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(54) **ULTRASONIC PROBE**

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- **PATENT ABSTRACTS OF JAPAN vol. 1996, no. 08, 30 August 1996 (1996-08-30) & JP 08 098838 A (TOSHIBA CORP), 16 April 1996 (1996-04-16)**
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Description

TECHNICAL FIELD

[0001] The present invention relates to an ultrasonic probe, more specifically, an ultrasonic probe which transmits and receives ultrasonic waves with respect to a subject, changing the surface to be scanned by the mechanical oscillation of an ultrasonic element.

BACKGROUND ART

[0002] In a medical field, ultrasonic diagnostic apparatuses are widely used, such an apparatus transmits and receives ultrasonic waves by using an ultrasonic probe with respect to a subject, so that it obtains information about the respective parts of the subject, depending on the acoustic characteristics of the parts. In the ultrasonic diagnostic apparatus, a transducer array as an ultrasonic element for transmitting and receiving ultrasonic waves is used, and this transducer array is oscillated mechanically to change the surface to be scanned with the ultrasonic waves, thereby obtaining three-dimensional information of the subject.

[0003] The probe used in such an ultrasonic diagnostic apparatus generally includes an ultrasonic element and an oscillation mechanism for oscillating the ultrasonic element. The oscillation mechanism is configured, for example, by connecting a supporting axis to an output axis of a motor via a gear and connecting to this supporting axis a holder that holds the ultrasonic element. In the oscillation mechanism, when the motor is driven, the rotatory power is transmitted to the supporting axis via the gear so as to cause rotation to the supporting axis, thereby the ultrasonic element rotates with the holder, in synchronization with the movement of the supporting axis. By reversing the rotating direction of the motor at predetermined time intervals so as to reverse the rotating direction of the ultrasonic element, oscillation of the ultrasonic element is provided.

[0004] Furthermore, the oscillation mechanism provided with an angle detector to detect oscillation angle of the ultrasonic element has been proposed (for example, see JP3(1991)-184532A). FIG. 7 is a perspective view showing the structure of the angle detector which composes a conventional ultrasonic probe. The angle detector 70 is composed of a slit plate 72 which rotates together with the supporting axis 71 and has plural slits arranged concentrically about the rotating axis, and an optical counter 73 arranged pinching the slit plate 72. The optical counter 73 is divided at the slit plate 72 into two parts: one is for emitting light and the other is for receiving light that has passed through the slits. Based on the number of the light reception counts, the rotation angle of the slit plate 72, that is, the rotation angle of the supporting axis 71 is detected. By detecting the rotation angle of the supporting axis as above, the rotation angle (the oscillation angle) of the ultrasonic element which rotates together with the supporting axis can be detected as well.

[0005] In the conventional ultrasonic probe, however, the detector detects only the number of light reception counts, thus it has been impossible to detect accurately an oscillation origin or the position of the ultrasonic element at the time of turning on a switch with respect to the ultrasonic probe. This has caused a problem that control of origin return of the ultrasonic element would be complicated, thus delaying a time for the origin return.

[0006] Patent document US 5,759,155 discloses an encoder device for an ultrasonic probe of an ultrasonographic apparatus. The device comprises a disk which has sections differing in the amount of reflected light arranged alternately on its entire periphery. A light projection/reception section positioned to face the disk is projects light onto, and receives light from the sections of the disk. A mechanism rotates the disk and the light projection/reception section relatively. An output signal is decomposed into high- and low-frequency components.

DISCLOSURE OF THE INVENTION

[0007] The object of the present invention is to provide an ultrasonic probe and method which can control the origin return of an ultrasonic element easily and swiftly.

[0008] In order to attain the above-mentioned object, the present invention provides the ultrasonic probe according to claim 1, and the diagnostics method according to claim 8.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

FIG. 1 is a cross-sectional view of an example of an ultrasonic probe according to Embodiment 1 of the present invention.

FIG. 2 is a schematic view of an example of a detector composing the ultrasonic probe according to Embodiment 1.

FIG. 3 is a timing chart of an example of an angle signal and a origin-return signal which are obtained by the detector.

FIG. 4 is a block diagram of a circuit structure of an ultrasonic tomographic diagnostic apparatus using the ultrasonic probe.

FIG. 5 is a cross-sectional view of an example of an ultrasonic probe according to Embodiment 2 of the present invention.

FIG. 6 is a schematic view of an example of a detector composing the ultrasonic probe according to Embodiment 2.

FIG. 7 is a schematic view of a detector composing a conventional ultrasonic probe.

BEST MODE FOR CARRYING OUT THE INVENTION

[0010] The ultrasonic probe of the present invention includes a detector for detecting the oscillation angle and the oscillation origin of an ultrasonic element unit. In addition, when the oscillation range of the ultrasonic element unit is divided at the oscillation origin into two regions of a positive region and a negative region, the detector detects in which area the ultrasonic element unit is located. In using the ultrasonic probe, origin return control for returning the ultrasonic element unit to its oscillation origin is performed on the basis of the result of the detection by the detector. More specifically, information about the position and the oscillation origin of the ultrasonic element unit is provided to a control mechanism of the ultrasonic diagnostic apparatus at the time of the origin return control when turning on the power, and the control of origin return can be performed on the basis of this information. Thereby, the return operation can be carried out easily and swiftly.

[0011] In the ultrasonic probe, the detector can be structured for outputting at least a single-phase rotary encoder pulse signal as an angle signal, detecting the oscillation angle on the basis of the angle signal, outputting an origin-return signal that shows different logic levels depending on whether the ultrasonic element unit is located in the positive region or the negative region, and detecting the oscillation origin on the basis of the changing point of the logic level of the origin-return signal (that is, a rising edge or a falling edge).

[0012] Moreover, in the ultrasonic probe, the detector can include: a slit plate which oscillates together with the ultrasonic element unit and has a first slit formed in an arc-shape from a position corresponding to the oscillation origin to a position at least corresponding to the end of the positive region or the negative region about the oscillation axis of the slit plate; a light source for radiating light to the slit plate; and a first photodetector which detects the light passed through the first slit, converts it into an electric signal and outputs the origin-return signal.

[0013] Furthermore, in the ultrasonic probe, the detector can include: a slit plate which oscillates together with the ultrasonic element unit and has plural second slits arranged at a predetermined pitch concentrically or in an arc-shape about the oscillation axis; a light source for radiating light to the slit plate and a second photodetector which detects the light emitted from the light source and passed through the second slits; converts it into an electric signal and outputs the angle signal.

[0014] Here, the first slit and the second slits are preferably formed to the same slit plate.

