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(71) Applicant (for all designated States except US): **KONINKLIJKE PHILIPS ELECTRONICS N.V.** [NL/NL];
Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **BOEVE, Hans, M. B.** [BE/BE]; c/o High Tech Campus Building 44, NL-5656 AE Eindhoven (NL).

(74) Agents: **SCHOUTEN, Marcus, M.** et al.; High Tech Campus Building 44, NL-5656 AE Eindhoven (NL).

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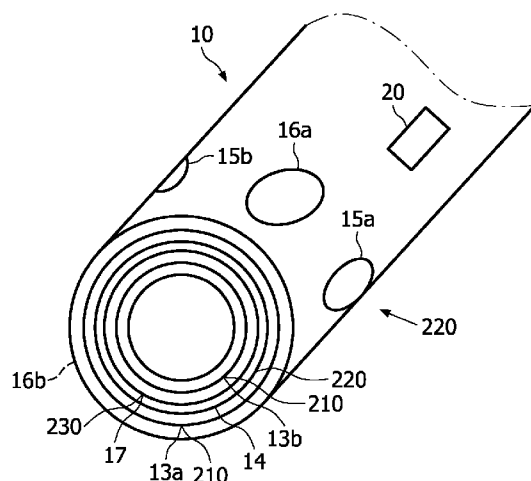


FIG. 1

(57) Abstract: An arrangement and method for influencing and/or detecting magnetic particles in a region of action of an examination object is disclosed, which arrangement comprises: -selection means for generating a magnetic selection field having a pattern in space of its magnetic field strength such that a first sub-zone having a low magnetic field strength and a second sub-zone having a higher magnetic field strength are formed in the region of action, -drive means for changing the position in space of the two sub-zones in the region of action by means of a magnetic drive field so that the magnetization of the magnetic particles changes locally, -receiving means for acquiring signals, which signals depend on the magnetization in the region of action, which magnetization is influenced by the change in the position in space of the first and second sub-zone, -an output device, wherein the selection means and/or the drive means and/or the receiving means are provided at least partly movable relative to the examination object, and wherein the region of action is situated outside a space surrounding the selection means and/or the drive means and/or the receiving means.

ARRANGEMENT AND METHOD FOR INFLUENCING AND/OR DETECTING
MAGNETIC PARTICLES IN A REGION OF ACTION OF AN EXAMINATION
OBJECT AND USE OF AN ARRANGEMENT

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The present invention relates to a method for influencing and/or detecting magnetic particles in a region of action of an examination object. Furthermore, the invention relates to an arrangement for influencing and/or detecting magnetic particles in a region of action of an examination object and to the use of such an arrangement.

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A method for influencing and/or detecting magnetic particles is known from German Patent Application DE 101 51 778 A1. In the case of the method described in that publication, first of all a magnetic field having a spatial distribution of the magnetic field strength is generated such that a first sub-zone having a relatively low magnetic field strength and a second sub-zone having a relatively high magnetic field strength are formed in the examination zone. The position in space of the sub-zones in the examination zone is then shifted, so that the magnetization of the particles in the examination zone changes locally. Signals are recorded which are dependent on the magnetization in the examination zone, which magnetization has been influenced by the shift in the position in space of the sub-zones, and information concerning the spatial distribution of the magnetic particles in the examination zone is extracted from these signals, so that an image of the examination zone can be formed. Such an arrangement and such a method have the advantage that it can be used to examine arbitrary examination objects – e. g. human bodies – in a non-destructive manner and without causing any damage and with a high spatial resolution, both close to the surface and remote from the surface of the examination object.

There exists always the need to enlarge the field of possible applications of such a known arrangement by reducing the number of requirements in terms of required space or in terms of weight of the arrangement or parts thereof.

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It is therefore an object of the present invention to provide an arrangement giving a higher degree of flexibility.

The above objective is achieved by an arrangement for influencing and/or detecting magnetic particles in a region of action of an examination object, which

10 arrangement comprises:

- selection means for generating a magnetic selection field having a pattern in space of its magnetic field strength such that a first sub-zone having a low magnetic field strength and a second sub-zone having a higher magnetic field strength are formed in the region of action,

15

- drive means for changing the position in space of the two sub-zones in the region of action by means of a magnetic drive field so that the magnetization of the magnetic particles changes locally,

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- receiving means for acquiring signals, which signals depend on the magnetization in the region of action, which magnetization is influenced by the change in the position in space of the first and second sub-zone,

- an output device,

wherein the selection means and/or the drive means and/or the receiving means are provided at least partly movable relative to the examination object, and wherein the region of action is situated outside a space surrounding

25 the selection means and/or the drive means and/or the receiving means.

It is an advantage of the arrangement according to the invention, that it is possible to achieve a higher flexibility in the application of magnetic particle imaging (MPI). In particular, the arrangement is advantageously suited for an operation theatre, for example for scanning the body surface of a patient or animal after injection of a

30 magnetic contrast agent like Resovist. After localisation of, for example, a lymph node which is nearest to a tumor (i.e. breast cancer), advantageously only this lymph node can

be removed and later, based on histology of the node (metastases) during the operation, the complete lymph node system can be removed if necessary, or not.

