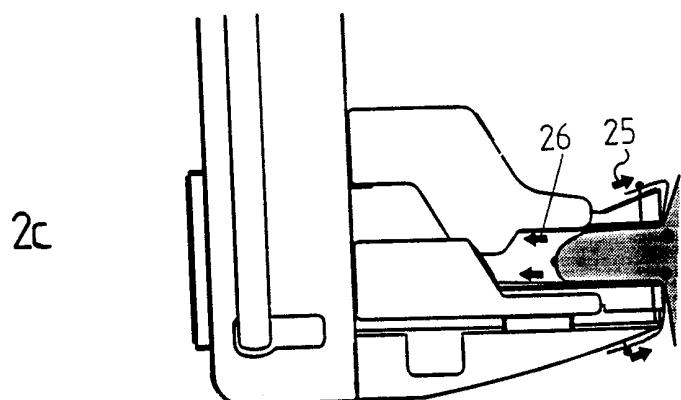
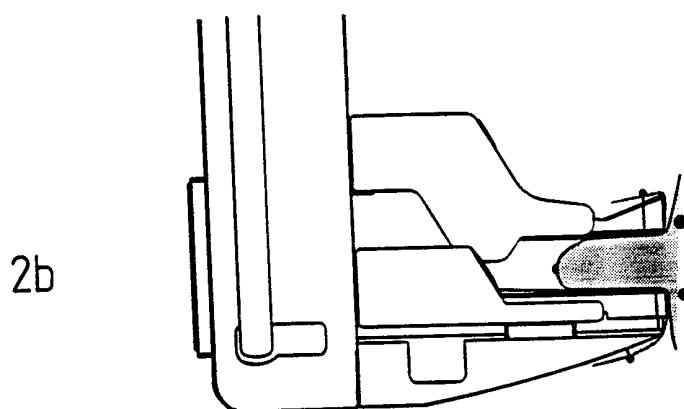