[0015] Still further, in the ultrasonic probe, the detector can include: a magnetic dram which oscillates together with the ultrasonic element unit and has plural magnetic patterns arranged at a predetermined pitch concentrically or in an arc-shape about the oscillation axis; and a magnetoresistive element which detects a magnetic pattern of the magnetic dram, converts it into an electric signal and outputs an angle signal.

[0016] Here, the magnetic dram is preferably provided on the oscillation axis which is fixed directly to the ultrasonic element unit.

[0017] The following is a description of preferred embodiments of the present invention, with reference to the accompanying drawings.

(Embodiment 1)

[0018] FIG. 1 is a cross-sectional view showing an example of the ultrasonic probe according to Embodiment 1 of the present invention. In the ultrasonic probe, a medium chamber is formed by connecting a window 11 to a frame 15. The medium chamber is filled with a degassed acoustical coupling medium 12. In the medium chamber, an ultrasonic element unit 13 formed by aligning plural oscillators is contained. The ultrasonic element unit 13 is fixed to an oscillation axis 14 by an oscillation axis holder 10, and the oscillation axis 14 is supported rotatably by a bearing 9 provided to the frame 15.

[0019] By fixing the oscillation axis 14 directly to the ultrasonic element unit 13 as mentioned above, the radius of the oscillation can be decreased, therefore, the size of the window 11 can be decreased relatively to the oscillation scanning angle of the ultrasonic element unit 13, and the moment of inertia with respect to the oscillation axis 14 can be reduced, thus realizing the reduction of the torque of a motor.

[0020] Further in the ultrasonic probe, an oscillation mechanism for oscillating the ultrasonic element unit 13 is contained. The oscillation mechanism includes a motor as a driving force and a oscillation transmitting mechanism for conveying the rotation driving force of the motor 2 to the ultrasonic element unit. The oscillation transmitting mechanism includes a driving pulley 5 attached to an output axis 3 of the motor, a driven pulley 7 attached to the oscillation axis and a transmission belt 8 bridged between these pulleys. The motor 2 is fixed to the frame 15 via an oil seal 4 which prevents the acoustical coupling medium 12 from entering into the motor. The output axis 3 of the motor is supported by a bearing 6 provided to the frame 15, and the motor 2 is covered with a cabinet 16 which is connected to the frame 15.

[0021] In the above oscillation mechanism, when the motor 2 is driven, the driving pulley 5 provided with the output axis 3 rotates. The rotation of the driving pulley 5 is transmitted to the driven pulley 7 via the transmission belt 8, thus the driven pulley 7 rotates. The oscillation axis 14 rotates in synchronization with the rotation of the driven pulley 7, subsequently the ultrasonic element unit 13 rotates in synchronization with the rotation of the oscillation axis 14. By reversing the rotating direction of the motor at a predetermined time interval, the rotating direction of the ultrasonic element is reversed as well, thus realizing the oscillation of the ultrasonic element.

[0022] Moreover, a detector 1 for detecting the oscillation of the ultrasonic element unit 13 is contained in the ultrasonic probe. The detector 1 is configured for enabling detection of the oscillation angle and the oscillation origin of the ultrasonic element unit 13. In addition, the detector 1 is configured so that it can detect, when the oscillation range of the ultrasonic element unit is divided into two regions (hereinafter, these regions are called a positive region and a negative region, respectively) at the position of the ultrasonic element unit 13 (that is, the oscillation origin), in which region of the positive region or the negative region the ultrasonic element unit 13 is located.

[0023] The detector can also be attached to the oscillation axis so as to detect the oscillation of the ultrasonic element unit directly. Alternatively, the detector can be structured to detect the movement of a member which oscillates (rotates) together with the ultrasonic element unit (for example, such as the output axis of the motor) so as to detect the oscillation of the ultrasonic element unit indirectly.

[0024] In the ultrasonic probe illustrated in FIG. 1, for example, the detector 1 is attached to the motor 2, and configured to detect the oscillation of the motor. As mentioned above, since the oscillation of the ultrasonic element unit is in synchronization with the rotation of the motor, the rotation of the ultrasonic element unit can be detected by detecting the rotation of the motor.

[0025] FIG. 2 is a schematic view showing an example of the configuration of the detector 1. The detector 1 is structured as an optical incremental-type rotary encoder. In the detector 1, a slit plate 23 is attached to the output axis 3 of the motor so that the slit plate can rotate together. In the slit plate 23, a first slit 24 used for detecting the position and the oscillation origin of the ultrasonic element unit and second slits 20 used for detecting the oscillation angle are formed concentrically about the rotation axis of the slit plate. Light from a light source 21 is directed to the second slit 20, and the amount of light L2 passed through the second slits 20 is detected by a second photodetector 22. The light signal detected by the second photodetector 22 is converted into an electric signal and subsequently output as an angle signal. The light from the light source 21 is also directed to the first slit 24, and the amount of light L1 passed through the first slit 24 is detected by a first photodetector 25. And the light signal detected by the first photodetector 25 is converted into an electric signal and subsequently output as an origin-return signal.

[0026] The slits formed in the slit plate will be described below in detail with reference to FIG. 2. In FIG. 2, O denotes the position that corresponds to the oscillation origin of the ultrasonic element unit, where the ultrasonic element unit overlaps the photodetector. The sign of R denotes a region that corresponds to the oscillation range of the ultrasonic element unit, in which the ultrasonic element unit can pass in front of the photodetector during its oscillation.

[0027] The first slit 24 is for detecting the position and the oscillation origin of the ultrasonic element unit, and it is formed circularly about the rotation axis of the slit plate 23. As illustrated in FIG. 2, the first slit 24 is formed as an opening so that one end thereof is aligned with the position (O) that corresponds to the oscillation origin, while the other end is aligned with one end of the region (R) that corresponds to the oscillation range of the ultrasonic element unit. That is, when the region (R) which corresponds to the oscillation range of the ultrasonic element unit is divided into two parts by the position (O) corresponding to the oscillation origin, the first slit is formed in the whole range of one of the above-mentioned parts, but not formed in the other part.

[0028] The plural second slits 20 for angle detection are formed at the periphery of the slit plate 23 at a predetermined pitch. Though, there is no specific limitation, it is preferable that the number of the second slits is larger (that is, the shorter the pitch is), because the resolution for detecting the oscillation angle becomes higher. Alternatively, as additional slits for angle detection, plural slits can be formed, and the slits are arranged concentrically at the same pitch (P) as that of the second slits with a phase difference of P/4 (hereinafter, these additional slits may be called 'third slits').