With the inventive arrangement, it is advantageously possible to provide continuous measurements of the location and/or the distribution of the magnetic particles
5 in the region of action while the region of action is moved relative to the examination object. The movement can also be performed e.g. by mechanically moving a permanent magnet as a part of the selection means.

It is a further advantage of such an MPI-based arrangement, that they represent minimal interaction to a patient hence a strongly reduced potential for
10 discomfort or harm. A further advantage of the MPI-based arrangement according to the invention is the inherent possibility for depth view. In comparison to a so-called SQUID apparatus, no cryogenic appliances are necessary for the arrangement according to the invention, which is thus advantageously comparably simple and cost-effective in manufacturing and operation.

15 According to the invention, a spatially inhomogeneous magnetic field is generated by the selection means. The selection means may, for example, be coils through which currents flow, or permanent magnets. The arrangement therefore generally comprises a three-dimensional structure that is composed of the coils and/or permanent magnets mentioned and that is of a certain extent in space, thus enabling a
20 space to be defined that surrounds the arrangement. The region of action is advantageously freely accessible from as many directions as possible, as the region of action is situated outside the space occupied by the arrangement, i.e. the selection means and/or the drive means and/or the receiving means. Due to the improved accessibility of the region of action in the arrangement according to the invention, there is also a
25 reduction in the mental stress on a patient under medical examination or treatment, because, for example, the patient does not feel hemmed in.

Magnetic particles such as are described in DE 101 51 778, for example, are situated in the region of action. The magnetic field in the first sub-zone is so weak that the magnetization of the particles deviates to a greater or lesser degree from the
30 external magnetic field, which means that it is not saturated. This first sub-zone is preferably a spatially coherent zone; it may be a punctiform zone, but also a line or a surface. In the second sub-zone (that is, in the remaining part of the examination zone

outside the first sub-zone), the magnetic field is strong enough to keep the particles in a state of saturation. The magnetization is saturated when the magnetization of practically all the particles is oriented approximately in the direction of the external magnetic field, so that when the strength of the magnetic field is further increased, the increase of the magnetization in this sub-zone will be substantially less than that in the first sub-zone in response to a corresponding increase of the magnetic field.

One possible way of changing the position in space of the two sub-zones is for a coil and/or permanent-magnet arrangement (or parts thereof) intended for generating the magnetic field on the one hand, or the object containing the magnetic particles on the other hand, to be moved relative to one another. This is a preferred method when very small objects are being examined with very high gradients (microscopy). By a magnetic drive field that is positionally and temporally variable in order to change the position in space of the two sub-zones in the region of action, however, mechanical movements are not required. The position in space of the two sub-zones can be changed relatively quickly in this case, which provides additional advantages for the acquisition of signals that depend on the magnetization in the region of action.

The output device of the arrangement according to the invention may be realized in a computer station used for analysis of MPI signals by default. According to a preferred embodiment, however, the output device comprises a visual and/or audible signal generator. Such simple output device is advantageously more suitable for an operation theatre. The visual and/or audible signal is preferably used to indicate a certain state of the acquired magnetization in the region of action and thus advantageously marks a location and depth of, for example, the lymph node nearest to a tumor.

According to a further preferred embodiment, the arrangement comprises a housing enclosing the arrangement, outside which housing the region of action is situated in front of a side of the housing. It is thus advantageously possible not only for the region of action to be positioned outside the selection means and/or the drive means and/or the receiving means, but also for the region of action to be separated in space from the entire arrangement. In this case, a wall of a housing surrounding the arrangement is, for example, situated between the region of action and the arrangement. The MPI scanning may be performed as soon as the arrangement is introduced to the

object containing the magnetic particles. In addition, the arrangement is protected against external influences.

According to a furthermore preferred embodiment, the arrangement comprises a medical instrument comprising at least part of the selection means and/or of the drive means and/or of the receiving means provided movable relative to the examination object. Thereby, a measurement of the distribution of the magnetic particles is possible, even in the case that the medical instrument is moved. Within the context of this invention, a medical instrument is to be understood as meaning any article which can be used by a medic or veterinary or other staff for medical purposes, for example examinations or treatments. In particular, this is to be understood as meaning articles which are passed over the object to be examined and are placed on the patient's skin. Using such medical instruments, it is then possible to create images for example of blood vessels below the skin. On account of the laws of physics, it is expected that signals worthy of evaluation can be generated and detected up to a certain penetration depth in the examination object. If coils are used as magnetic field means, this penetration depth is proportional, for example, to the central area of these coils. According to a furthermore preferred embodiment, the medical instrument is a handheld device. Preferably, the medical instrument is a probe head. Furthermore preferable, the medical instrument is a scalpel.

However, the term medical instrument is also to be understood as meaning probes which can be inserted into the gullet, stomach, intestine, ear or other points of the human or animal body. This list is given by way of non-limiting example.

