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(54) **Apparatus and method for ultrasound imaging with contrast agents**

Verfahren und Vorrichtung zur Ultraschallbildgebung unter Verwendung von Kontrastmitteln

Appareil et procédé d'imagerie par ultrasons avec des agents de contraste

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(56) References cited:

- **ASHFAQ M ET AL: "A new approach towards ultrasonic transmission tomography with a standard ultrasound system", ULTRASONICS SYMPOSIUM, 2004 IEEE MONTREAL, CANADA 23-27 AUG. 2004, PISCATAWAY, NJ, USA,IEEE, vol. 3, 23 August 2004 (2004-08-23), pages 1848-1851, XP010784349, DOI: 10.1109/ULTSYM.2004.1418189 ISBN: 978-0-7803-8412-5**
- **ERMERT H ET AL: "2E-6 Contrast Enhanced Perfusion Imaging by means of Spatial Compounding", ULTRASONICS SYMPOSIUM, 2006. IEEE, IEEE, PI, 1 October 2006 (2006-10-01), pages 424-427, XP031076321, DOI: 10.1109/ULTSYM.2006.117 ISBN: 978-1-4244-0201-4**
- **GIORGIO RIZZATTO ET AL: "Importance of staging of breast cancer and role of contrast ultrasound", EUROPEAN RADIOLOGY, vol. 11, no. S3, 1 December 2001 (2001-12-01), pages E47-E52, XP055004029, ISSN: 0938-7994, DOI: 10.1007/PL00014130**

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Description

[0001] The invention relates to an apparatus for detecting ultrasound images from a body under examination, which apparatus comprises a first unit emitting ultrasound pulses comprising one or more electroacoustic transducers and a first unit receiving ultrasound pulses comprising one or more electroacoustic transducers, said first emitting unit and said first receiving unit being faced each other and being spaced apart from each other by a predetermined distance such that they are arranged at opposite sides of a cavity housing said body under examination and the ultrasound pulses emitted from said first emitting unit are received by said first receiving unit after passing through the body under examination and are transformed into transmission signals, a control unit for said first emitting unit, a unit processing the received signals, image generating means and displaying means for said images, said processing unit comprising a unit evaluating the attenuation of ultrasound pulses and/or the propagation speed of ultrasound pulses.

[0002] The operation of such type of apparatuses is usually called as transmission mode, in which only the wave that has passed through the body is examined without considering the reflected echoes and by means of which it is possible to evaluate the propagation speed of ultrasound pulses when the ultrasound beam passes through the body under examination and the attenuation due to the structures of the body under examination.

[0003] It is also possible to use the transmission mode in combination with the reflection mode, by means of which it is possible to generate images by means of the echoes generated from the structures of the body under examination in response to the ultrasound beam transmitted to said body under examination.

[0004] Such technology can be used particularly in breast ultrasound imaging.

[0005] Apparatuses of this type are described in documents US7699783 and US7771360, which content is to be considered as a part of the present description.

[0006] In particular three types of images are produced by using the two different modes: images that represent maps of the propagation speed of ultrasound pulses and attenuation of ultrasound pulses of tissues for each point of the body under examination are generated by the transmission mode, while by the reflection mode tomographic images are generated.

[0007] Information about propagation speed of ultrasound pulses can be used for spatially correcting the geometric deformations in tomographic images due to tissues being heterogeneous.

[0008] As regards ultrasound imaging a widely used and increasingly developing method is the use of contrast agents, typically microbubbles that have a non-linear reflection behaviour and therefore that generate echoes with frequencies corresponding to fundamental frequency harmonics of the emission pulses transmitted to the body under examination.

[0009] The use of contrast agents is typically useful for investigating properties or conditions of blood flow and/or the condition of tissue vascularization.

[0010] There is a rising attention in using the so called "targeted" contrast agents, wherein microbubbles are associated to ligands that bind to receptors characteristic of specific diseases, causing contrast agents to gather in the areas affected by the disease.

[0011] In the known apparatuses described above there is the unsolved problem of recognizing the second harmonic signal components actually due to contrast agents, since the harmonic generation can be due to the nonlinearity in scattering and propagation of ultrasounds in tissues.

[0012] This leads to the uncertainty in interpreting information obtained from imaging with contrast agents, while on the contrary the need of having reliable systems for recognizing the presence of contrast agents increases both in the analysis of blood flows according to the different modes and/or for several diagnostic purposes.

[0013] The present invention aims at solving the problems mentioned above by an apparatus as described hereinbefore and wherein in addition said processing unit comprises a unit comparing said values of propagation speed of ultrasound pulses and/or of the attenuation of ultrasound pulses with predetermined threshold values, the transmission signals resulting from the presence of contrast agents within the body under examination when the comparison of said attenuation of ultrasound pulses and/or of said propagation speed of ultrasound pulses has a specific difference with respect to the corresponding threshold value.

[0014] Depending on the type of contrast agent and of the tissue under examination, the values of the attenuation of ultrasound pulses or of the propagation speed of ultrasound pulses under the presence of contrast agents to be considered as indicating the presence of such contrast agents, can be under or over said threshold values.

[0015] Experimental studies have shown that, in the transmission ultrasound mode by means of which it is possible to obtain information about the propagation speed of ultrasound pulses and attenuation of ultrasound pulses, the presence of contrast agents can significantly affect the values of the propagation speed of ultrasound pulses and in particular of the attenuation of ultrasound pulses.

[0016] The present invention has the advantage of exploiting this result for recognizing the presence in the body under examination of contrast agents and it reaches this only by simply comparing the attenuation of ultrasound pulses and/or the propagation speed of ultrasound pulses with predetermined threshold values.

[0017] In a further embodiment there is provided a second unit receiving ultrasound pulses, comprising one or more electroacoustic transducers, for receiving echoes generated by the body under examination and for transforming them into reflection signals, said processing unit comprising a unit for extracting harmonic distortion com-

ponents of said reflection signals and said harmonic distortion components of the reflected signals resulting from a reflection due to contrast agents when the comparison of said attenuation of ultrasound pulses and/or of said propagation speed of ultrasound pulses in the reflection point from where the reflected pulse comes has a given difference with respect to the corresponding threshold value particularly the values of said attenuation of ultrasound pulses and/or of said propagation speed of ultrasound pulses can be under or over said threshold values depending on the cases.

[0018] The unit for extracting harmonic components can be anyone, such as for instance a digital or analog spectrography analysis unit, or in combination or as an alternative it can comprise digital or analog filters.

[0019] Thus the transmission mode can be combined with the reflection mode and moreover the so called harmonic imaging can be carried out such that the harmonic components of the reflected signal are selectively detected.

[0020] It is possible to provide, in combination or as an alternative, the use of harmonic components for the transmission mode such that one or more of the harmonic components of the transmitted signal is selectively detected.

[0021] According to a further embodiment there are provided a second emitting unit, comprising one or more electroacoustic transducers, and a control unit for said second emitting unit, such that the echoes received from the second receiving unit derive from the pulses emitted from said second emitting unit.

[0022] Thus for the transmission mode and the reflection mode respectively dedicated emitters and receivers are used, such that they can be carried out independently from each other.

[0023] In a further embodiment said second emitting unit and said second receiving unit comprise the same one or more electroacoustic transducers.

[0024] This allows only one transducer array dedicated to the reflection mode to be provided, as however it is provided in known ultrasound probes.

[0025] According to a further embodiment said second emitting unit and/or said second receiving unit are movable from a location near said first emitting unit to a location near said first receiving unit.

[0026] In a further embodiment said image generating means generate a transmission image from signals received by said first receiving unit and a reflection image from signals received by said second receiving unit, said unit evaluating the attenuation of ultrasound pulses and/or the propagation speed of ultrasound pulses of ultrasonic pulses calculates for each pixel or voxel of the transmission image the attenuation of ultrasound pulses and/or the propagation speed of ultrasound pulses, said unit extracting the harmonic components of said reflection signals calculates for each pixel or voxel of the reflection image the intensity of the harmonic components, said comparing unit compares for each corresponding pixel or voxel of the transmission image and of the reflection image the values of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses and the intensity of the harmonic components with specific threshold values, thus detecting the presence of contrast agents for each pixel or voxel.

[0027] Thus the pixels or voxels corresponding to areas of the body under examination wherein the presence of contrast agents is detected are discriminated from those wherein it is not detected on the basis of the comparison of the harmonic components of the received signals in the reflection mode and of the values of attenuation of the ultrasound pulses obtained by the transmission mode.

[0028] Therefore this allows a spatial reference to be given to the presence of contrast agents in the body under examination and it allows three-dimensional diagrams of blood flows or perfusion maps to be reconstructed.

[0029] According to a further embodiment there are provided means for the suppression of the image contribution due to fundamental frequency signals of transmitted pulses such that only images deriving from signals of harmonic components are provided.

[0030] Such means are known and widely used in the several methods such as the so called pulse inversion or the like.

[0031] These means can be for example image subtraction means such that a first reflection image is acquired from harmonic components of reflection reception signals received by said second receiving unit with no contrast agents, then a second reflection image is acquired from harmonic components of reflection reception signals received by said second receiving unit with contrast agents, a subtraction is performed between said first reflection image and said second reflection image by said subtraction means, generating an image wherein for each pixel or voxel a determination is made whether the signal derives from the presence of a contrast agent by means of said comparing unit which compares for each pixel or voxel the intensity value of the harmonic components of the reflection reception signal and the value of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses of the transmission reception signal acquired at the same time as said second reflection image with specific threshold values.

[0032] The subtraction of the first image acquired with no contrast agents from the second image acquired with contrast agents allows an image to be obtained wherein the most significant pixels and voxels mainly derive from contrast agents, but it will contain also information about reflectors into the body under examination that have a echogenic behaviour similar to that of the contrast agents.