[0029] The operation by the detector 1 for detecting the oscillation is described below with reference to FIG. 3. FIG. 3 is a timing chart of an example of the detection signal obtained by the detector. In FIG. 3, the detection signals S1 and S3 are obtained respectively with respect to the second slits and the third slits and used as angle signals. The detection signal S2 is obtained with respect to the first slit 24, and used as an origin-return signal.

[0030] The position of the ultrasonic element unit can be detected by detecting the light passed through the first slit 24. As mentioned above, the first slit 24 is formed so that when the region (R) corresponding to the oscillation range of the ultrasonic element unit is divided into two regions at the position (O) that corresponds to the oscillation origin, the opening is formed in the whole range of one of the regions, but no opening is formed in the other region. Therefore, when the ultrasonic element unit 13 is located in one of the parts of the oscillation range (for example, in the positive region) which is one of the oscillation regions is divided at the oscillation origin, the first slit 24 is positioned between the light source and the first photodetector, thus the light passed through the first slit 24 will be detected. Alternatively, when the ultrasonic element unit 13 is located in the other region of the oscillation range (for example, in the positive region), the first slit 24 is not be positioned between the light source and the first photoreceptor, thus the light passed through the first slit 24 is not detected. Thereby, it is possible to decide, by detecting whether light passing through the first slit 24, in which part of the right or left region with respect to the oscillation origin (in other words, the positive area or the negative area) the ultrasonic element unit is located.

[0031] In addition, the oscillation origin is detected from the signal obtained by detecting the light passed through the first slit 24 (that is, the origin-return signal). The detection of the oscillation origin is described with reference to FIG. 3. When the output axis of the motor rotates and the slit plate 23 rotates together with the output axis, the origin-return signal which is obtained by the first slit 24 becomes a binary signal as illustrated as, for example, S2 in FIG. 3. Each logic level of the signal for origin return corresponds to the light passed through the first slit: logically high level is output when the light passed through the first slit is detected, and logically low level is output when the light passed through the first slit is not substantially detected. A changing point (O) where the origin-return signal changes from the logically high level to the logically low level is located at only one position in the region (R) which corresponds to the oscillation range, and this changing point corresponds to oscillation origin. Thereby, the oscillation origin can be detected by detecting the changing point from the logically high level to the logically low level.

[0032] Detection of the oscillation angle of the ultrasonic element unit is carried out by detecting the light passing through the second slits 20. When the slit plate 23 rotates, the signal (the angle signal) obtained by the second slits 20 becomes, for example, a binary pulse signal as illustrated as S1 in FIG. 3. The each logic level of the angle signal depends on the detection of the light passed through the second slits. The number of pulses corresponds to the number of the second slits passed in front of the second photodetector within a predetermined time period. Therefore, the oscillation angle can be obtained by counting the number of these pulses.

[0033] In a case where the third slits are provided, when the slit plate 23 rotates, the signal (the angle signal) obtained by the third slits becomes, for example, a binary pulse signal having a phase difference of T/4 with respect to the signal (S1) obtained by the second slits 20 as illustrated as S2 in FIG. 3. Thereby, a double-phase pulse can be obtained as an angle signal by providing the third slits, thus improving further angle-detecting resolution.

[0034] For a case of an encoder of 500 pulses (that is, having 500 slits), when the angle signal is a single-phase pulse, an angle-detecting resolution will be 0.36, and the resolution will be 0.18 when the angle signal is a double-phase pulse. Moreover, in a case where the angle signal is a single-phase pulse, stop control can be performed with an accuracy of T/2 for the frequency (T) of the pulse or with a higher accuracy of T/4 when the angle signal is a double-phase pulse.

[0035] In the above description, the example of forming a slit in an opaque plate is illustrated, but the present invention is not limited to the example. Similar functions can be obtained by forming black grids on a transparent plate such as a glass plate. The present embodiment exemplified a transmission-type optical rotary encoder as the detector, but a reflection-type optical rotary encoder can provide similar functions.

[0036] Ultrasonic diagnostics using the above-mentioned ultrasonic probe will be described below. FIG. 4 is a block diagram showing an example of a circuit structure of an ultrasonic diagnostic apparatus using the ultrasonic probe. In FIG. 4, 31 denotes the structure inside the ultrasonic probe, and 33 illustrates the structure inside the ultrasonic diagnostic apparatus.

[0037] The angle signals S1, S3, and the origin-return signal S2 are produced at the detector 32 and these signals are transmitted to a detection signal processing circuit 35 of the diagnostic apparatus 33. On the basis of the angle signals S1, S3 and the origin-return signal S2 produced at the detector 32, the detection signal processing circuit 35 produces a control signal S4 for performing the oscillation control and the control for origin return of the ultrasonic element unit, and transmits the control signal S4 to an oscillation driving control circuit 39. The oscillation driving control circuit 39 produces a driving signal S5 and transmits the signal to a motor 2 in the ultrasonic probe for the purpose of drive-control. The rotary driving force of the motor is transmitted to the ultrasonic element unit 13 by an oscillation transmitting mechanism 37, thereby the oscillation operation and the control for origin return of the ultrasonic element unit 13 are performed.

[0038] The angle detection signal processing circuit 35 transmits a control signal S6 to a transmission-reception circuit 38, and the transmission-reception circuit 38 sends a driving signal S7 to the ultrasonic element unit 13. This signal is converted at the ultrasonic element unit 13 into ultrasonic waves, and transmitted to a subject. The ultrasonic wave is reflected by the subject, and a part of the reflected wave is received by the ultrasonic element unit, converted into an electric signal S8 (received signal), and sent to the transmission-reception circuit. Subsequently, the signal S8 is converted into an image signal S9 by an image processing circuit 50, thereby a tomographic image of the subject corresponding to the image signal S9, is displayed on a monitor 51.

[0039] As mentioned above, according to the ultrasonic probe of the present embodiment, it is possible to detect, by using the detector, the position of the ultrasonic element unit as well as its oscillation angle and oscillation origin of the ultrasonic element unit. Therefore, for example, for the origin return control at the time of turning on the power, information about the position and the oscillation origin of the ultrasonic element unit is provided as a origin-return signal S2 to a control mechanism of the ultrasonic diagnostic apparatus, and the origin return control can be performed on the basis of the information. Thereby, the return operation can be performed easily and swiftly.

[0040] Furthermore, the present embodiment has an advantage that both of the oscillation angle and the oscillation origin of the ultrasonic element unit can be detected easily by one detector.

(Embodiment 2)

[0041] FIG. 5 is a cross-sectional view showing an example of the structure of the ultrasonic probe according to Embodiment 2 of the present invention. A detector in the present invention is composed of an oscillation angle detector and an oscillation origin detector which are separated from each other. In FIG. 5, the same parts as in FIG. 1 are assigned with the same reference numerals, and the description about the parts are omitted.