According to a furthermore preferred embodiment, the arrangement comprises a tracing means for tracing the movement of the region of action relative to the examination object. Thereby, it is advantageously possible to examine bigger objects without the need of large magnetic field generators like heavy coils or the like. This brings the possibility to provide the inventive arrangement lightweight and very flexible. For example, the cut of a (medical) cutting instrument can be viewed or followed by the inventive arrangement during the movement of the cut. It is advantageously possible to continuously scan the region of action when there is a movement of the region of action relative to the examination object.

According to a furthermore preferred embodiment, the tracing means are realized by means of signal processing of the acquired signals and/or by means of optically and/or mechanically and/or electrically tracing the movement of at least a part of the selection means and/or of the drive means and/or of the receiving means.

- 5 Furthermore preferable, the tracing means comprises an acceleration sensor and/or a gyroscope. This enables the skilled artisan to apply a multitude of different tracing or tracking techniques in order to follow the movement of the region of action relative to the examination object.

The invention further relates to a method for influencing and/or detecting
10 magnetic particles in a region of action of an examination object, wherein the method comprises the steps of

- introducing magnetic particles into a region of action,
- generating a magnetic selection field by means of selection means, the magnetic selection field having a pattern in space of its magnetic field strength such that
15 a first sub-zone having a low magnetic field strength and a second sub-zone having a higher magnetic field strength are formed in the region of action
- changing the position in space of the two sub-zones in the region of action by means of a magnetic drive field generated by drive means so that the magnetization of the magnetic particles change locally,
- 20 - acquiring signals by means of receiving means, which signals depend on the magnetization in the region of action, which magnetization is influenced by the change in the position in space of the first and second sub-zone,
- outputting a visual or audible signal depending on the acquired signals, wherein the selection means and/or the drive means and/or the receiving
25 means are provided at least partly movable relative to the examination object during the acquisition and/or the change in the position in space of the two sub-zones in the region of action, the region of action being situated outside a space surrounding the selection means and/or the drive means and/or the receiving means.

With the method according to the invention, it is advantageously possible
30 to execute continuous measurements of the location and/or the distribution of the magnetic particles in the region of action while the region of action is moved relative to

the examination object. The movement can also be performed e.g. by mechanically moving a permanent magnet as a part of the selection means.

The invention further relates to a use of the arrangement according to the invention for locating and/or marking a lymph node.

5 These and other characteristics, features and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention. The description is given for the sake of example only, without limiting the scope of the invention. The reference figures quoted below refer to the
10 attached drawings.

Figure 1 illustrates schematically an arrangement according to the present invention for carrying out the method according to the present invention.

Figures 2a and 2b illustrate an example of the field line pattern generated by an arrangement according to the present invention.

Figure 3 illustrates different examples of tracing a movement of the region of action relative to the examination object.

Figure 4 illustrates schematically an example of an examination situation using the arrangement according to the present invention.

25 The present invention will be described with respect to particular
embodiments and with reference to certain drawings but the invention is not limited
thereto but only by the claims. The drawings described are only schematic and are non-
limiting. In the drawings, the size of some of the elements may be exaggerated and not
drawn on scale for illustrative purposes.

30 Where an indefinite or definite article is used when referring to a singular noun, e.g. “a”, “an”, “the”, this includes a plural of that noun unless something else is specifically stated.

Furthermore, the terms first, second, third and the like in the description and in the claims are used for distinguishing between similar elements and not necessarily for describing a sequential or chronological order. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments
5 of the invention described herein are capable of operation in other sequences than described of illustrated herein.

Moreover, the terms top, bottom, over, under and the like in the description and the claims are used for descriptive purposes and not necessarily for describing relative positions. It is to be understood that the terms so used are
10 interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other orientations than described or illustrated herein.

It is to be noticed that the term “comprising”, used in the present description and claims, should not be interpreted as being restricted to the means listed
15 thereafter; it does not exclude other elements or steps. Thus, the scope of the expression “a device comprising means A and B” should not be limited to devices consisting only of components A and B. It means that with respect to the present invention, the only relevant components of the device are A and B.

Fig. 1 schematically shows the tip of an arrangement 10 according to the
20 present invention, in the depicted embodiment a probe head 10. In order to obtain information about the spatial distribution of magnetic particles in the examination object (both not depicted) which are located in the vicinity of the probe head 10, coils and coil pairs are located on the probe head 10, the magnetic fields of which also pass through a region in front of the probe head 10. The coils described as follows are shown
25 schematically as circles, so that supply lines, for example, are not depicted for the sake of clarity. A selection means comprises a first coil pair comprising two windings 13a and 13b, which surround one another coaxially and during operation are flowed through by currents in opposite directions, the common axis of which windings runs more or less along a long axis of the probe head 10. A gradient magnetic field generated thereby is
30 shown and described in Figs. 2a and 2b. The position of a field-free point or of a region with a low field strength, the first sub-zone 301, is selected such that it is located in front of the tip of the probe head 10. Starting from this field- free point, the strength of the

magnetic field increases in all three spatial direction as the distance from the field-free point increases.