[0033] In order to further distinguish which are the pixels actually related to the presence of contrast agents the resulting image is therefore analyzed in comparison with values of the propagation speed of ultrasound pulses and of attenuation of ultrasound pulses.

[0034] In a further embodiment said displaying means display said reflection image, highlighting in a different manner pixels or voxels wherein the presence of said contrast agents is detected.

[0035] Such displaying means can advantageously comprise a screen where the image is displayed with pixels or voxels wherein the presence of said contrast agents is detected coloured in a different manner than the remaining part of the image.

[0036] The present invention further relates to an ultrasound imaging method for discriminating ultrasound signals deriving from contrast agents, which method comprises the following steps:

a) emitting an ultrasound beam at a fundamental frequency within said body under examination;
b) receiving said ultrasound beam transmitted by the body under examination obtaining transmission reception signals;
c) calculating the attenuation of ultrasound pulses and/or the propagation speed of transmitted ultrasound pulses by comparing the transmission reception signals with the corresponding emitted signals;
d) finding whether the transmission reception signal results from the presence of a contrast agent by comparing the values of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses with specific threshold values.

[0037] By means of this method it is possible to discriminate the reception signals in which the presence of contrast agents is detected from those in which it is not detected on the basis of the comparison between the values of attenuation of the ultrasound pulses and/or of the propagation speed of ultrasound pulses obtained by the transmission mode, on the basis of the results from experimental studies mentioned above.

[0038] Such method does not provide the injection of contrast agents as a step.

[0039] In a further embodiment the method of the present invention comprises the following further steps:

e) receiving echoes generated by the reflection of said transmitted ultrasound beam obtaining reflection reception signals;
f) extracting harmonic components from said reflection reception signals;
g) finding whether said harmonic components of the reflection reception signals are due to a reflection by contrast agents by comparing the intensity values of the harmonic components and/or said attenuation of ultrasound pulses and/or said propagation speed of ultrasound pulses with specific threshold values.

[0040] In a further embodiment before step e) a second ultrasound beam at a fundamental frequency is emitted into said body under examination such that the echoes received for obtaining the reflection reception signals derive from said second emitted ultrasound beam.

[0041] In a further embodiment the method of the present invention comprises the following further steps:

g) generating a transmission image from said transmission reception signals;
h) generating a reflection image from harmonic components of said reflection reception signals;
i) possibly registering the transmission image and the reflection image with the same reference system;
j) calculating for each pixel or voxel of the transmission image the attenuation of ultrasound pulses and/or the propagation speed of ultrasound pulses of the transmission reception signal;
k) calculating for each pixel or voxel of the reflection image the intensity of the harmonic components of the reflection reception signal;
1) finding out whether for each pixel or voxel the signal results from the presence of the contrast agent or from a general resonator or reflector by comparing for each pixel or voxel the value of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses of the transmission reception signal and the intensity value of the harmonic components of the reflection reception signal with specific threshold values.

[0042] According to a further embodiment a first reflection image is acquired from harmonic components of reflection reception signals with no contrast agents, then a second reflection image is acquired from harmonic components of reflection reception signals with contrast agents, a subtraction is performed between said first reflection image and said second reflection image, generating an image wherein for each pixel or voxel a determination is made whether the signal results from the presence of a contrast agent by comparing for each pixel or voxel the intensity value of the harmonic components of the reflection reception signal and the value of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses of the transmission reception signal acquired at the same time as said second reflection image with specific threshold values.

[0043] In a further embodiment transmission images and reflection images are 3D images obtained by sequentially scanning planes parallel each other of said body under examination.

[0044] According to a further embodiment the breast is subjected to imaging in an uncompressed condition.

[0045] The present invention further relates to a method for controlling an apparatus for detecting ultrasound images from a body under examination, which apparatus comprises a first unit emitting ultrasound pulses comprising one or more electroacoustic transducers and a first unit receiving ultrasound pulses comprising one or more electroacoustic transducers, said first emitting unit and said first receiving unit being faced each other and being spaced apart from each other by a predetermined dis-

tance such that they are arranged at opposite sides of a cavity housing said body under examination and the ultrasound pulses emitted from said first emitting unit are received by said first receiving unit after passing through the body under examination and are transformed into transmission signals, a second unit receiving ultrasound pulses, comprising one or more electroacoustic transducers, for receiving echoes generated by the body under examination and for transforming them into reflection signals, a control unit for said first emitting unit, a unit processing the received signals, image generating means and displaying means for said images, said processing unit comprising a unit evaluating the attenuation of ultrasound pulses and/or the propagation speed of ultrasound pulses and a unit extracting the harmonic components of said reflection signals, wherein said processing unit comprises a unit comparing said values of the intensity of said harmonic components, of the propagation speed of ultrasound pulses and/or of the attenuation of ultrasound pulses with specific threshold values, transmission and reflection signals resulting from the presence of contrast agents within the body under examination when the comparison of said harmonic components of the reflected signals, of said attenuation of ultrasound pulses and/or of said propagation speed of ultrasound pulses is under or over said threshold values.

[0046] These and other characteristics and advantages of the present invention will be more clear from the following description of some embodiments shown in annexed drawings wherein:

figs. 1, 2, 3 and 4 are a diagram of different embodiments of the apparatus of the present invention;
figs. 5, 6 and 7 are different embodiments of the apparatus of the present invention.

[0047] Figure 1 shows a preferred embodiment of the apparatus of the present invention.

[0048] The apparatus described is of the type according to documents US7699783 and US7771360 and it has a substantially horizontal table 8 with a patient laying prone on it, which table is provided with a cavity 20 housing the breast 2, where the breast 2 is housed suspended and not in the compressed condition.

[0049] Within the housing cavity there are provided a first unit 10 emitting ultrasound pulses comprising one or more electroacoustic transducers and a first unit 11 receiving ultrasound pulses comprising one or more electroacoustic transducers.

[0050] The first emitting unit 10 and the first receiving unit 11 are faced each other and are spaced apart from each other by a predetermined distance such that they are arranged at opposite sides of the cavity 20 housing the breast 2.

[0051] The ultrasound pulses emitted from the first emitting unit 10 are received by the first receiving unit 11 after passing through the breast 2 and are transformed into transmission signals.

[0052] The apparatus further comprises a control unit 320 for the first emitting unit, a unit 300 processing the received signals, an image generating unit 330 and image displaying means, particularly a display 4.

[0053] The processing unit 300 further comprises a unit evaluating the attenuation of ultrasound pulses 301 and/or the propagation speed of ultrasound pulses 302.

[0054] The processing unit comprises a unit 320 comparing the values of the propagation speed of ultrasound pulses and/or of the attenuation of ultrasound pulses calculated by the unit evaluating the attenuation of ultrasound pulses 301 and by the unit evaluating the propagation speed of ultrasound pulses 302 respectively, where they are compared with predetermined threshold values, stored into a storage unit 5 for the threshold values.

[0055] The transmission signals therefore result from the presence of contrast agents within the body under examination when the comparison of the values of attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses is under or over the threshold values stored into the storage unit 5 for the threshold values.

[0056] Therefore an image is generated by the image generating unit 330 and it is displayed on the display 4 and pixels or voxels of the image in which the presence of said contrast agents is detected are displayed in a different colour than the remaining part of the image.

[0057] The first emitting unit 10 and the first receiving unit 11 are supported by a support element 60, which is moved by an actuator 61 such to rotate on itself about a vertical axis substantially passing by the centre of the housing cavity 20 and such to translate from a lowermost position to an uppermost position.

[0058] Thus 3D images are generated by sequentially scanning planes parallel to each other of said body under examination.

[0059] This arrangement corresponds to what shown in figure 5, wherein the first emitting unit 10 and the first receiving unit 11 are shown, faced each other on opposed side of the breast 2 under examination.

[0060] A part of the ultrasound pulses emitted from the first emitting unit 10 are received by the first receiving unit 11 after passing through an area 21 of the breast 2 where contrast agents are provided, undergoing the consequent changes in the attenuation of the ultrasound pulses and propagation speed of ultrasound pulses.

[0061] Therefore this arrangement allows a method comprising the following step to be carried out:

a) emitting an ultrasound beam at a fundamental frequency within said body under examination;
b) receiving said ultrasound beam transmitted by the body under examination obtaining transmission reception signals;
c) calculating the attenuation of ultrasound pulses and/or the propagation speed of transmitted ultrasound pulses by comparing the transmission recep-

tion signals with the corresponding emitted signals;
d) finding whether the transmission reception signal results from the presence of a contrast agent by comparing the values of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses with specific threshold values.

[0062] Such method does not provide the injection of contrast agents as a step.

[0063] In the embodiment shown in figure 2 there is further provided a second receiving unit 12 for ultrasound pulses, comprising one or more electroacoustic transducers, for receiving echoes generated by the body under examination and for transforming them into reflection signals.

[0064] The processing unit further comprises a unit 303 for extracting harmonic components of the reflection signals.

[0065] The harmonic components of the reflected signals extracted in this manner therefore result from a reflection due to contrast agents when the comparison of said attenuation of ultrasound pulses and/or of said propagation speed of ultrasound pulses is under or over the threshold values stored into the storage unit 5 for the threshold values.

[0066] This arrangement corresponds to what shown in figure 6, wherein the second receiving unit 12 is shown, which can be moved in different positions, some of them are shown by broken lines, from a position near the first emitting unit 10 to a position near the first receiving unit 11.