[0042] An origin detector 43 is for detecting the position and the oscillation origin of the ultrasonic element unit. This is structured as an optical rotary encoder, and attached to an output axis of a motor 2. The origin detector 43 can have the same structure as the detector illustrated in FIG. 2, except that the second slits 20 and the second photodetector 22 are omitted. The detection operation is substantially the same as that of the first slits in Embodiment 1.

[0043] An oscillation angle detector 40 is for detecting the oscillation angle of the ultrasonic element unit, and it can be structured as a magnetic rotary encoder. FIG. 6 is a detailed configuration of the oscillation detector 40. This oscillation detector 40 includes a magnetic dram 41 attached to an oscillation axis 14 and a magnetoresistive element 42 attached to a frame 15. A magnetic pattern 44 is formed on the surface 43 of the magnetic dram 41 at a predetermined pitch. This magnetic pattern 44 is detected by using the magnetoresistive element 42, and the obtained detection signal is used for detecting the oscillation angle.

[0044] In the present embodiment, the oscillation angle is detected by the oscillation angle detector 40, and the position and the oscillation origin of the ultrasonic element unit are detected by the origin detector 43. Therefore, at the time of the origin return control, information about the position and the oscillation origin of the ultrasonic element unit is provided to a control mechanism of the ultrasonic diagnostic apparatus as an origin-return signal. Thereby, the return operation can be carried out easily and swiftly.

[0045] Moreover, in the present embodiment, since the oscillation angle detector 40 is structured by using the magnetic rotary encoder, the oscillation angle can be detected even in the acoustical coupling medium 12. Therefore, the angle detector can be arranged in larger area in the ultrasonic probe.

[0046] Furthermore, unlike Embodiment 1, since the angle detector 40 in the present embodiment provided to the oscillation axis 14 that is directly fixed to the ultrasonic element unit 13, the oscillation angle of the ultrasonic element unit 13 can be detected directly, not via the oscillation transmitting mechanism. Thereby, influences of a transmission error such as a back lash by the oscillation transmission mechanism can be prevented, thus realizing a high-accuracy detection of the oscillation angle of the ultrasonic element unit 13.

INDUSTRIAL APPLICABILITY

[0047] As described above, the ultrasonic probe of the present invention can detect the position and the oscillation origin of the ultrasonic element unit when turning on the power, for example. Thus, control of the origin return of the ultrasonic element unit can be performed easily, thereby the origin return can be performed swiftly. The ultrasonic probe is particularly useful for an ultrasonic diagnostic apparatus which can obtain information about the interior of a living organism by transmitting and receiving ultrasonic waves with respect to the living organism.

Claims

1. An ultrasonic probe comprising:

an ultrasonic element unit (13) for transmitting and receiving ultrasonic waves;
an oscillation mechanism for causing oscillation to the ultrasonic element unit (13); and
a detector (1) for detecting oscillation of the ultrasonic element unit (13),
characterized in that
the detector (1) includes an oscillation angle detecting rotary encoder and an origin detecting rotary encoder separate from the oscillation angle detecting rotary encoder that rotate in synchronization with the ultrasonic element unit (13), wherein:

- the oscillation angle detecting rotary encoder is constituted to output at least a single-phase rotary encoder pulse signal as an angle signal,
- the origin detecting rotary encoder includes a rotary body that rotates in synchronization with the ultrasonic element unit (13), and an oscillation detecting portion that detects a state of the rotary body,
- wherein in the rotary body, a positive region and a negative region having different states, respectively, are formed, wherein a border between the positive region and the negative region is at a position corresponding to an oscillation origin of the ultrasonic element unit(13),

the oscillation detecting portion outputting an origin return signal that shows different logic levels depending on whether the ultrasonic element unit (13) is located in the positive region or the negative region,
the oscillation mechanism causes the oscillation to the ultrasonic element unit (13) in a direction determined by the origin return signal,
the oscillation origin is detected on the basis of the changing point of the logic level of the origin-return signal, and
a control of origin return for the ultrasonic

element unit (13) to its oscillation origin is performed on the basis of the result of the detection by the detector (1).

2. The ultrasonic probe according to claim 1, wherein the rotary body is a slit plate (23) which oscillates together with the ultrasonic element unit (13) and has a first slit (24) formed in an arc-shape about the oscillation axis (14) from a position corresponding to the oscillation origin to at least a position corresponding to the end of the positive region or the negative region, and
the oscillation detecting portion includes:

   a light source (21) for radiating light to the slit plate (23); and
   a first photodetector (25) which detects the light emitted from the light source (21) and passed through the first slit (24), converts the detected light into an electric signal and outputs an origin-return signal.

3. The ultrasonic probe according to claim 2, wherein the oscillation angle detecting rotary encoder comprises:

   a slit plate (23) which oscillates together with the ultrasonic element unit (13) and has plural second slits (20) aligned at a predetermined pitch concentrically or in an arc-shape about the oscillation axis (14);
   a light source (21) for radiating light to the slit plate (23); and
   a second photodetector (22) which detects the light emitted from the light source (21) and passed through the second slits (20), converts the detected light into an electric signal and outputs an angle signal.

4. The ultrasonic probe according to claim 3, wherein the first slit (24) and the second slits (20) are formed on the same slit plate (23).

5. The ultrasonic probe according to claim 2, wherein the oscillation angle detecting rotary encoder comprises:

   a magnetic dram (41) which oscillates together with the ultrasonic element unit (13) and has plural magnetic patterns (44) aligned at a predetermined pitch concentrically or in an arc-shape about the oscillation axis (14); and
   a magnetoresistive element (42) which detects a magnetic pattern (44) of the magnetic dram (41) converts into an electric signal and outputs an angle signal.

6. The ultrasonic probe according to claim 5, wherein the magnetic dram (41) is provided on the oscillation axis (14) which is fixed directly to the ultrasonic element unit (13).

7. The ultrasonic probe according to claim 1,
wherein the detector comprises a transparent plate formed with black grids which oscillates together with the ultrasonic element unlit, and a light source for radiating to the transparent plate; and
the detector is a reflection-type optical rotary encoder.