In order to position the field-free point on the common axis, various parameters of the arrangement may be changed. If the current intensity of the current
5 flowing through the winding 13a is increased or the current intensity of the current flowing through the winding 13b is reduced, the field-free point is displaced in the direction towards the probe head 10. If, on the other hand, the current intensity of the current flowing through the winding 13a is reduced or the current intensity of the current flowing through the winding 13b is increased, the field-free point is displaced in the
10 opposite direction. Moreover, the position, in particular the starting position, of the field-free point can be affected by changing the diameter of the windings 13a and 13b. Furthermore, it must be ensured by virtue of the dimensioning of the coil arrangement that the spatial size of the region with a higher field strength is sufficiently large. This means that, in this region, there should be magnetic particles, the signals of which could
15 in principle be detected by detection means described below but which in fact do not generate any signal and therefore are kept in a state of magnetic saturation. If the magnetic particles are relatively far away from the detection means such that their signals are detected only weakly or not at all by the detection means, they no longer need to lie in the region with a higher magnetic field strength, second sub-zone 302 (Fig. 2a, 2b).

20 The size of the first sub-zone 301 (reference 301 in Fig. 2b) which determines the spatial resolution of the arrangement depends on the one hand on the strength of the gradient of the gradient magnetic field and on the other hand on the size of the magnetic field required for saturation. If one or more further magnetic fields are superposed on the gradient magnetic field in the zone of action, the field-free point or
25 the region with a low field strength is then displaced along this superposed magnetic field, wherein the size of the displacement increases with the strength of the superposed magnetic fields. The superposed magnetic fields have different directions and may be temporally variable. In order to generate these temporally variable magnetic fields for any direction in space, three further coil arrangements are provided as drive means 220.
30 A coil 14 generates a magnetic field which runs in the direction of the coil axis of the coil pair 13a, 13b. In principle, the effect that can be achieved by means of this coil pair can also be achieved by superposing currents of the same direction on the currents of

opposite direction in the coil pair 13a, 13b, as a result of which the current decreases in one coil pair and increases in the other coil pair. However, it may be desirable if the temporally constant gradient magnetic field and the temporally variable vertical magnetic field are generated by separate coil pairs.

5 In order to generate magnetic fields which run spatially perpendicular to the common axis of the coils 13a and 13b and/or perpendicular to the medical instrument axis, two further coils pairs of the drive means 220 are provided, comprising the windings 15a, 15b and 16a, 16b. The winding 16b is not shown since it is arranged on the underside of the probe head 10, which is not visible. The windings 15a and 15b and
10 the windings 16a and 16b are respectively arranged in an identical manner near the outer surface of the probe head 10 and lie opposite one another. The common axis of the coil pair comprising the windings 15a and 15b is perpendicular to the common axis of the coil pair 16a and 16b and the two axes of the coil pairs are in each case perpendicular to the long axis of the probe head 10. During operation, a magnetic field forms between the
15 two windings of a coil pair, the field lines of which magnetic field run on the one hand almost in a straight line through the probe head 10. On the other hand, they run in a curved manner around the probe head 10, wherein they also pass through the field-free point or the region with a low field strength in front of the probe head tip 10 with a component perpendicular to the probe head long axis.

20 The shape of the windings may also be different in order to optimize the respective curved magnetic field. It is also conceivable for the reasons mentioned above to arrange a soft-magnetic core (not shown) inside the respective coils.

 Finally, Fig. 1 shows a further coil 17 which serves as receiving means 230 to detect signals generated in the zone of action 300. In principle, any of the field-
25 generating coil pairs 13 to 16 could also be used for this purpose. However, when use is made of a special coil, a more favorable signal- to-noise-ratio is obtained, particularly if a number of receiving coils (not shown) are used. In addition, the coil may be arranged and connected in such a way that it is decoupled from the other coils. If, for example, the receive means 230 comprises three receiving coils, fitted on the probe head 10, their
30 directions of action may lie at an angle of 90° with respect to each other. As a result, signals are detected from all directions around the probe head tip 10. In addition, it is also possible to fit other external receiving coils (not shown) next to the examination

object. The probe head 10 further comprises an output device 20, in particular a very simple audible and/or visual signal generator to indicate a certain state of the acquired magnetisation in the region of action.

By virtue of the design of the probe head 10 shown in Fig. 1, the position
5 of the first sub-zone 301 with a low magnetic field strength relates to the probe head 10 and no longer to a fixed examination area or to the external components. In the basic state, therefore, the position of the first sub-zone 301 with a low field strength changes within the examination object only when there is a relative movement between the probe head 10 and the examination object. If, during the time of signal detection, the probe
10 head 10 is stationary with respect to the patient from which the signals are to be detected, the patient may advantageously move without this giving rise to movement artifacts. It is also possible, depending on the application, not to fit all of the coils shown in Fig. 1 to the probe head 10. By way of example, the coils 14, 15a, 15b, 16a and 16b may be omitted if external coils are used to shift the region with a low field strength.