[0067] A part of the ultrasound pulses emitted from the first emitting unit 10 are partially reflected by an area 21 of the breast 2 where contrast agents are provided, and the corresponding echoes, comprising harmonic components due to the non-linear behaviour of the contrast agents, are received by the second receiving unit 12.

[0068] This arrangement allows a method comprising the following further steps to be carried out:

e) receiving echoes generated by the reflection of said transmitted ultrasound beam obtaining reflection reception signals;
f) extracting harmonic components from said reflection reception signals;
g) finding whether said harmonic components of the reflection reception signals are due to a reflection by contrast agents by comparing the intensity value of the harmonic components and/or said attenuation of ultrasound pulses and/or said propagation speed of ultrasound pulses with specific threshold values.

[0069] In a further embodiment shown in figure 3 there is provided a second emitting unit, comprising one or more electroacoustic transducers, denoted in figure with number 12 since it comprises the same one or more electroacoustic transducers of the second receiving unit 12.

[0070] There is further provided a control unit 312 for said second emitting unit and the echoes received by the second receiving unit 12 derive from pulses emitted from the second emitting unit 12.

[0071] A switch 120 is provided among the control unit 312 for the second emitting unit, the processing unit 300 for the received signals and the second emitting and receiving unit 12, such that it is possible to alternately send signals to the electroacoustic transducers and to receive signals therefrom.

[0072] The image generating unit 330 generates a transmission image from signals received by the first receiving unit 11 and a reflection image from signals received from the second receiving unit 12.

[0073] The unit evaluating the attenuation of ultrasound pulses 302 and the unit evaluating the propagation speed of ultrasound pulses 301 calculate for each voxel of the transmission image the attenuation of ultrasound pulses and the propagation speed of ultrasound pulses.

[0074] The unit 303 extracting the harmonic components of the reflection signals extracts the harmonic components of the reflection signals and it calculates for each voxel of the reflection image the intensity of the harmonic components.

[0075] The comparing unit 320 compares for each corresponding voxel of the transmission image and of the reflection image the values of the attenuation of ultrasound pulses and of the propagation speed of ultrasound pulses and the intensity of the harmonic components with specific threshold values stored into the storage unit 5 for the threshold values, by detecting for each voxel the presence of contrast agents.

[0076] The arrangement shown in figure 3 corresponds to what shown in figure 7, wherein the second receiving unit 12 and the second emitting unit 12 coincide, such that the same electroacoustic transducers emit the ultrasound pulses and receive the corresponding echoes.

[0077] This arrangement allows a method as described above to be carried out, wherein before step e) a second ultrasound beam is emitted into said body under examination at a fundamental frequency such that the echoes received for obtaining the reflection reception signals derive from said second ultrasound beam emitted.

[0078] Moreover it is possible to carry out a method comprising the following further steps:

g) generating a transmission image from said transmission reception signals;
h) generating a reflection image from harmonic components of said reflection reception signals;
i) possibly registering the transmission image and the reflection image with the same reference system;
j) calculating for each pixel or voxel of the transmission image the attenuation of ultrasound pulses and/or the propagation speed of ultrasound pulses of the transmission reception signal;
k) calculating for each pixel or voxel of the reflection image the intensity of the harmonic components of

the reflection reception signal;
1) finding out whether for each pixel or voxel the signal results from the presence of the contrast agent or from a general resonator or reflector by comparing for each pixel or voxel the value of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses of the transmission reception signal and the intensity value of the harmonic components of the reflection reception signal with specific threshold values.

[0079] In a further embodiment shown in figure 4 there is provided an image subtraction unit 340.

[0080] A first reflection image is acquired from harmonic components of reflection reception signals received by said second receiving unit with no contrast agents, then a second reflection image is acquired from harmonic components of reflection reception signals received by said second receiving unit with contrast agents, and the image subtraction unit 340 makes a subtraction between the first reflection image and the second reflection image.

[0081] Thus an image is generated wherein for each pixel or voxel a determination is made whether the signal results from the presence of a contrast agent said comparing unit comparing for each pixel or voxel the intensity value of the harmonic components of the reflection reception signal and the value of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses of the transmission reception signal acquired at the same time as said second reflection image with specific threshold values.

[0082] This arrangement allows a method to be carried out wherein a first reflection image is acquired from harmonic components of reflection reception signals with no contrast agents, then a second reflection image is acquired from harmonic components of reflection reception signals with contrast agents, a subtraction is performed between said first reflection image and said second reflection image, generating an image wherein for each pixel or voxel a determination is made whether the signal results from the presence of a contrast agent by comparing for each pixel or voxel the intensity value of the harmonic components of the reflection reception signal and the value of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses of the transmission reception signal acquired at the same time as said second reflection image with specific threshold values.

Claims

1. Apparatus for detecting ultrasound images from a body (2) under examination, the apparatus comprises
a first emitting unit (10) arranged for emitting ultrasound pulses, the first emitting unit (10) comprises one or more electroacoustic transducers, and a first receiving unit (11) arranged for receiving ultrasound pulses, the first receiving unit (11) comprises one or more electroacoustic transducers, said first emitting unit (10) and said first receiving unit (11) facing each other and spaced apart from each other by a predetermined distance such that they are arranged at opposite sides of a cavity (20) housing said body (2) under examination and the ultrasound pulses emitted from said first emitting unit (10) are received by said first receiving unit (11) after passing through the body (2) under examination and are transformed into transmission signals,
a control unit (310) for said first emitting unit, a processing unit (300) arranged for processing the received signals, image generating means (330) and displaying means (4) for said images,
said processing unit (300) comprising a unit evaluating the attenuation of ultrasound pulses (301) and/or the propagation speed of ultrasound pulses (302),
characterized in that
said processing unit (300) comprises a unit (320) comparing said values of the propagation speed of ultrasound pulses and/or of the attenuation of ultrasound pulses with predetermined threshold values, the processing unit (300) is arranged so as to detect if the transmission signals indicate the presence of contrast agents within the body (2) under examination when the comparison of said attenuation of ultrasound pulses and/or of said propagation speed of ultrasound pulses is under or over said threshold values.

2. Apparatus for detecting ultrasound images according to claim 1, wherein it comprises a second receiving unit (12) receiving ultrasound pulses, comprising one or more electroacoustic transducers, for receiving echoes generated by the body (2) under examination and for transforming them into reflection signals, said processing unit (300) comprising a unit (303) for extracting harmonic components of said reflection signals and said harmonic components of the reflection signals resulting from a reflection due to contrast agents when the comparison of said attenuation of ultrasound pulses and/or of said propagation speed of ultrasound pulses is under or over said threshold values.

3. Apparatus for detecting ultrasound images according to claim 2 wherein it comprises a second emitting unit (12), comprising one or more electroacoustic transducers, and a control unit (312) for said second emitting unit, such that the echoes received by the second receiving unit (12) results from pulses emitted from said second emitting unit (12).

4. Apparatus for detecting ultrasound images according to claim 3 wherein said second emitting unit (12)

and said second receiving unit (12) comprise the same one or more electroacoustic transducers.

5. Apparatus for detecting ultrasound images according to claims 3 or 4 wherein said second emitting unit (12) and/or said second receiving unit (12) are movable from a location near said first emitting unit (10) to a location near said first receiving unit (11).

6. Apparatus for detecting ultrasound images according to claims 3-5, wherein said image generating means (330) generate a transmission image from signals received by said first receiving unit (11) and a reflection image from signals received by said second receiving unit (12), said unit (301) evaluating the attenuation of ultrasound pulses and/or the propagation speed of ultrasound pulses (302) calculates for each pixel or voxel of the transmission image the attenuation of ultrasound pulses and/or the propagation speed of ultrasound pulses, said unit (303) extracting the harmonic components of the reflection signals calculates for each pixel or voxel of the reflection image the intensity of the harmonic components, said comparing unit (320) compares for each corresponding pixel or voxel of the transmission image and of the reflection image the values of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses and the intensity of the second harmonic component with specific threshold values, thus detecting the presence of contrast agents for each pixel or voxel.

7. Apparatus for detecting ultrasound images according to claims 2-6, wherein it is provided with image subtraction means (340) such that a first reflection image is acquired from harmonic components of reflection reception signals received by said second receiving unit (12) with no contrast agents, then a second reflection image is acquired from harmonic components of reflection reception signals received by said second receiving unit (12) with contrast agents, a subtraction is performed between said first reflection image and said second reflection image by said subtraction means (340), generating an image wherein for each pixel or voxel a determination is made whether the signal results from the presence of a contrast agent by means of said comparing unit (320) which compares for each pixel or voxel the intensity value of the harmonic components of the reflection reception signal and the value of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses of the transmission reception signal acquired at the same time as said second reflection image with specific threshold values.

8. Apparatus for detecting ultrasound images according to claim 7, wherein said displaying means (4) display said second reflection image, highlighting in a different manner pixels or voxels wherein the presence of said contrast agents is detected.

9. Ultrasound imaging method for discriminating ultrasound signals deriving from contrast agents, the method comprises the following steps:

a) emitting an ultrasound beam at a fundamental frequency within said body (2) under examination;
b) receiving said ultrasound beam transmitted by body (2) under examination obtaining transmission reception signals;
c) calculating attenuation of ultrasound pulses and/or propagation speed of ultrasound pulses of transmitted ultrasonic pulse by comparing the transmission reception signals with corresponding emitted signals;

characterized in that
it further comprises the following steps:

d) finding whether the transmission reception signal results from the presence of a contrast agent by comparing the values of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses with specific threshold values.