8. A method of ultrasonic diagnostics, wherein, while a detector including an encoder that oscillates with an oscillation of an ultrasonic element unit is caused to output at least a single-phase rotary encoder pulse signal as an angle signal (S1, S3) so as to detect an oscillation angle of the ultrasonic element unit based on the angle signal (S1, S3), the ultrasonic element unit is caused to perform ultrasonic wave scanning, the method comprising:

   the detector outputting the angle signal (S1, S3), and outputting an origin-return signal (S2) that shows different logic levels depending on whether the ultrasonic element unit is located in a positive region or a negative region, the positive region and the negative region being divided at an oscillation origin;
   when power is turned on,
   causing the detector to detect the origin-return signal (S2) at a position of the ultrasonic element unit when the power is turned on;
   performing a control of origin return in which the ultrasonic element unit is caused to oscillate in a direction determined by the origin-return signal (S2) while being caused to detect an origin-return signal at each oscillation position, so that the ultrasonic element unit is caused to oscillate to a changing point of the logic level of the origin-return signal (S2); and
   after the control of origin return, causing the ultrasonic element unit to perform ultrasonic wave scanning, while causing the detector to detect an oscillation angle of the ultrasonic element unit on the basis of the angle signal (S1, S3).

9. The method of claim 8, comprising using the ultrasonic probe according to one of claims 1 to 7.

Patentansprüche

1. Ultraschallsonde, umfassend:

   eine Ultraschallelementeinheit (13) zum Übertragen und Empfangen von Ultraschallwellen;
   einen Oszillationsmechanismus zum Bewirken

einer Oszillation der Ultraschallelementeinheit (13); und
einen Detektor (1) zum Erfassen einer Oszillation der Ultraschallelementeinheit (13),
dadurch gekennzeichnet, dass
der Detektor (1) einen Drehwertgeber zum Erfassen eines Oszillationswinkels und einen Drehwertgeber zum Erfassen eines Nullpunktes umfasst, der vom Drehwertgeber zum Erfassen des Oszillationswinkels getrennt ist, welche synchron zur Ultraschallelementeinheit (13) rotieren, wobei:

der Drehwertgeber zum Erfassen des Oszillationswinkels zum Ausgeben von mindestens einem einphasigen Drehwertgeberimpulssignal als Winkelsignal ausgebildet ist,
der Drehwertgeber zum Erfassen des Nullpunkts einen Rotationskörper, welcher synchron zur Ultraschallelementeinheit (13) rotiert, und einen Oszillationserfassungsteil umfasst, der den Zustand des Rotationskörpers feststellt,
wobei im Rotationskörper ein positiver Bereich und ein negativer Bereich, die unterschiedliche Zustände haben, gebildet sind, wobei eine Grenze zwischen dem positiven Bereich und dem negativen Bereich sich an einer Position befindet, die einem Oszillationsnullpunkt der Ultraschallelementeinheit (13) entspricht,
der Oszillationserfassungsteil ein Nullpunktsrückkehrsignal ausgibt, das unterschiedliche Logikpegel aufweist, je nachdem, ob die Ultraschallelementeinheit (13) sich im positiven Bereich oder im negativen Bereich befindet,
der Oszillationsmechanismus die Oszillation der Ultraschallelementeinheit (13) in eine Richtung bewirkt, die durch das Nullpunktsrückkehrsignal bestimmt ist,
der Oszillationsnullpunkt auf der Grundlage des Wechselpunktes des Logikpegels des Nullpunktsrückkehrsignals erfasst ist, und
eine Steuerung der Nullpunktsrückkehr der Ultraschallelementeinheit (13) zu ihrem Oszillationsnullpunkt auf der Grundlage des Ergebnisses der Erfassung durch den Detektor (1) erfolgt.

2. Ultraschallsonde gemäß Anspruch 1, wobei der Rotationskörper eine Spaltplatte (23) ist, die zusammen mit der Ultraschallelementeinheit (13) oszilliert und einen ersten Spalt (24) hat, der bogenförmig um die Oszillationsachse (14) von einer Position aus, die dem Oszillationsnullpunkt entspricht, zumindest bis zu einer Position gebildet ist, die dem Ende des positiven Bereichs oder des negativen Bereichs entspricht, und
der Oszillationserfassungsteil umfasst:

eine Lichtquelle (21) zum Ausstrahlen von Licht zu der Spaltplatte (23); und
einen ersten Fotodetektor (25), der das Licht, welches von der Lichtquelle (21) emittiert wurde und den ersten Spalt (24) passiert hat, erfasst, das erfasste Licht in ein elektrisches Signal umwandelt und ein Nullpunktsrückkehrsignal ausgibt.

3. Ultraschallsonde gemäß Anspruch 2, wobei der Drehwertgeber zum Erfassen des Oszillationswinkels folgendes umfasst:

eine Spaltplatte (23), die zusammen mit der Ultraschallelementeinheit (13) oszilliert und mehrere zweite Spalte (20) hat, die mit einem vorgegebenen Abstand konzentrisch oder in Bogenform um die Oszillationsachse (14) ausgerichtet sind;
eine Lichtquelle (21) zum Ausstrahlen von Licht zu der Spaltplatte (23); und
einen zweiten Fotodetektor (22), der das Licht, welches von der Lichtquelle (21) emittiert wurde und die zweiten Spalte (20) passiert hat, erfasst, das erfasste Licht in ein elektrisches Signal umwandelt und ein Winkelsignal ausgibt.

4. Ultraschallsonde gemäß Anspruch 3, wobei der erste Spalt (24) und die zweiten Spalte (20) auf derselben Spaltplatte (23) gebildet sind.

5. Ultraschallsonde gemäß Anspruch 2, wobei der Drehwertgeber zum Erfassen des Oszillationswinkels folgendes umfasst:

einen magnetischen DRAM (41), der zusammen mit der Ultraschallelementeinheit (13) oszilliert und mehrere Magnetmuster (44) hat, die mit einem vorgegebenen Abstand konzentrisch oder in Bogenform um die Oszillationsachse (14) ausgerichtet sind; und
ein magnetoresistives Element (42), welches ein Magnetmuster (44) des magnetischen DRAMs (41) erfasst, in ein elektrisches Signal umwandelt und ein Winkelsignal ausgibt.

6. Ultraschallsonde gemäß Anspruch 5, wobei der magnetische DRAM (41) auf der Oszillationsachse (14) bereitgestellt ist, die direkt an der Ultraschallelementeinheit (13) befestigt ist.

7. Ultraschallsonde gemäß Anspruch 1,
wobei der Detektor eine transparente Platte, welche mit schwarzen Gittern gebildet ist, die zusammen

mit der Ultraschallelementeinheit oszilliert, und eine Lichtquelle zum Bestrahlen der transparenten Platte umfasst; und
der Detektor ein optischer Drehwertgeber vom Reflexionstyp ist.