15 In the probe head 10, it is also possible, by virtue of a different design and arrangement of the magnetic field means, to define the position of the field-free point or of the region with a low field strength so that it is not in front of but rather next to the tip of the probe head 10. This is useful, for example, when images of regions which are mainly located next to the probe head 10 are to be created. The coils or coil
20 arrangements shown in detail in Fig. 1 may then possibly have different shapes or be oriented differently and as a result be arranged differently on the probe head 10. However, their function does not change.

The gradient magnetic field generated by an arrangement according to the present invention is shown in Figs. 2a and 2b by means of the field lines 30, 30a and 30b
25 in the region of action 300. The field lines 30a of the magnetic field generated by the outer winding 13a are shown as solid lines and the field lines 30b of the magnetic field generated by the inner winding 13b are shown as dashed lines. The magnetic fields from the two windings are superimposed on one another to form the resulting magnetic field 211 indicated by the field lines 30. This field 211 has a gradient in the direction of the
30 common axis of the pair of coils 13a and 13b and at one point along this axis it reaches a value of zero. The position of this field-free point along the common axis is selected in such a way that it is located outside the probe head 10 (Fig. 1), the region of action 300

thus being located in the object of examination, to which the probe head 10 is being applied. Starting from this field-free point, the strength of the magnetic field increases in all three directions in space with increasing distance from the point. In a zone 301 (the first sub-zone) around the field-free point, which zone is indicated, the field strength is
5 so low that the magnetization of magnetic particles (not depicted) situated in it is not saturated. In the remaining zone outside the first sub-zone 301, i.e. in the second sub-zone 302, the magnetization of the magnetic particles is in a state of saturation.

Various parameters of the arrangement can be varied to position the field-free point along the common axis. If the intensity of the current flowing through the
10 winding 13a is increased or the intensity of that flowing through the winding 13b is reduced, the field-free point is displaced along the common axis in the direction towards the windings 13a and 13b. If on the other hand the intensity of the current flowing through the winding 13a is reduced or that of the current flowing through the winding 13b is increased, the field-free point is displaced in the opposite direction. Also, the
15 position, and particularly the starting position, of the field-free point can be influenced by varying the diameter of the windings 13a and 13b. Furthermore, the sizing of the coil arrangement must ensure that the extent of the second sub-zone 302 in space at least corresponds to that of the region of action so that all the magnetic particles not situated in the first sub-zone 301 are kept in a state of saturation.

20 The size of the first sub-zone 301 that determines the spatial resolution of the arrangement 10 is dependent on the one hand on the magnitude of the gradient of the gradient magnetic field 211 and on the other hand on the strength of the magnetic field required for saturation.

The skilled artisan will recognize that the relative sizes shown in Figs. 2a
25 and 2b are not to scale. The first sub-zone 301, for example, is depicted too large in relation to the diameters of the coils formed by windings 13a and 13b, and the cross-sections of the conductors forming the windings 13a and 13b (which may alternatively be of the same size) are shown as too large in relation to the diameters of the windings.

In one aspect of the present invention, a part of the arrangement 10 is also
30 transferred to another medical instrument, which is movable relative to the object of examination 350, e.g. a catheter or probe that can be inserted into the gullet, stomach, intestine, ear or other points of the body. According to the method and the arrangement

10 of the present invention, it is possible to determine a movement of the region of action 300 relative to the examination object 350 by tracking or tracing the movement of the mobile device or the handheld. Thereby, it is possible to strongly reduce the equipment needed in an arrangement 10 for influencing and/or detecting magnetic particles according to the method of magnetic particle imaging. In the case where the movement of the first sub-zone 301 in the region of action 300 by means of the drive means 220 covers only a relatively small volume of e.g. several cubic centimetres and there exists the need for a larger volume to scan, the use of further (comparably bulky and costly) magnetic field generating means would be a possibility. The integration of such supplementary magnetic field generating means in a handheld device is difficult. According to one aspect of the present invention, it is therefore suggested to use the movement of the handheld device in order to enlarge the volume to scan. In order to link the different regions of the size of the region of action 300 which is scannable at once (or at least comparably quickly), the inventive arrangement 10 preferably comprises a tracing means 250 for tracing the movement of the movable part of the arrangement 10, e.g. the handheld part.

In Figure 3, different examples or possibilities of tracing a movement M of the region of action 300 relative to the examination object 350 are depicted schematically. The movement M of the region of action 300 corresponds to a movement M of the arrangement 10 or at least a part thereof, e.g. a handheld device comprising at least a part of the selection means 210, of the drive means 220 and/or of the receiving means 230. The location of the moved region of action 300 and the moved arrangement 10 or part of the arrangement 10 is denoted by small-dashed lines in Figure 3.