10. Ultrasound imaging method according to claim 9, wherein it does not provide contrast agent injection as a step.

11. Ultrasound imaging method according to claim 9 or 10, **characterized in that** it comprises the further following steps:

e) receiving echoes generated by the reflection of said transmitted ultrasound beam obtaining reflection reception signals;
f) extracting harmonic components from said reflection reception signals;
g) finding whether said harmonic components of the reflection reception signals are due to a reflection by contrast agents by comparing the intensity value of the second harmonic component and/or said attenuation of ultrasound pulses and/or said propagation speed of ultrasound pulses with specific threshold values.

12. Ultrasound imaging method according to claim 11, wherein before step e) a second ultrasound beam at a fundamental frequency is emitted into said body (2) under examination such that the echoes received for obtaining the reflection reception signals result from said second emitted ultrasound beam.

13. Ultrasound imaging method according to one or

more claims 9 to 12, wherein it further comprises the following steps:

g) generating a transmission image from said transmission reception signals;
h) generating a reflection image from harmonic components of said reflection reception signals;
i) possibly registering the transmission image and the reflection image with the same reference system;
j) calculating for each pixel or voxel of the transmission image the attenuation of ultrasound pulses and/or the propagation speed of ultrasound pulses of the transmission reception signal;
k) calculating for each pixel or voxel of the reflection image the intensity of the harmonic components of the reflection reception signal;
1) finding out whether for each pixel or voxel the signal results from the presence of the contrast agent or from a general resonator or reflector by comparing for each pixel or voxel the value of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses of the transmission reception signal and the intensity value of the harmonic components of the reflection reception signal with specific tereshold values.

14. Ultrasound imaging method according to one or more claims 9 to 13, wherein a first reflection image is acquired from harmonic components of reflection reception signals with no contrast agents, then a second reflection image is acquired from harmonic components of reflection reception signals with contrast agents, a subtraction is performed between said first reflection image and said second reflection image, generating an image wherein for each pixel or voxel a determination is made whether the signal results from the presence of a contrast agent by comparing for each pixel or voxel the intensity value of the harmonic components of the reflection reception signal and the value of the attenuation of ultrasound pulses and/or of the propagation speed of ultrasound pulses of the transmission reception signal acquired at the same time as said second reflection image with specific threshold values.

15. Ultrasound imaging method according to claim 14, wherein transmission images and reflection images are 3D images obtained by sequentially scanning planes parallel each other of said body (2) under examination.

Patentansprüche

1. Vorrichtung zum Erfassen von Ultraschallbildern aus einem zu prüfenden Körper (2), wobei die Vorrichtung aufweist:

eine erste Sendereinheit (10) die zum Aussenden von Ultraschallimpulse eingerichtet ist, wobei die erste Sendereinheit (10) einen oder mehrere elektroakustische Wandler umfasst, und eine erste Empfangeinheit (11), die zum Empfangen von Ultraschallimpulse eingerichtet ist, wobei die erste Empfangseinheit (11) einen oder mehrere elektroakustische Wandler umfasst, die erste Sendereinheit (10) und die erste Empfangseinheit (11), liegen einander gegenüber und sind voneinander um einen vorbestimmten Abstand entfernt, so dass sie an gegenüberliegenden Seiten eines Hohlraums (20) angeordnet sind welches den zu untersuchenden Körper (2) aufnimmt und die Ultraschallimpulse die von der ersten Sendereinheit (10) emittiert sind werden von der ersten Empfangseinheit (11) empfangen nachdem diese den zu untersuchenden Körper (2) durchlaufen haben und in Übertragungssignale transformiert worden sind,
eine Steuereinheit (310) für die erste Sendereinheit, eine Verarbeitungseinheit (300), die zur Verarbeitung der Empfangene Signale eingerichtet ist, Bilderzeugungsmittel (330) und eine Anzeigeeinrichtung (4) für die Bilder,
wobei die Verarbeitungseinheit (300) eine Einheit umfasst, die die Dämpfung von Ultraschallimpulsen (301) und/oder die Ausbreitungsgeschwindigkeit von Ultraschallimpulsen (302) bewertet,
Dadurch gekennzeichnet, dass
besagte Verarbeitungseinheit (330) eine Einheit (320) aufweist welche die besagten Werte der Ausbreitungsgeschwindigkeit der Ultraschallimpulse und/oder der Dämpfung von Ultraschallimpulsen mit einem Schwellwert vergleicht, wobei die Verarbeitungseinheit (300) so eingerichtet ist, dass diese erkennt ob die Übertragungssignale die Anwesenheit von Kontrastmitteln in den untersuchten Körper (2) anzeigen wenn der Vergleich der besagten Dämpfungswerte der Ultraschallimpulse und/oder der Werte der Ausbreitungsgeschwindigkeit der Ultraschallimpulsen oberhalb oder unterhalb des besagten Schwellwertes liegt.

2. Vorrichtung zum Erfassen von Ultraschallbildern nach Anspruch 1, welche eine zweite Empfangseinheit (12) aufweist für den Empfang von Ultraschallimpulse, umfassend eine oder mehrere elektroakustische Wandler um von dem in Untersuchung stehenden Körper (2) erzeugte Echos zu empfangen (2) und um diese in Reflexionssignale zu transformieren, wobei die Verarbeitungseinheit (300) eine Einheit (303) zum Extrahieren von harmonischen

Komponenten der Reflexionssignale umfasst und wobei besagten harmonischen Komponenten der Reflexionssignale von der Reflexion durch Kontrastmittel bewirkt ist wenn beim Vergleich die besagte Dämpfung von Ultraschallimpulsen und/oder die genannte Ausbreitungsgeschwindigkeit der Ultraschallimpulse unterhalb oder oberhalb der Schwellwerte liegt.

3. Vorrichtung zum Erfassen von Ultraschallbildern nach Anspruch 2 wobei diese Vorrichtung eine zweite Sendereinheit (12) aufweist umfassend eine oder mehrere elektroakustische Wandler und eine Steuereinheit (312) für die genannte zweite Sendereinheit (12) so dass die Echos, die von der zweiten Empfangseinheit (12) empfangen werden sind von Impulse der genannten zweiten Sendereinheit (12) bewirkt.

4. Vorrichtung zum Erfassen von Ultraschallbildern nach Anspruch 3 wobei die zweite Sendereinheit (12) und die zweite Empfangseinheit (12) dieselbe einen oder mehrere elektroakustische Wandler umfassen.

5. Vorrichtung zum Erfassen von Ultraschallbildern nach Anspruch 3 oder 4 wobei die zweite Sendereinheit (12) und/oder die zweite Empfangseinheit (12) bewegbar sind von einer Lage nahe der ersten Sendereinheit (10) zu einer Lage in der Nähe der genannten ersten Empfangseinheit (11).

6. Vorrichtung zum Erfassen von Ultraschallbildern nach den Ansprüchen 3-5, wobei die Bilderzeugungseinrichtung (330) ein Transmissionsbild aus den von der ersten Empfangseinheit (11) empfangenen Signalen und ein Reflexionsbild aus den Signalen die von der zweiten Empfangseinheit (12) empfangen worden sind, wobei die Einheit (301) welche die Dämpfung von Ultraschallimpulse und/oder die Ausbreitungsgeschwindigkeit von Ultraschallimpulse (302) bewertet, berechnet für jedes Pixel oder Voxel des Transmissionsbildes die Dämpfung der Ultraschallimpulse und/oder die Ausbreitungsgeschwindigkeit der Ultraschallimpulse, wobei die Einheit (303) welche die harmonischen Komponenten der Reflexionssignale extrahiert, berechnet für jedes Pixel oder Voxel des Reflexionsbildes die Intensität der harmonischen Komponenten, und wobei, für jeden korrespondierenden Pixel oder Voxel des Transmissionsbildes und des Reflexionsbildes vergleicht die besagte Vergleichseinheit (320) die Werte der Dämpfung von den Ultraschallimpulsen und/oder der Ausbreitungsgeschwindigkeit von den Ultraschallimpulsen und die Intensität der zweiten harmonische Komponente mit spezifischen Schwellwerte so dass für jeden Pixel oder Voxel die Anwesenheit von Kontrastmitteln ermittelt wird.

7. Vorrichtung zum Erfassen von Ultraschallbildern nach den Ansprüchen 2-6, wobei diese mit Bildsubtraktionsmittel (340) versehen ist in der Art dass ein erstes Reflexionsbild ist aus den harmonischen Komponenten des reflektierten Empfangssignal welches von der besagten zweiten Empfangseinheit (12) in Abwesenheit von Kontrastmitteln empfangen worden ist, erhalten, dann wird ein zweites Reflexionsbild erhalten aus den harmonischen Komponenten des reflektierten Empfangssignal welches von der besagten zweiten Empfangseinheit (12) in Anwesenheit von Kontrastmitteln empfangen worden ist, wobei mittels der Subtraktionseinrichtung (340) eine Subtraktion durchgeführt wird zwischen das genannte erste Reflexionsbild und das genannte zweite Reflexionsbild und wobei, mittels der besagten Vergleichseinheit (320) welche für jedes Pixel oder Voxel spezifische Schwellwerte mit dem Wert vergleicht der Intensität der harmonischen Komponente des reflektierten Empfangssignal und mit dem Wert der Dämpfung der Ultraschallimpulse und/oder der Ausbreitungsgeschwindigkeit der Ultraschallimpulse der transmittierten Empfangssignale welche gleichzeitig mit dem zweiten Reflexionsbild erfasst worden sind, ein Bild erzeugt wird, in dem für jedes Pixel oder Voxel bestimmt wird, ob das Signal aus der Anwesenheit eines Kontrastmittels stammt.

8. Vorrichtung zum Erfassen von Ultraschallbildern nach den Anspruch 7, wobei die besagte Anzeigemittel (4) das zweite Reflexionsbild anzeigen in dem sie die Pixel oder Voxel bei denen die Anwesenheit besagter Kotrastmittel ermittelt worden ist in einer andren weise hervorheben.