8. Verfahren der Ultraschalldiagnostik, wobei, während bewirkt wird, dass ein Detektor, der einen Geber umfasst, der mit einer Oszillation einer Ultraschallelementeinheit schwingt, zumindest ein einphasiges Drehwertgeberimpulssignal als ein Winkelsignal (S1, S3) ausgibt, um so einen Oszillationswinkel der Ultraschallelementeinheit, der auf dem Winkelsignal (S1, S3) beruht, zu erfassen, bewirkt wird, dass die Ultraschallelementeinheit einen Ultraschallwellenscanprozess ausführt, wobei das Verfahren folgendes umfasst:

durch den Detektor Ausgeben des Winkelsignals (S1, S3) und eines Nullpunktsrückkehrsignals (S2), das unterschiedliche Logikpegel zeigt, je nachdem, ob die Ultraschallelementeinheit sich in einem positiven Bereich oder in einem negativen Bereich befindet, wobei der positive Bereich und der negative Bereich am Oszillationsnullpunkt getrennt sind;
wenn Betriebsspannung eingeschaltet wird, Bewirken, dass der Detektor das Nullpunktsrückkehrsignal (S2) an einer Position der Ultraschallelementeinheit erfasst, wenn die Spannung eingeschaltet wird;
Ausführen einer Steuerung der Nullpunktsrückkehr, bei der bewirkt wird, dass die Ultraschallelementeinheit in einer Richtung oszilliert, die vom Nullpunktsrückkehrsignal (S2) bestimmt ist, während bewirkt wird, dass in jeder Oszillationsposition ein Nullpunktsrückkehrsignal erfasst wird, so dass die Ultraschallelementeinheit bis zu einem Änderungspunkt des Logikpegels des Nullpunktsrückkehrsignals (S2) oszilliert; und
nach der Steuerung der Nullpunktsrückkehr, Bewirken, dass die Ultraschallelementeinheit einen Ultraschallwellenscanprozess ausführt, während bewirkt wird, dass der Detektor einen Oszillationswinkel der Ultraschallelementeinheit auf der Grundlage des Winkelsignals (S1, S3) erfasst.

9. Verfahren gemäß Anspruch 8, welches das Verwenden der Ultraschallsonde nach einem der Ansprüche 1 bis 7 umfasst.

Revendications

1. Sonde ultrasonique comprenant :

une unité à élément ultrasonique (13) pour transmettre et recevoir des ondes ultrasoniques ;
un mécanisme d'oscillation pour provoquer l'oscillation de l'unité à élément ultrasonique (13) ; et
un détecteur (1) pour détecter l'oscillation de l'unité à élément ultrasonique (13),
caractérisée en ce que
le détecteur (1) inclut un codeur rotatif de détection de l'angle d'oscillation et un codeur rotatif de détection d'origine séparé du codeur rotatif de détection de l'angle d'oscillation et qui tourne en synchronisme avec l'unité à élément ultrasonique (13), où
■ le codeur rotatif de détection de l'angle d'oscillation est conçu pour produire au moins un signal impulsionnel monophase de codeur rotatif en tant que signal d'angle,
■ le codeur rotatif de détection d'origine inclut un corps rotatif qui tourne en synchronisme avec l'unité à élément ultrasonique (13), et une portion de détection d'oscillation qui détecte un état du corps rotatif,
■ une région positive et une région négative ayant différents états étant, respectivement, formées dans le corps rotatif, une limite entre la région positive et la région négative étant située au niveau d'une position correspondant à une origine d'oscillation de l'unité à élément ultrasonique (13),
■ la portion de détection d'oscillation produisant un signal de retour à l'origine qui montre différents niveaux logiques selon que l'unité à élément ultrasonique (13) est située dans la région positive ou la région négative,
le mécanisme d'oscillation provoquant l'oscillation de l'unité à élément ultrasonique (13) dans une direction déterminée par le signal de retour à l'origine,
le signal d'oscillation étant détecté sur la base du point de changement du niveau logique du signal de retour à l'origine ; et
une commande du retour à l'origine de l'unité à élément ultrasonique (13) vers son origine d'oscillation étant mise en oeuvre sur la base du résultat de la détection par le détecteur (1).

2. Sonde ultrasonique selon la revendication 1, dans laquelle le corps rotatif est une plaque à fentes (23) qui oscille avec l'unité à élément ultrasonique (13) et qui comporte une première fente (24) en arc de cercle autour de l'axe d'oscillation (14) depuis une position correspondant à l'origine de l'oscillation vers au moins une position correspondant à l'extrémité de la région positive ou de la région négative, et
la portion de détection d'oscillation incluant :

une source lumineuse (21) pour faire rayonner de la lumière vers la plaque à fentes (23) ; et
un premier photodétecteur (25) qui détecte la lumière émise depuis la source lumineuse (21) et qui a passé au travers de la première fente (24), transforme la lumière détectée en un signal électrique et produit un signal de retour à l'origine.

3. Sonde ultrasonique selon la revendication 2, dans laquelle le codeur rotatif de détection de l'angle d'oscillation comprend :

une plaque à fentes (23) qui oscille avec l'unité à élément ultrasonique (13) et comporte plusieurs secondes fentes (20) alignées, avec un pas prédéterminé, concentriquement ou selon un arc de cercle, autour de l'axe d'oscillation (14) ;
une source lumineuse (21) pour faire rayonner de la lumière vers la plaque à fente (23) ; et
un second photodétecteur (22) qui détecte la lumière émise depuis la source lumineuse (21) et qui a passé au travers des secondes fentes (20), transforme la lumière détectée en un signal électrique et produit un signal d'angle.

4. Sonde ultrasonique selon la revendication 3, dans laquelle la première fente (24) et les secondes fentes (20) sont formées dans la même plaque à fentes (23).

5. Sonde ultrasonique selon la revendication 2, dans laquelle le codeur rotatif de détection de l'angle d'oscillation comprend :

une mémoire RAM dynamique magnétique (41) qui oscille avec l'unité à élément ultrasonique (13) et comporte plusieurs variations (44) des propriétés magnétiques, lesquelles sont alignées, avec un pas prédéterminé, concentriquement ou selon un arc de cercle, autour de l'axe d'oscillation (14) ; et
un élément magnétorésistif (42) qui détecte des variations (44) des propriétés magnétiques de la mémoire RAM dynamique magnétique (41), les transforment en un signal électrique et produit un signal d'angle.

6. Sonde ultrasonique selon la revendication 5, dans laquelle la mémoire RAM dynamique magnétique (41) est prévue sur l'axe d'oscillation (14) qui est fixé directement sur l'unité à élément ultrasonique (13).

7. Sonde ultrasonique selon la revendication 1, dans laquelle le détecteur comprend une plaque transparente présentant un quadrillage noir qui oscille avec l'unité à élément ultrasonique, et une source lumineuse pour irradier la plaque transparente ; le détecteur étant un codeur rotatif optique du type à réflexion.