Several possibilities exist in order to determine the movement M. According to one aspect of the present invention, this can be done by tracing means 250 determining e.g. the acceleration and deceleration of the part of the arrangement 10, e.g. an accelerometer (not depicted) and preferably mounted to the handheld device. Furthermore, the movement can be trace by optical means, e.g. by a laser beam (schematically shown by means of an exterior housing of the tracing means 250 and arrows detecting the position of the arrangement 10 or a part thereof). Likewise, it is possible that a mechanical embodiment of the tracing means 250 is provided, e.g. a mechanical transmission of the movement M.

According to another possibility, the movement M can be detected by means of reconstructing the volume to be scanned by means of regions thereof that have already been scanned. This can be understood in the following manner: The region of action 300 is moved a sufficiently small distance in order to provide an overlap region 300' of the region of action 300 before the movement has been performed and the region of action 300 after the movement has been performed. If the supposition is justified that e.g. the distribution of the magnetic particles 100 has not changed dramatically during the time the movement was performed, then the information of the overlap region 300' can be used by a suitable signal processing in order to enlarge the scannable region, e.g. by means adding a new volume (which was not covered at the position of the region of action 300 before the movement M) to the image of the scanned region.

Another possibility exists in order to determine the orientation of the probe in a three-dimensional reference frame. It has been assumed that the handheld probe is handled perpendicular to the surface of a patient body, i.e. the object of examination 350. Any tilt of the handheld device can be detected electrically and/or optically and/or mechanically in terms of orientation. This information can be used in reconstruction and visualization of a volume indicating the concentration distribution of magnetic nanoparticles. Alternatively, the operator of the handheld device can be guided to hold the handheld probe in a particular orientation, to focus on a particular point in the object of examination 350. The guidance can be given by audible, including speech, or visual signal generator. The latter one is preferably indicated on the probe, e.g. as a level indicator. According to one aspect of the present invention, this can be done by tracing means 250, determining e.g. the orientation of the part of the arrangement 10, e.g. an inertial measurement unit comprising an accelerometer and a gyroscope (not depicted) which are preferably mounted to the handheld device. It is to be noted that an accelerometer measures the total acceleration vector which includes body acceleration as well as gravity.

According to the present invention, either one or a plurality of different tracing methods can be used in order to determine the position of the arrangement 10 or the part of the arrangement after the movement M. Furthermore, it is possible that the different possibilities of tracing are combined such that for long range movements only or preferably one kind of tracing means 250 is used and for short range movements only

or preferably another kind of tracing means 250 is used, e.g. the tracing means using signal processing only for short range and relatively fast movements. The recorded signal of the enlarged region which had been an interaction with the region of action 300 during the movement, can then be used to form a well spatially resolved tomographic
5 image, e.g. of a part of the body of a patient. In addition, the recorded signals may also be represented optically or acoustically allowing for fast determination of localized particle concentrations. Thereby, an effective detection of special body tissues or other objects over a relatively large volume is possible, e.g. sentinel lymph node detection.

In Fig. 4 an example of an examination situation using the arrangement 10
10 according to the present invention is schematically depicted. The arrangement 10, for example, a probe head 10, is handheld by a user 1 or mechanical device 1, examining an object of examination 350, for example a patient. The probe head 10 is used to manually locate and mark the lymph node 2 of a lymph node system 4, which is closest to a tumor 3, which is a vital step for determining whether a cancer has spread or not.

CLAIMS:

1. An arrangement (10) for influencing and/or detecting magnetic particles (100) in a region of action (300) of an examination object (350), which arrangement comprises:
 - selection means (210) for generating a magnetic selection field (211) having a pattern in space of its magnetic field strength such that a first sub-zone (301) having a low magnetic field strength and a second sub-zone (302) having a higher magnetic field strength are formed in the region of action (300),
 - drive means (220) for changing the position in space of the two sub-zones (301, 302) in the region of action (300) by means of a magnetic drive field (221) so that the magnetization of the magnetic particles (100) changes locally,
 - receiving means (230) for acquiring signals, which signals depend on the magnetization in the region of action (300), which magnetization is influenced by the change in the position in space of the first and second sub-zone (301, 302),
 - an output device,wherein the selection means (210) and/or the drive means (220) and/or the receiving means (230) are provided at least partly movable relative to the examination object (350),
and wherein the region of action is situated outside a space surrounding the selection means (210) and/or the drive means (220) and/or the receiving means (230).
2. An arrangement according to claim 1, wherein the output device comprises a visual and/or audible signal generator.
3. An arrangement according to claim 1, further comprising a housing enclosing the arrangement, outside which housing the region of action is situated in front of a side of the housing.