9. Ultraschallbilderfassungsverfahren zur Unterscheidung von Ultraschallsignale welche von Kontrastmitteln stammen, welches Verfahren die folgenden Schritte umfasst:

a) Aussenden eines Ultraschallstrahls an einer Grundwellen Frequenz innerhalb des zu prüfenden Körpers (2) ;
b) Empfangen des Ultraschallstrahls welches durch den Körper (2) unter Prüfung transmittiert worden ist wodurch ein Transmissionsempfangssignal erhalten worden ist;
c) Berechnung der Dämpfung der Ultraschallimpulse und/oder der Ausbreitungsgeschwindigkeit der Ultraschallimpulse des transmittierten Ultraschallimpulses durch Vergleich der Transmissionsempfangssignale mit entsprechende ausgesendete Signale;

Dadurch gekennzeichnet, dass
Das Verfahren folgenden weitere Schritte umfasst:

d) Feststellung, ob der Transmissionsemp-

fangssignal aus der Anwesenheit eines Kontrastmittels stammt, indem die Werte der Dämpfung der Ultraschallimpulse und/oder der Ausbreitungsgeschwindigkeit des Ultraschallimpulse mit bestimmten Schwellwerten verglichen werden.

10. Ultraschallbilderfassungsverfahren nach Anspruch 9, wobei es keinen Kontrastmittelinjektion Schritt aufweist.

11. Ultraschallbilderfassungsverfahren nach Anspruch 9 oder 10, **dadurch gekennzeichnet, dass** es folgende weiter Schritte umfasst:

e) Empfang von Echos welche durch die Reflektion der besagten transmittierten Ultraschallstrahlen bewirkt sind wobei Reflektionsempfangssignale erhalten werden;
f) Extraktion von harmonischen Komponenten der genannten Reflexionsempfangssignale;
g) Ermittlung ob die genannte harmonischen Komponente der Reflektionsempfangssignale von der Reflektion an Kontrastmitteln bewirkt worden sind indem der Wert der Intensität der zweiten harmonischen Komponente und/oder die besagte Dämpfung der Ultraschallimpulse und7oder die Ausbreitungsgeschwindigkeit der Ultraschallimpulse mit spezifischen Schwellwerte verglichen werden.

12. Ultraschallbilderfassungsverfahren nach Anspruch 11, wobei bevor Schritt e) einen zweiten Ultraschallstrahl in den genannten untersuchten Körper (2) ausgesendet wird mit einer Grundfrequenz, so dass die Echos welche zum erhalten der Reflektionsempfangssignale empfangen werden von diesem zweiten ausgesendeten Ultraschallstrahle bewirkt sind.

13. Ultraschallbilderfassungsverfahren nach einem oder mehreren der vorhergehenden Ansprüche 9 bis 12, welches die folgenden weiteren Schritte umfasst:

g) Erzeugen eines Transmissionsbildes aus den Transmissionsempfangssignalen;
h) Erzeugen eines Reflexionsbildes aus den harmonischen Komponenten der Reflexionsempfangssignale;
i) gegebenenfalls Registrierung des Transmissionsbildes und des Reflexionsbildes in dem gleichen Bezugssystem;
j) Berechnung für jeden Pixel oder Voxel des Transmissionsbildes die Dämpfung der Ultraschallimpulse und/oder die Ausbreitungsgeschwindigkeit der Ultraschallimpulse von dem Transmissionsempfangssignal;
k) Berechnen für jeden Pixel oder Voxel des Reflexionsbildes die Intensität der harmonischen Komponenten des Reflexionsempfangssignals;
l) ermitteln ob für jeden Pixel oder Voxel das Signal in Anwesenheit des Kontrastmittels oder von einem allgemeinen Resonator oder Reflektor resultiert indem, für jeden Pixel oder Voxel der Wert der Dämpfung der Ultraschallimpulse und/oder der Ausbreitungsgeschwindigkeit der Ultraschallimpulse des Transmissionsempfangssignals und der Intensitätswert der harmonischen Komponenten des Reflexionsempfangssignals mit einem spezifischen Schwellenwert verglichen wird.

14. Ultraschallbilderfassungsverfahren nach einem oder mehreren der vorhergehenden Ansprüche 9 bis 13, wobei ein erstes Reflexionsbild aus den harmonischen Komponenten der Reflexionsempfangssignale in Abwesenheit von Kontrastmitteln erfasst wird, dann ein zweites Reflexionsbild aus den harmonischen Komponenten der Reflexionsempfangssignale in Anwesenheit von Kontrastmitteln erfasst wird, wobei eine Subtraktion durchgeführt wird zwischen dem ersten Reflexionsbild und dem zweiten Reflexionsbild, wodurch ein Bild erzeugt wird, in welchem für jedes Pixel oder Voxel eine Bestimmung erfolgt, ob das Signal aus Anwesenheit eines Kontrastmittels bewirkt ist mittels Vergleich, für jeden Pixel oder Voxel, des Intensitätswertes
der harmonischen Komponenten des Reflexionsempfangssignals und des Wertes der Dämpfung der Ultraschallimpulse und/oder der Ausbreitungsgeschwindigkeit der Ultraschallimpulse des Transmissionsempfangssignals der gleichzeitig wie das zweite Reflexionsbild empfangen worden ist mit spezifische Schwellenwerte.

15. Ultraschallbilderfassungsverfahren nach Anspruch 14, wobei die Transmissionsbilder und die Reflexionsbilder 3D Bilder sind welche durch sequentieller Abtastung von zueinander paralleler Ebenen der untersuchten Körper (2).

Revendications

1. Appareil pour l'acquisition d'images échographiques d'un corps (2) examiné, l'appareil comprenant
une première unité d'émission (10) conçue pour émettre des impulsions ultrasonores, la première unité d'émission (10) comprenant un ou plusieurs transducteurs électroacoustiques, et une première unité de réception (11), conçue pour recevoir des impulsions ultrasonores, la première unité de réception (11) comprenant un ou plusieurs transducteurs électroacoustiques, ladite première unité d'émission (10) et ladite première unité de réception (11) étant face à face à une distance prédéterminée l'une de l'autre, de manière qu'elles soient placées sur des

côtés opposées d'une cavité (20) de logement dudit corps (2) examiné et que les impulsions ultrasonores émises par ladite première unité d'émission (10) soient reçues par ladite première unité de réception (11) après avoir traversé le corps (2) examiné et soient transformées en signaux de transmission,
une unité de commande (310) pour ladite première unité d'émission, une unité de traitement (300) conçue pour traiter les signaux reçus, des moyens générateurs d'images (330) et des moyens d'affichage (4) desdites images,
ladite unité de traitement (300) comprenant une unité d'évaluation de l'atténuation des impulsions ultrasonores (301) et/ou de la vitesse de propagation des impulsions ultrasonores (302),
caractérisé en ce que
ladite unité de traitement (300) comprend une unité (320) de comparaison desdites valeurs de la vitesse de propagation des impulsions ultrasonores et/ou de l'atténuation des impulsions ultrasonores avec des valeurs de seuil prédéterminées, l'unité de traitement (300) étant conçue pour détecter si les signaux de transmission indiquent la présence d'agents de contraste à l'intérieur du corps (2) examiné lorsque la valeur comparée de ladite atténuation des impulsions ultrasonores et/ou de ladite vitesse de propagation des impulsions ultrasonores est au-dessous ou au-dessus desdites valeurs de seuil.

2. Appareil pour l'acquisition d'images échographiques selon la revendication 1, dans lequel il comprend une seconde unité de réception (12) recevant des impulsions ultrasonores, comprenant un ou plusieurs transducteurs électroacoustiques, pour recevoir les échos générés par le corps (2) examiné et pour les convertir en signaux de réflexion, ladite unité de traitement (300) comprenant une unité (303) d'extraction de composantes harmoniques desdits signaux de réflexion, lesdites composantes harmoniques des signaux de réflexion dérivant d'une réflexion due à des agents de contraste lorsque la valeur comparée de ladite atténuation des impulsions ultrasonores et/ou de ladite vitesse de propagation des impulsions ultrasonores est au-dessous ou au-dessus desdites valeurs de seuil.

3. Appareil pour l'acquisition d'images échographiques selon la revendication 2, dans lequel il comprend une seconde unité d'émission (12), comprenant un ou plusieurs transducteurs électroacoustiques, et une unité de commande (312) pour ladite seconde unité d'émission, de manière que les échos reçus de la seconde unité de réception (12) dérivent d'impulsions émises de ladite seconde unité d'émission (12).

4. Appareil pour l'acquisition d'images échographiques selon la revendication 3, dans lequel ladite seconde unité d'émission (12) et ladite seconde unité de réception comprennent les mêmes un ou plusieurs transducteurs électroacoustiques,

5. Appareil pour l'acquisition d'images échographiques selon la revendication 3 ou 4, dans lequel ladite seconde unité d'émission (12) et/ou ladite seconde unité de réception (12) sont déplaçables d'une position près de ladite première unité d'émission (10) à une position près de ladite première unité de réception (11).