8. Procédé de diagnostic ultrasonique, dans lequel, tandis qu'un détecteur, incluant un codeur qui oscille en même temps qu'oscille une unité à élément ultrasonique, est conduit à produire au moins un signal impulsionnel monophase de codeur rotatif en tant que signal d'angle (S1, S3) de façon à détecter un angle d'oscillation de l'unité à élément ultrasonique sur la base du signal d'angle (S1, S3), l'unité à élément ultrasonique est conduite à mettre en oeuvre un balayage par ondes ultrasoniques, le procédé comprenant :

le fait pour le détecteur de produire le signal d'angle (S1, S3), et de produire un signal de retour à l'origine (S2) qui montre différents niveaux logiques selon que l'unité à élément ultrasonique est située dans la région positive ou la région négative, la région positive et la région négative étant divisées au niveau d'une origine d'oscillation ;
lorsque l'alimentation en énergie est mise sur marche,
le détecteur est conduit à détecter le signal de retour à l'origine (S2) pour une position de l'unité à élément ultrasonique lorsque l'alimentation en énergie est mise sur marche ;
une commande de retour à l'origine est mise en oeuvre selon laquelle l'unité à élément ultrasonique est conduite à osciller selon une direction déterminée par le signal de retour à l'origine (S2) tout en étant conduite à détecter un signal de retour à l'origine à chaque position d'oscillation, de sorte que l'unité à élément ultrasonique (13) est conduite à osciller vers un point de changement du niveau logique du signal de retour à l'origine (S2) ; et
après la commande du retour à l'origine, l'unité à élément ultrasonique (13) est conduite à mettre en oeuvre un balayage d'ondes ultrasoniques, tout en conduisant le détecteur à détecter un angle d'oscillation de l'unité à élément ultrasonique sur la base du signal d'angle (S1; S3).

9. Procédé selon la revendication 8, comprenant l'utilisation de la sonde ultrasonique selon l'une quelconque des revendications 1 à 7.