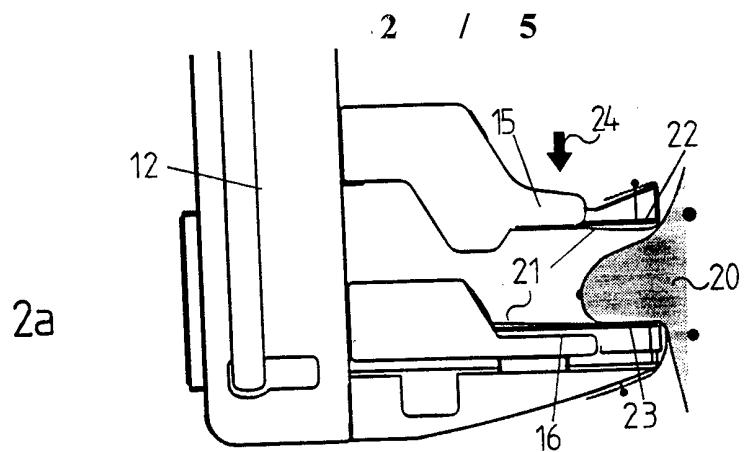
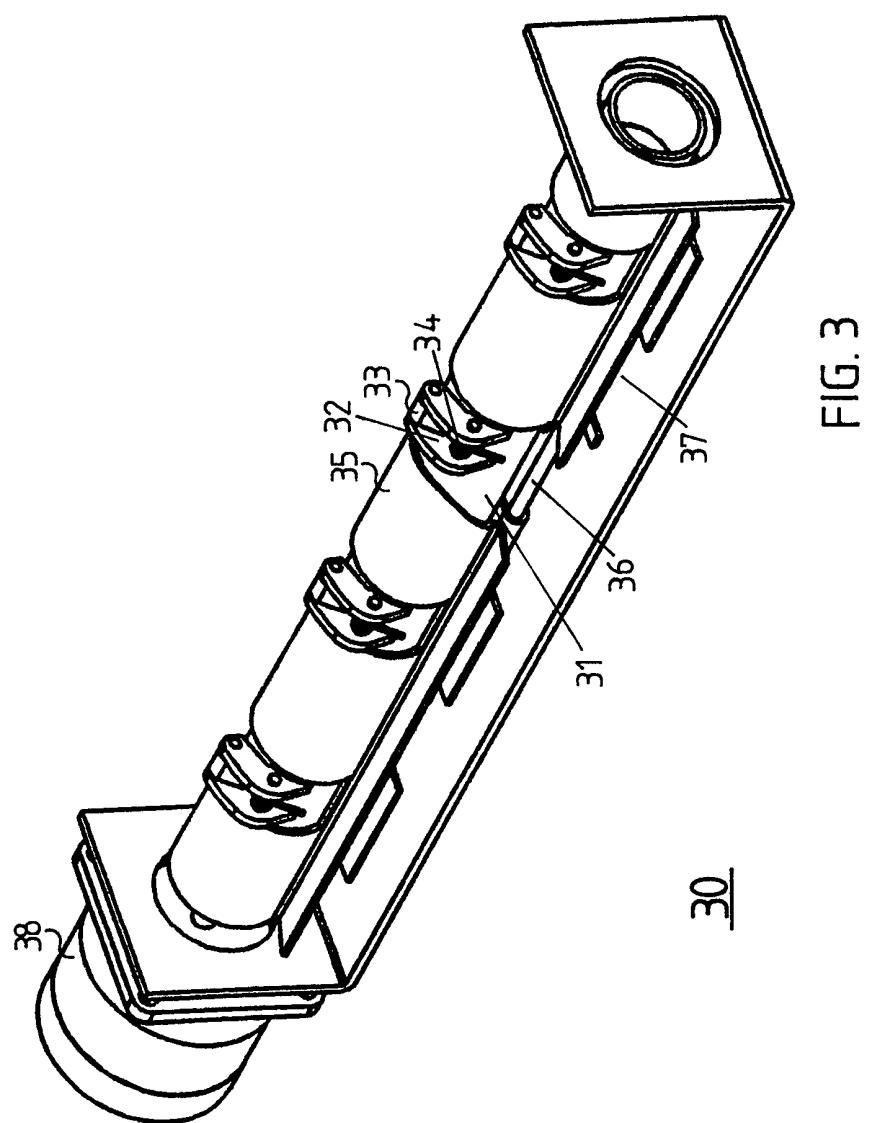