6. Appareil pour l'acquisition d'images échographiques selon les revendications 3 à 5, dans lequel lesdits moyens de génération d'images (330) génèrent une image de transmission à partir de signaux reçus de ladite première unité de réception (11) et une image de réflexion à partir de signaux reçus de ladite seconde unité de réception (12), ladite unité (301) d'évaluation de l'atténuation des impulsions ultrasonores et/ou de la vitesse de propagation des impulsions ultrasonores (302) calcule, pour chaque pixel ou voxel de l'image de transmission, l'atténuation des impulsions ultrasonores et/ou la vitesse de propagation des impulsions ultrasonores, ladite unité (303) d'extraction de composantes harmoniques desdits signaux de réflexion calcule pour chaque pixel ou voxel de l'image de réflexion, l'intensité des composantes harmoniques, ladite unité de comparaison (320) compare, pour chaque pixel ou voxel correspondant de l'image de transmission et de l'image de réflexion, les valeurs de l'atténuation des impulsions ultrasonores et/ou de la vitesse de propagation des impulsions ultrasonores et l'intensité de la composante de seconde harmonique, avec des valeurs de seuil spécifiques, et détecte ainsi la présence d'agents de contraste pour chaque pixel ou voxel.

7. Appareil pour l'acquisition d'images échographiques selon les revendications 2 à 6, dans lequel il est prévu des moyens de soustraction d'image (340) de manière qu'une première image de réflexion est acquise à partir de composantes harmoniques de signaux de réception de réflexion reçus par ladite seconde unité de réception (12) sans agents de contraste, ensuite une seconde image de réflexion est acquise à partir des composantes harmoniques de signaux de réception de réflexion reçus par ladite seconde unité de réception (12) avec des agents de contraste, une soustraction est effectuée entre ladite première image de réflexion et ladite seconde image de réflexion par lesdits moyens de soustraction (340), ce qui conduit à la génération d'une image, dans lequel, pour chaque pixel ou voxel il est déterminé si le signal résulte de la présence d'un agent de contraste au moyen de ladite unité de comparaison (320), comparant, pour chaque pixel ou voxel, la valeur d'inten-

sité des composantes harmoniques du signal de réception de réflexion et la valeur de l'atténuation des impulsions ultrasonores et/ou de la vitesse de propagation des impulsions ultrasonores du signal de réception de transmission acquis en même temps que ladite seconde image de réflexion avec des valeurs de seuil spécifiques.

8. Appareil pour l'acquisition d'images échographiques selon la revendication 7, dans lequel lesdits moyens d'affichage (4) affichent ladite seconde image de réflexion, en mettant en vedette de façon différente les pixels ou les voxels dans lesquels la présence desdits agents de contraste est détectée.

9. Procédé d'imagerie échographique pour discriminer les signaux ultrasonores dérivant d'agents de contraste, le procédé comprenant les étapes suivantes :

a) émettre un faisceau ultrasonore à une fréquence fondamentale dans ledit corps (2) examiné ;
b) recevoir ledit faisceau ultrasonore transmis par le corps examiné pour obtenir des signaux de réception de transmission ;
c) calculer l'atténuation des impulsions ultrasonores et/ou la vitesse de propagation des impulsions ultrasonores des impulsions ultrasonores transmises par la comparaison des signaux de réception de transmission avec des signaux émis correspondants ;

caractérisé en ce qu'il comprend par ailleurs les étapes suivantes :

d) découvrir si le signal de réception de transmission résulte de la présence d'un agent de contraste, par la comparaison des valeurs d'atténuation des impulsions ultrasonores et/ou de la vitesse de propagation des impulsions ultrasonores avec des valeurs de seuil spécifiques.

10. Procédé d'imagerie échographique selon la revendication 9, dans lequel il n'est prévu aucune étape d'injection d'agents de contraste.

11. Procédé d'imagerie échographique selon la revendication 9 ou 10, **caractérisé en ce qu'**il comporte également les étapes suivantes :

e) recevoir des échos générés par la réflexion dudit faisceau ultrasonore transmis, et obtenir ainsi des signaux de réception de réflexion ;
f) extraire les composantes harmoniques desdits signaux de réception de réflexion ;
g) découvrir si lesdites composantes harmoniques des signaux de réception de réflexion sont dûs à une réflexion par des agents de contraste, par la comparaison de la valeur d'intensité de la composante de seconde harmonique et/ou de ladite atténuation d'impulsions ultrasonores et/ou de ladite vitesse de propagation d'impulsions ultrasonores avec des valeurs de seuil spécifiques.

12. Procédé d'imagerie échographique selon la revendication 11, dans lequel, avant l'étape e), un second faisceau ultrasonore, à une fréquence fondamentale, est émis vers ledit corps (2) examiné de manière que les échos reçus pour obtenir les signaux de réception de réflexion résultent dudit second faisceau ultrasonore émis.

13. Procédé d'imagerie échographique selon une ou plusieurs des revendications 9 à 12, **caractérisé en ce qu'**il comprend par ailleurs les étapes suivantes :

g) générer une image de transmission à partir desdits signaux de réception de transmission ;
h) générer une image de réflexion à partir des composantes harmoniques desdits signaux de réception de réflexion ;
i) éventuellement aligner l'image de transmission et l'image de réflexion avec le même système de référence ;
j) calculer, pour chaque pixel ou voxel de l'image de transmission, l'atténuation des impulsions ultrasonores et/ou de la vitesse de propagation des impulsions ultrasonores du signal de réception de transmission ;
k) calculer, pour chaque pixel ou voxel de l'image de réflexion, l'intensité des composantes harmoniques du signal de réception de réflexion ;
l) découvrir si, pour chaque pixel ou voxel, le signal résulte de la présence de l'agent de contraste ou d'un résonateur ou d'un réflecteur non spécifique, par la comparaison, pour chaque pixel ou voxel, de la valeur de l'atténuation des impulsions ultrasonores et/ou de la vitesse de propagation des impulsions ultrasonores du signal de réception de transmission et de la valeur d'intensité des composantes harmoniques du signal de réception de réflexion avec des valeurs de seuil spécifiques.

14. Procédé d'imagerie échographique selon une ou plusieurs des revendications 9 à 13, dans lequel une première image de réflexion est acquise à partir de composantes harmoniques de signaux de réception de réflexion sans agents de contraste, ensuite une seconde image de réflexion est acquise à partir des composantes harmoniques de signaux de réception de réflexion avec des agents de contraste, une soustraction est effectuée entre ladite première image de réflexion et ladite seconde image de réflexion, ce qui conduit à la génération d'une image, dans lequel,

pour chaque pixel ou voxel il est déterminé si le signal résulte de la présence d'un agent de contraste par la comparaison, pour chaque pixel ou voxel, de la valeur d'intensité des composantes harmoniques du signal de réception de réflexion et de la valeur de l'atténuation des impulsions ultrasonores et/ou de la vitesse de propagation des impulsions ultrasonores du signal de réception de transmission acquis en même temps que ladite seconde image de réflexion avec des valeurs de seuil spécifiques.

15. Procédé d'imagerie échographique selon la revendication 14, dans lequel les images de transmission et les images de réflexion sont des images 3D obtenues par le balayage d'une séquence de plans parallèles dudit corps (2) examiné.

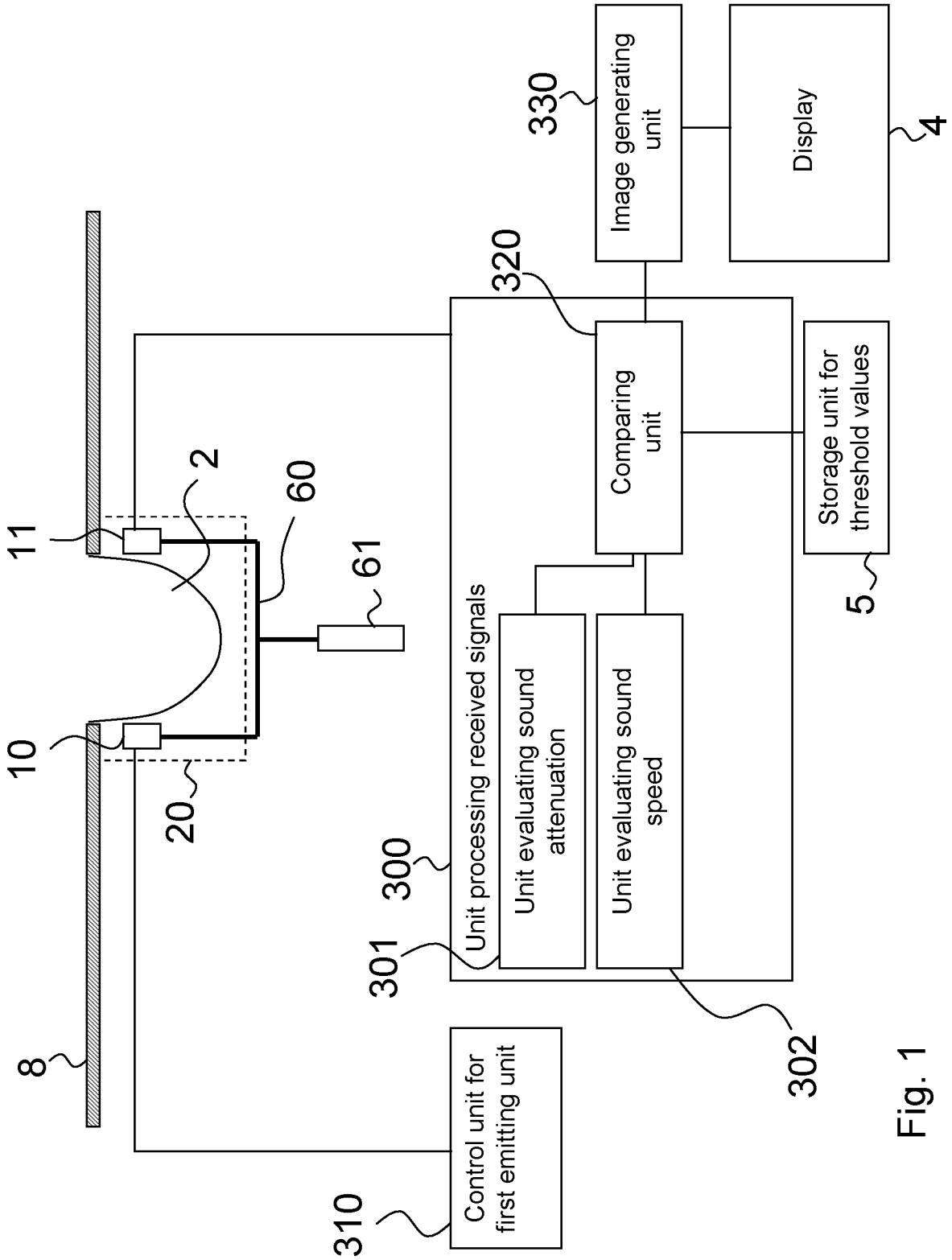
330
Image generating unit
Display
4
320
Comparing unit
Storage unit for threshold values
5
Unit processing received signals
Unit evaluating sound attenuation
Unit evaluating sound speed
300
301
302
Control unit for first emitting unit
310
11
2
60
61
10
20
8