4. An arrangement according to claim 1, wherein the arrangement (10) comprises a medical instrument comprising at least part of the selection means (210) and/or of the drive means (220) and/or of the receiving means (230) provided movable relative to the examination object (350).
- 5
5. An arrangement according to claim 3, wherein the medical instrument is a handheld device.
6. An arrangement according to claim 3, wherein the medical instrument is a probe
- 10 head.
7. An arrangement according to claim 3, wherein the medical instrument is a scalpel.
- 15 8. An arrangement according to claim 1, wherein the arrangement (10) comprises a tracing means (250) for tracing the movement of the region of action relative to the examination object.
9. An arrangement according to claim 7, wherein the tracing means (250) are
- 20 realized by means of signal processing of the acquired signals.
10. An arrangement according to claim 7, wherein the tracing means (250) are realized by means of optically and/or mechanically and/or electrically tracing the movement of at least a part of the selection means (210) and/or of the drive means (220)
- 25 and/or of the receiving means (230).
11. An arrangement according to claim 9, wherein the tracing means (250) comprises an acceleration sensor and/or a gyroscope.
- 30 12. A method for influencing and/or detecting magnetic particles (100) in a region of action (300) of an examination object (350), wherein the method comprises the steps of

- introducing magnetic particles (100) into a region of action (300),
- generating a magnetic selection field (211) by means of selection means (210), the magnetic selection field (211) having a pattern in space of its magnetic field strength such that a first sub-zone (301) having a low magnetic field strength and a
5 second sub-zone (302) having a higher magnetic field strength are formed in the region of action (300)
- changing the position in space of the two sub-zones (301, 302) in the region of action (300) by means of a magnetic drive field (221) generated by drive means (220) so that the magnetization of the magnetic particles (100) change locally,
- 10 - acquiring signals by means of receiving means (230), which signals depend on the magnetization in the region of action (300), which magnetization is influenced by the change in the position in space of the first and second sub-zone (301, 302),
- outputting a visual or audible signal depending on the acquired signals, wherein the selection means (210) and/or the drive means (220) and/or
15 the receiving means (230) are provided at least partly movable relative to the examination object (350) during the acquisition and/or the change in the position in space of the two sub-zones (301, 302) in the region of action (300), the region of action being situated outside a space surrounding the selection means (210) and/or the drive means (220) and/or the receiving means (230).

20

13. The use of an arrangement (10) according to claim 1 for locating and/or marking a lymph node.

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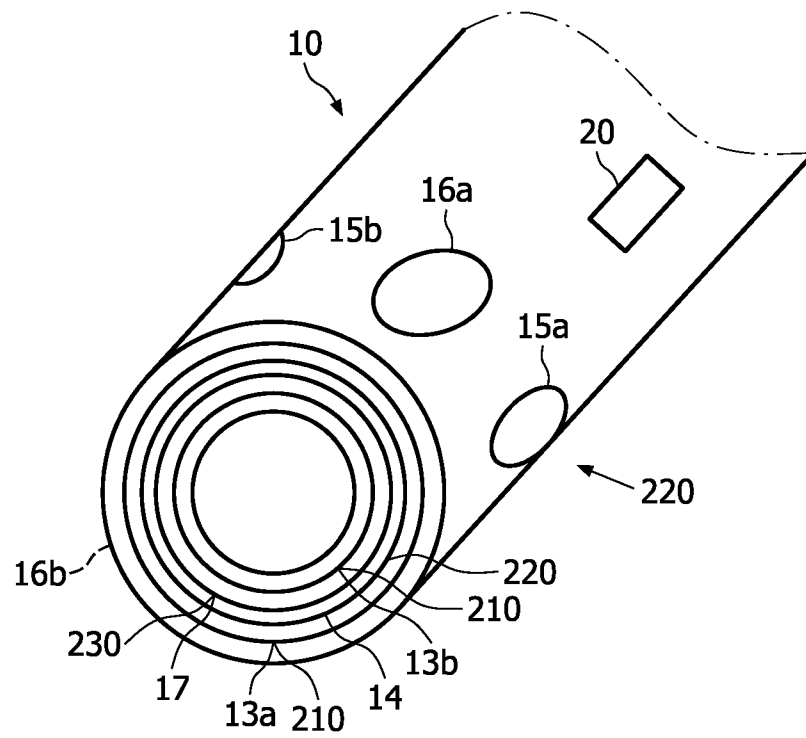


FIG. 1

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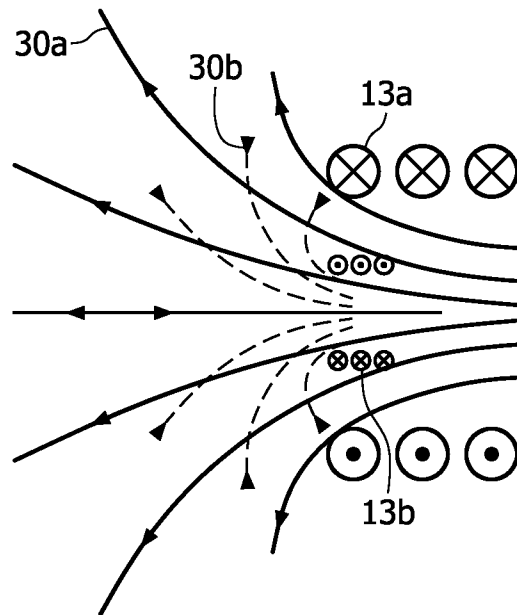