FIG. 2



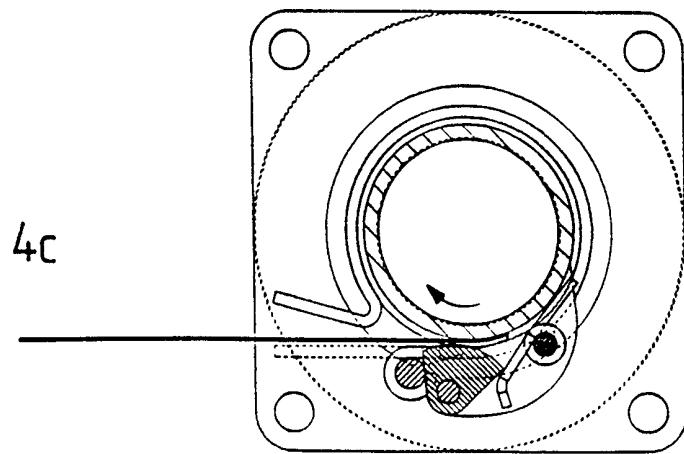
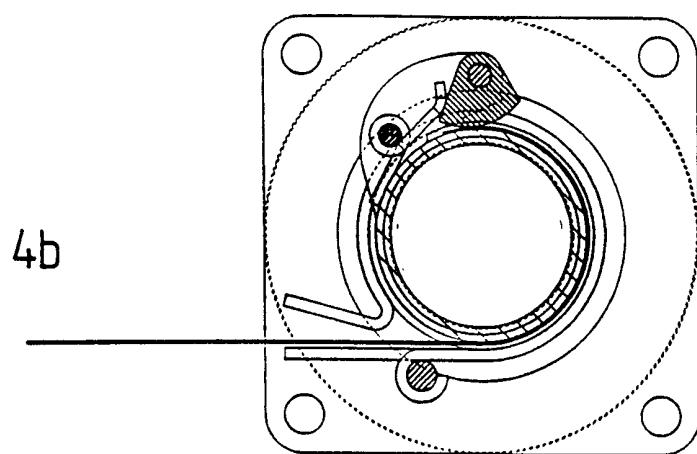
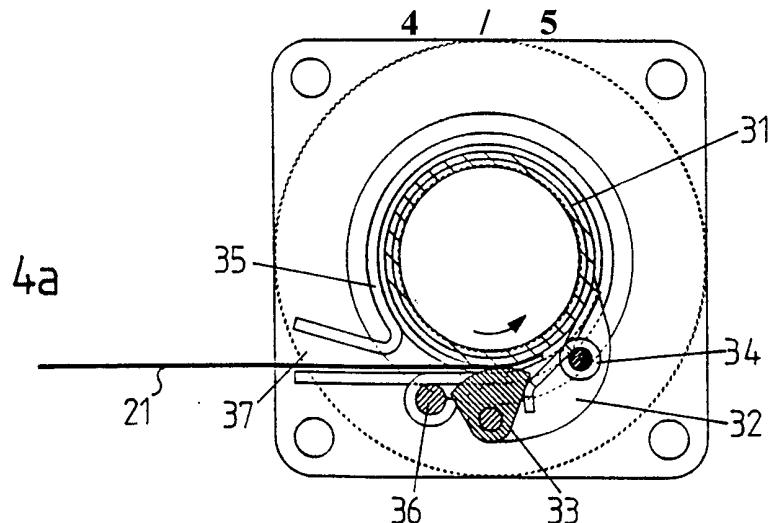