Fig. 1

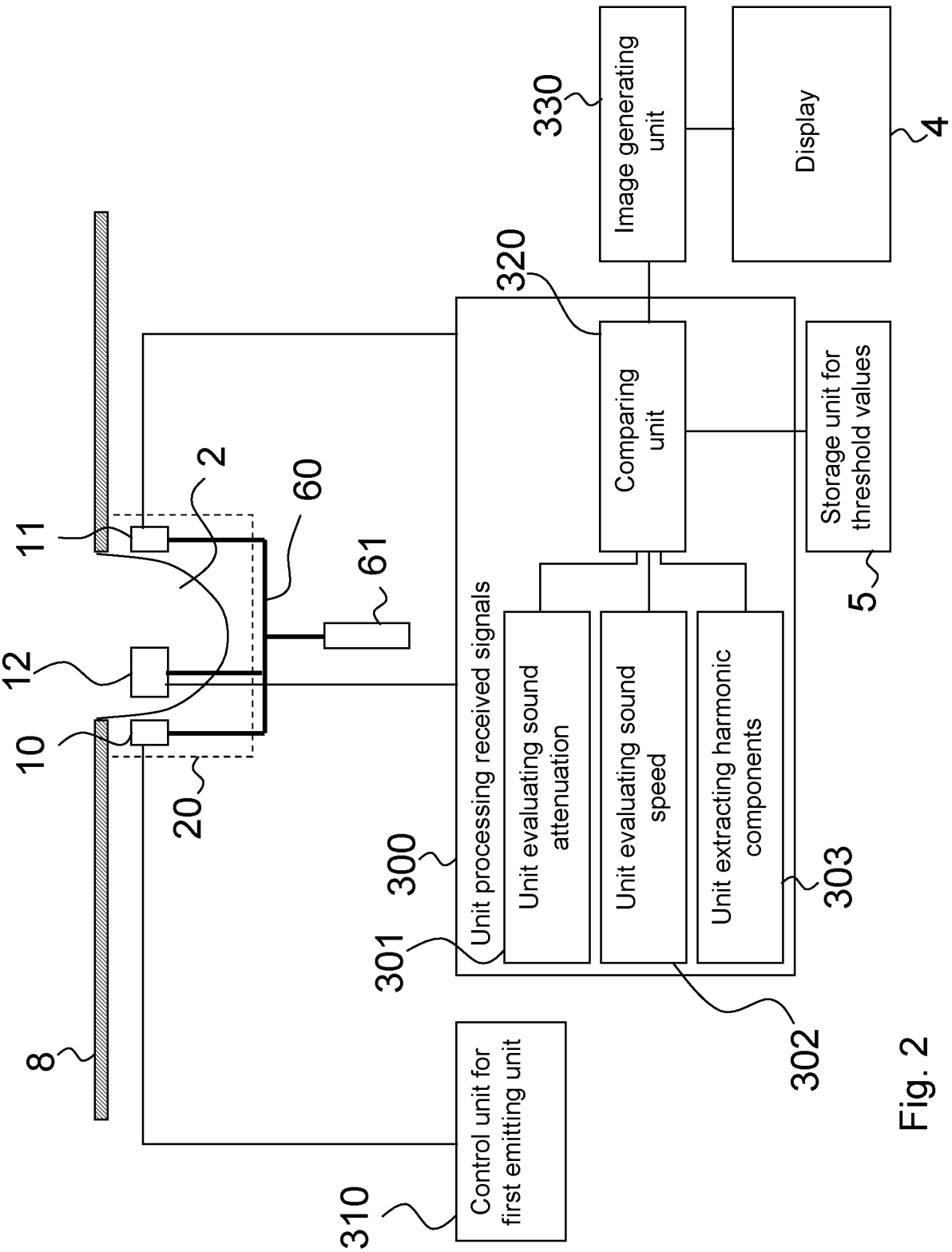
330
Image generating unit
Display
4
320
Comparing unit
Storage unit for threshold values
5
Unit processing received signals
300
Unit evaluating sound attenuation
Unit evaluating sound speed
Unit extracting harmonic components
303
301
302
Control unit for first emitting unit
310
8
11
12
10
2
60
61
20

Fig. 2

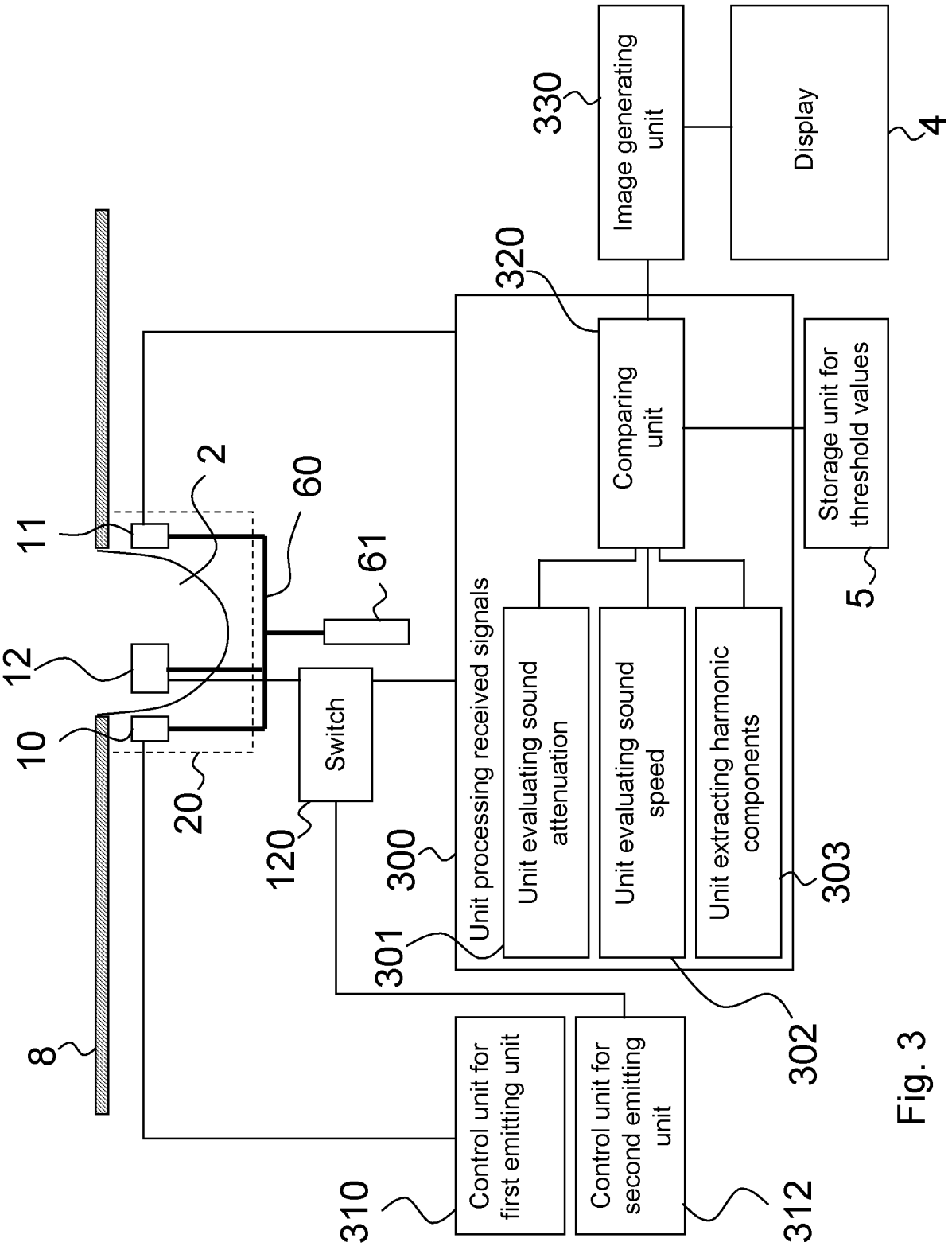
330
Image generating unit
Display
4
320
Comparing unit
Storage unit for threshold values
5
Unit processing received signals
Unit evaluating sound attenuation
Unit evaluating sound speed
Unit extracting harmonic components
303
300
301
302
Switch
120
61
60
2
11
12
10
20
8
Control unit for first emitting unit
310
Control unit for second emitting unit
312