FIG. 2a

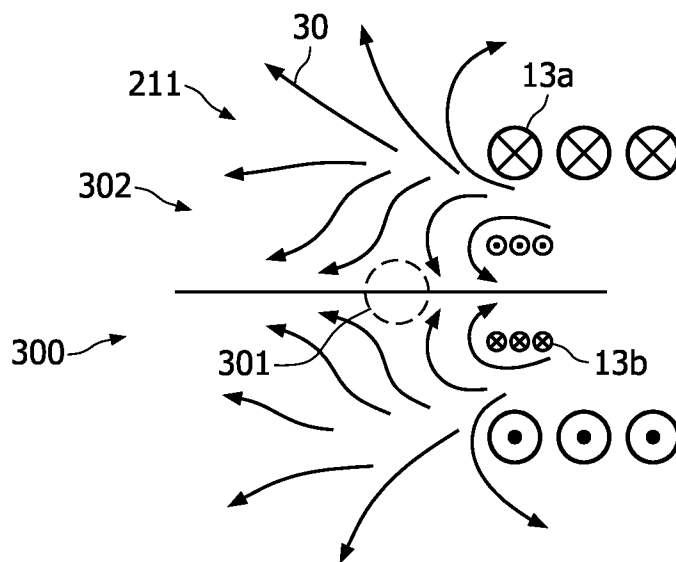


FIG. 2b

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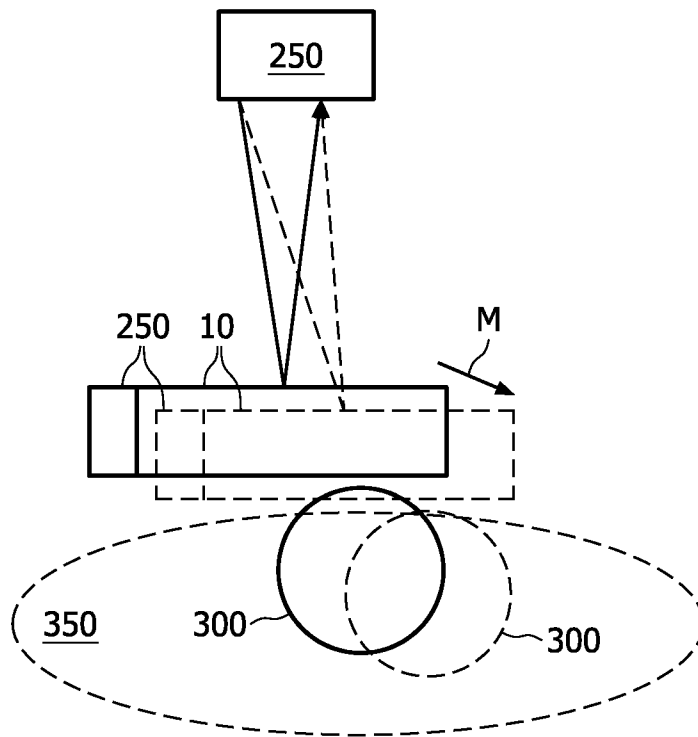


FIG. 3

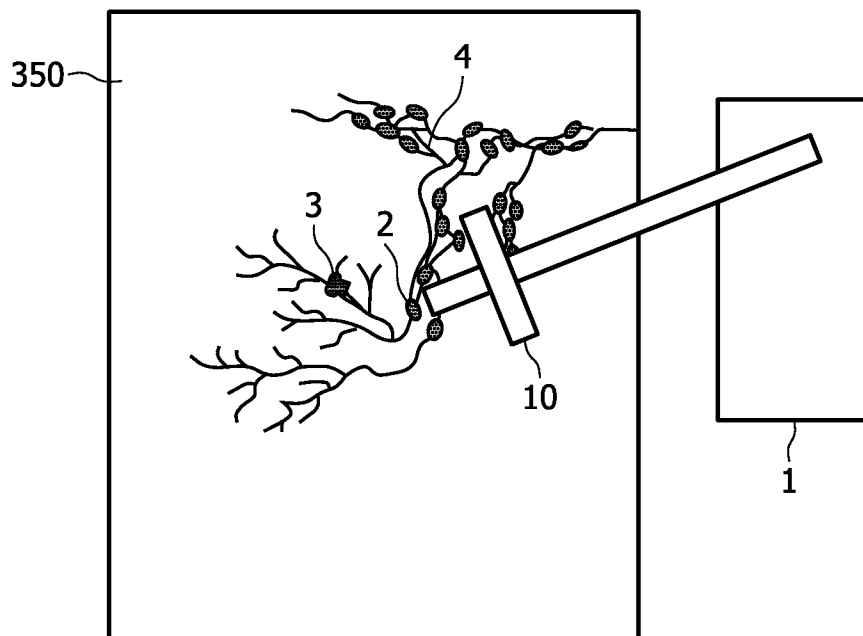


FIG. 4