FIG. 4

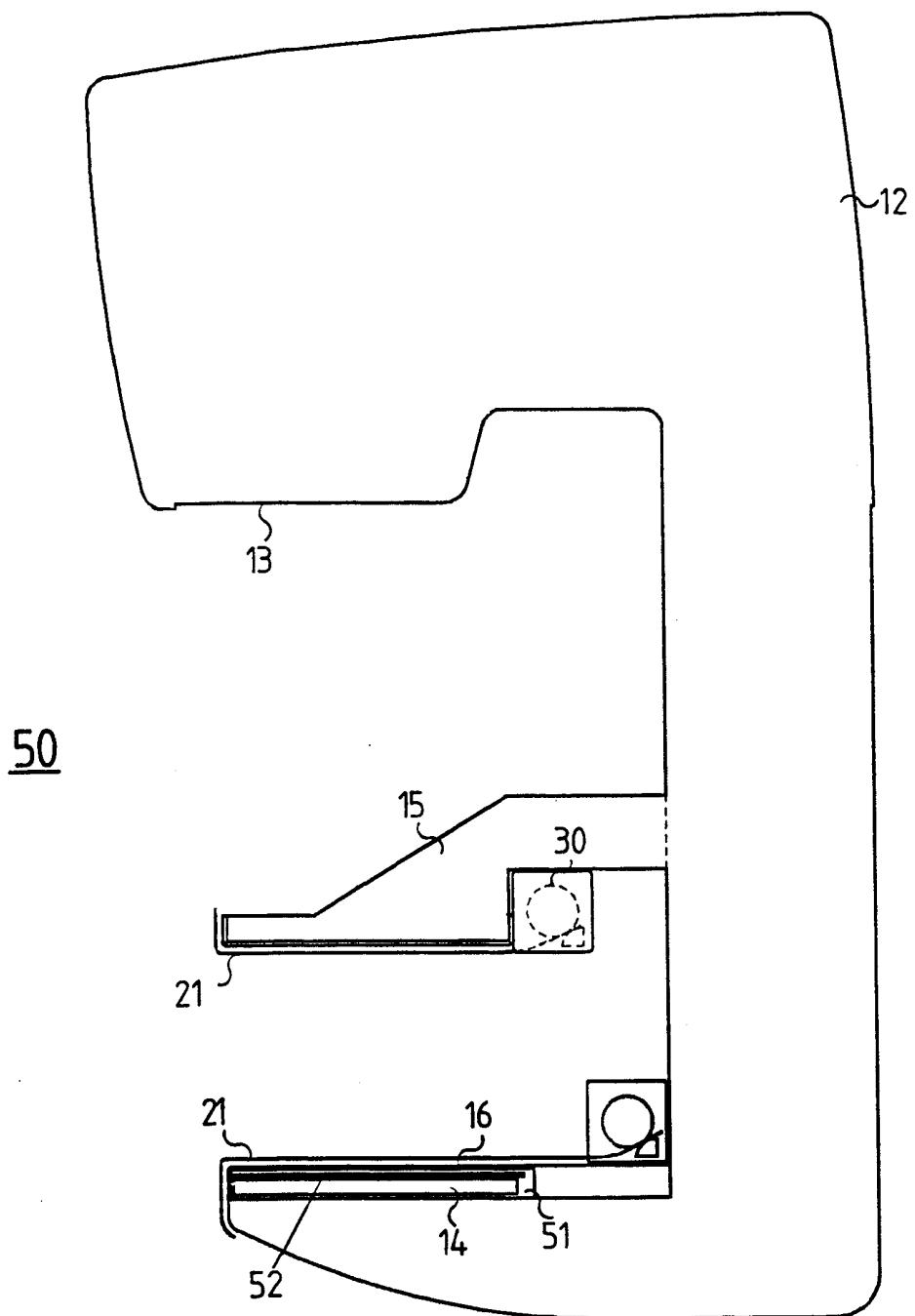


FIG. 5

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 99/00988

## A. CLASSIFICATION OF SUBJECT MATTER

**IPC7: A61B 6/04**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**IPC7: A61B**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

**SE,DK,FI,NO classes as above**

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5553111 A (RICHARD MOORE ET AL), 3 Sept 1996 (03.09.96), column 6, line 52 - line 60; column 8, line 41 - line 55; column 9, line 25 - line 37, figures 3,4, claims 4,5,11,12,18,22,col 9, l 53-66; col 10,1 1-8; col11,1 33-60;col 12,1 12-39	1-4,16-20, 22,24-30, 33-34,36, 42-46,48-49,
Y	column 9, line 25 - line 37; column 9, line 61 - line 66, figures 3,4, claims 4,5,11,22, col 10,1 1-8; col 12,1 12-39 --	5-9,13,35, 41,47
Y	US 4122587 A (KARL WEISS ET AL), 31 October 1978 (31.10.78), column 5, line 50 - column 6, line 13, figure 3 --	5-6,8-9,13, 35

Further documents are listed in the continuation of Box C.

See patent family annex.

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- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

**6 April 2000**

**13 -04- 2000**

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## INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00988

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	US 5851180 A (PETER ANDREW CROSBY ET AL), 22 December 1998 (22.12.98), column 3, line 38 - line 46  --	47
A	US 4143445 A (ARTHUR FOUGMAN), 13 March 1979 (13.03.79), see the whole document  --	1-52
A	FR 2447708 A1 (DEUTSCH MICHEL), 29 August 1980 (29.08.80), see the whole document  -----	1-52

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

02/12/99

International application No.

PCT/FI 99/00988

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			FR	2344264 A,B	14/10/77
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			EP	0955886 A	17/11/99
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			FR	2385376 A,B	27/10/78
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			SE	7713572 A	02/10/78
FR	2447708 A1	29/08/80	NONE		