Fig. 3

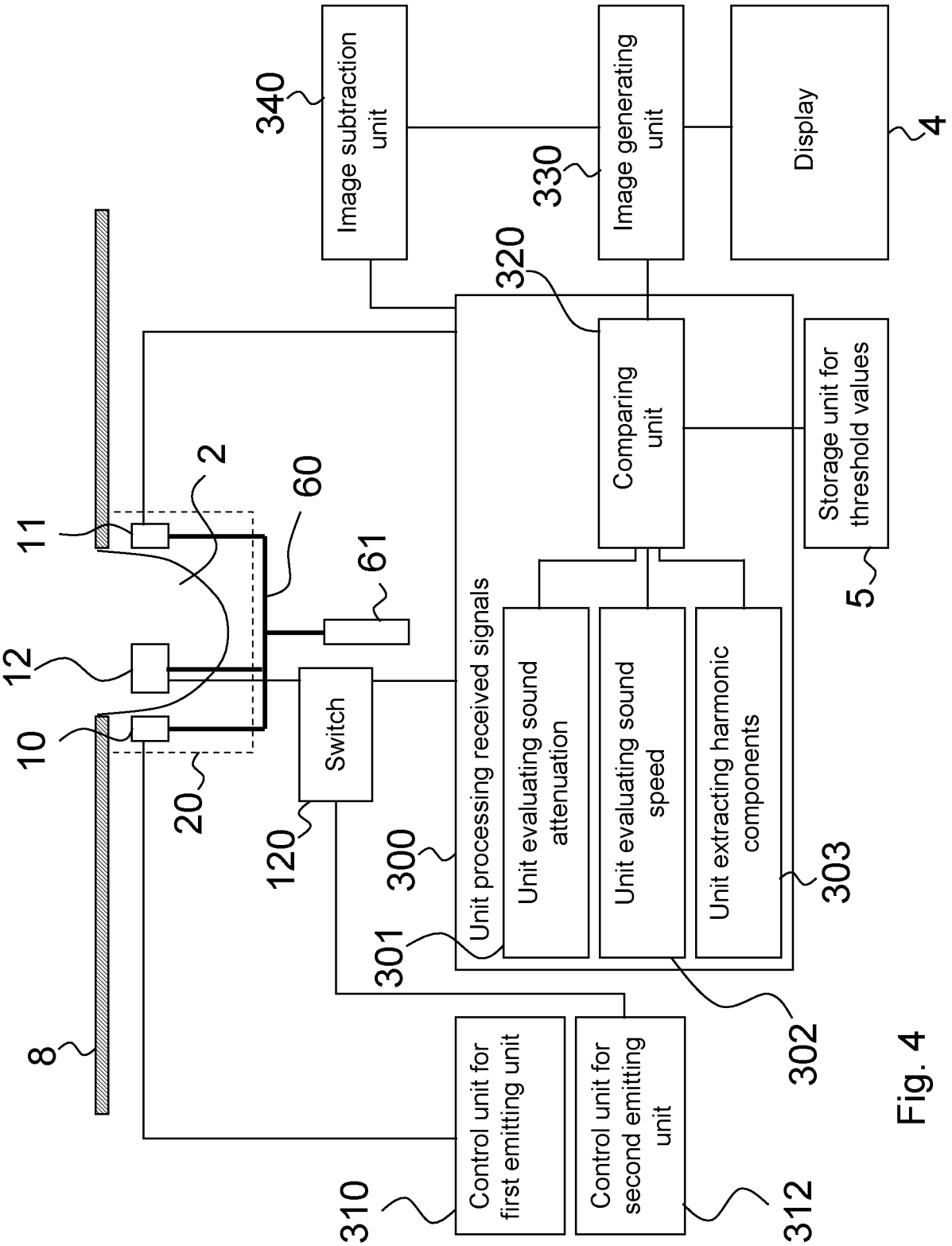
Image subtraction unit
340
Image generating unit
330
Display
4
320
Comparing unit
Storage unit for threshold values
5
2
60
61
11
12
10
20
Switch
120
300
Unit processing received signals
Unit evaluating sound attenuation
Unit evaluating sound speed
Unit extracting harmonic components
303
301
302
8
Control unit for first emitting unit
Control unit for second emitting unit
310
312

Fig. 4

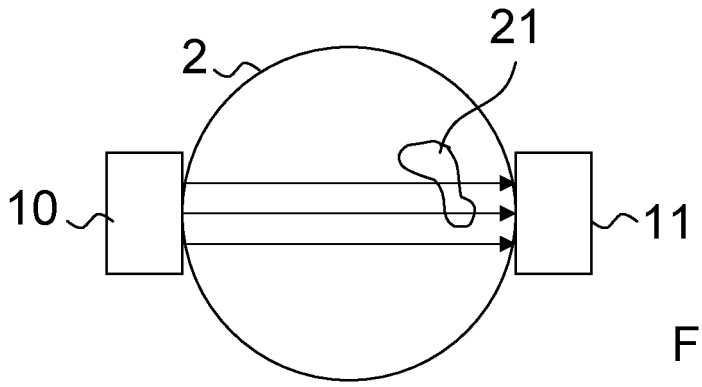

Fig. 5

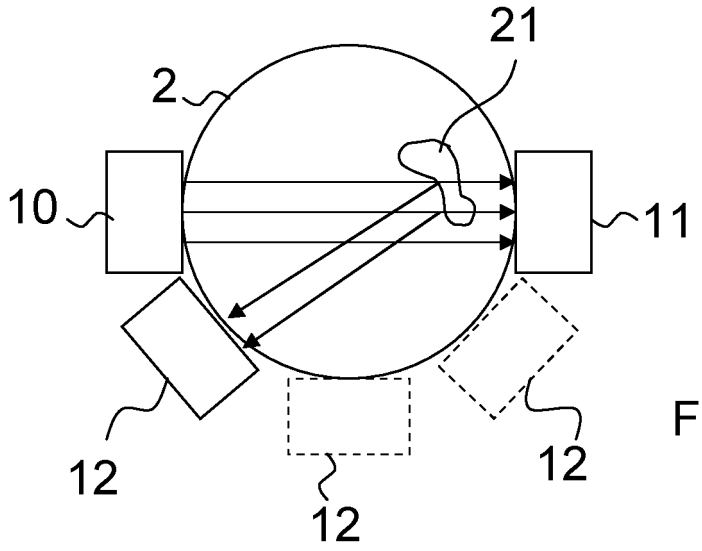

Fig. 6

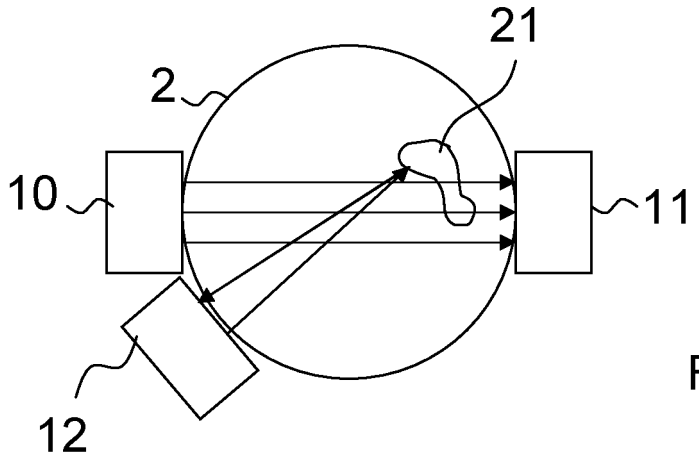

Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 7699783 B **[0005] [0048]**
- US 7771360 B **[0005] [0048]**

专利名称(译)	用造影剂进行超声成像的装置和方法		
公开(公告)号	EP2508136B1	公开(公告)日	2016-11-30
申请号	EP2012163037	申请日	2012-04-03
[标]申请(专利权)人(译)	百胜集团		
申请(专利权)人(译)	ESAOTE S.P.A.		
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发明人	PELLEGRETTI, PAOLO		
IPC分类号	A61B8/13		
CPC分类号	A61B8/406 A61B8/0825 A61B8/481		
优先权	GE2011000037 2011-04-05 IT		
其他公开文献	EP2508136A1		
外部链接	Espacenet		

摘要(译)

用于检测来自检查中的身体的超声图像的设备和方法，该设备包括发射超声脉冲的单元和接收超声脉冲的单元，发射单元和接收单元彼此面对并且彼此间隔开预定距离，使得它们布置在容纳被检查体的腔体的相对侧，并且从发射单元发射的超声脉冲在通过被检查体之后由接收单元接收并且被转换成传输信号，用于发射单元的控制单元处理单元，处理接收信号，图像生成装置和图像显示装置，处理单元包括评估超声脉冲衰减和/或超声脉冲传播速度的单元，其中处理单元包括比较所述超声脉冲的所述值的单元。超声脉冲的传播速度和/或超声波的衰减d。具有预定阈值的脉冲，当超声脉冲的衰减和/或超声脉冲的所述传播速度的比较低于或超过阈值时，由检查中的体内存在造影剂产生的传输信号。

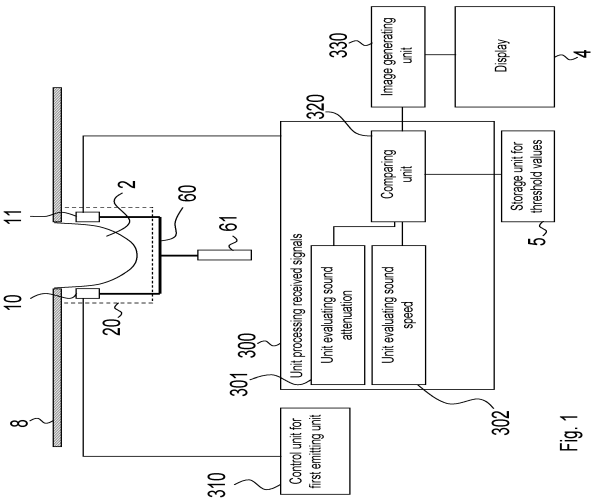

Fig. 1