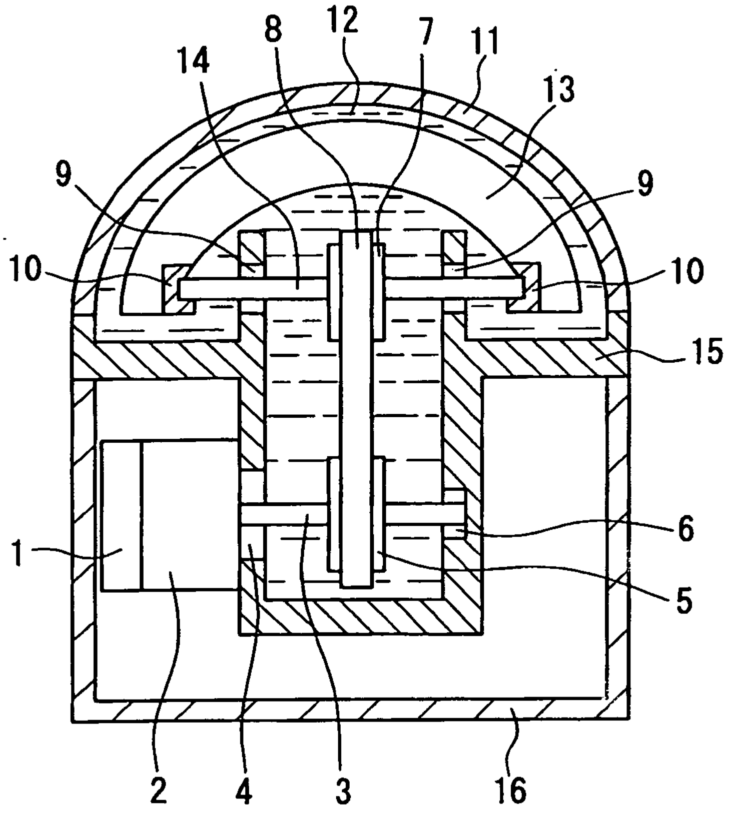


FIG. 1

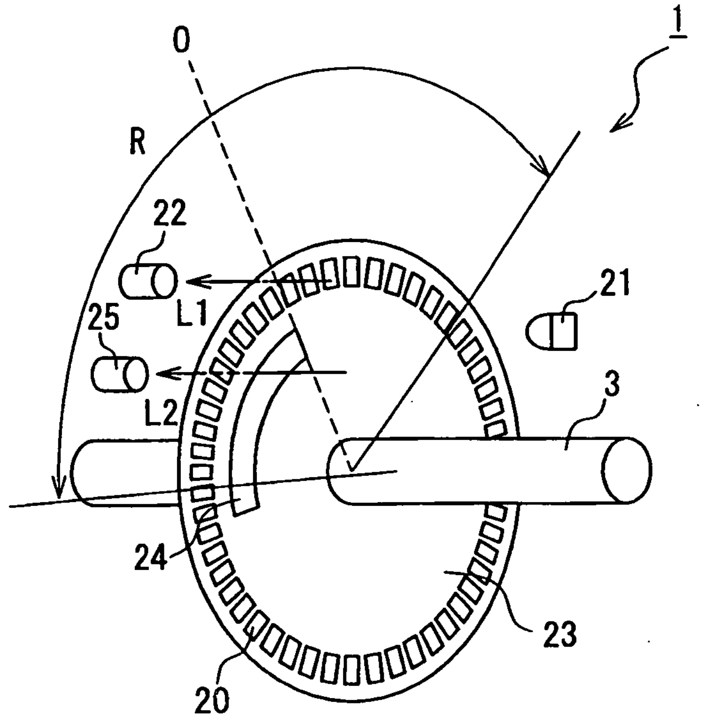


FIG. 2

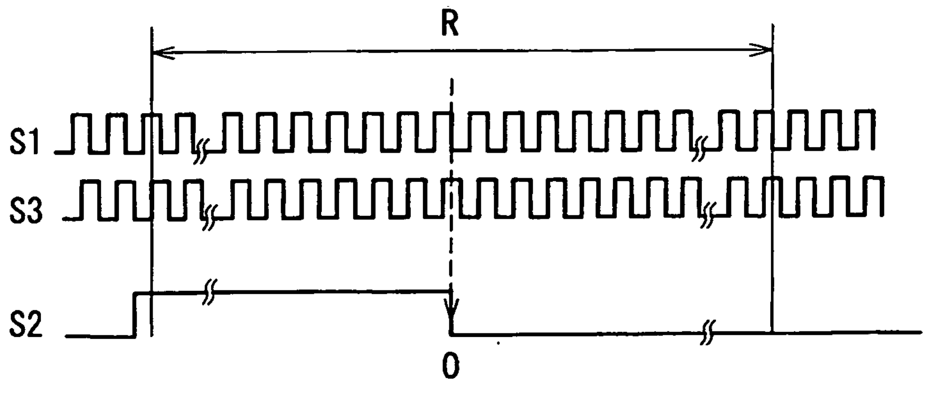
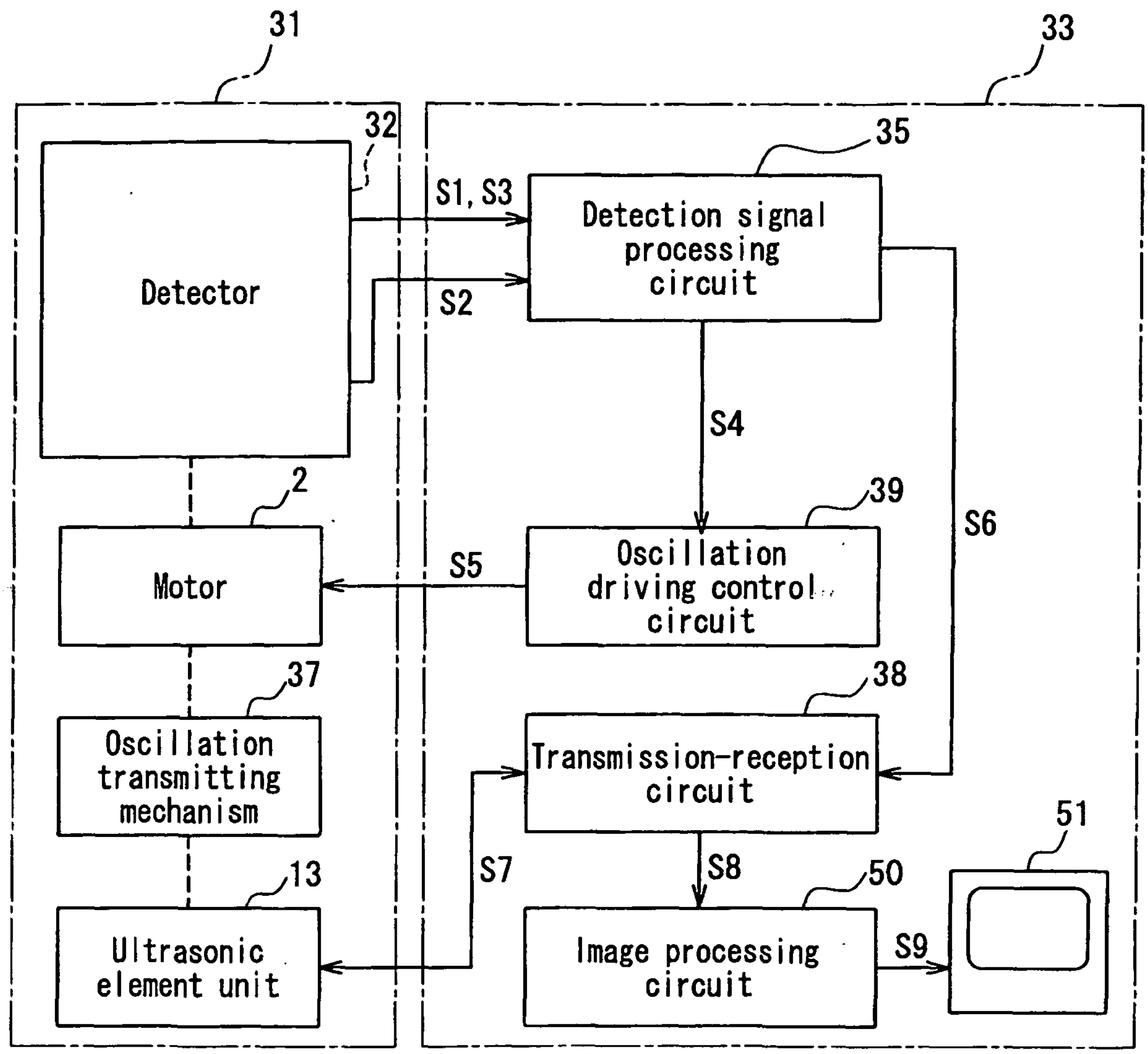


FIG. 3



31
33
32
35
S1, S3
Detection signal processing circuit
Detector
S2
S4
2
39
S6
Motor
S5
Oscillation driving control circuit
37
38
Oscillation transmitting mechanism
Transmission-reception circuit
51
13
S7
S8
50
Ultrasonic element unit
Image processing circuit
S9

FIG. 4

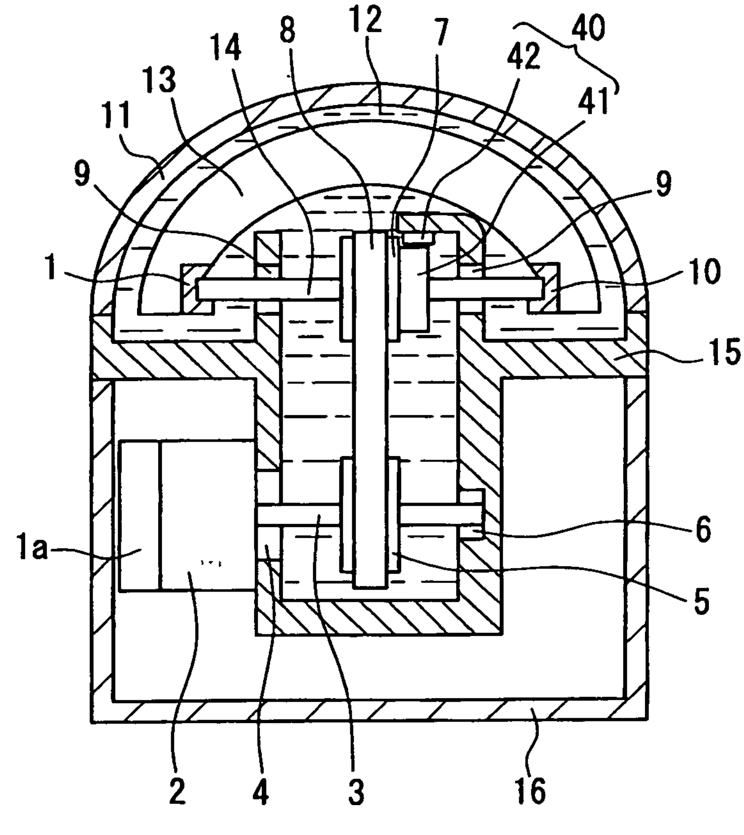


FIG. 5

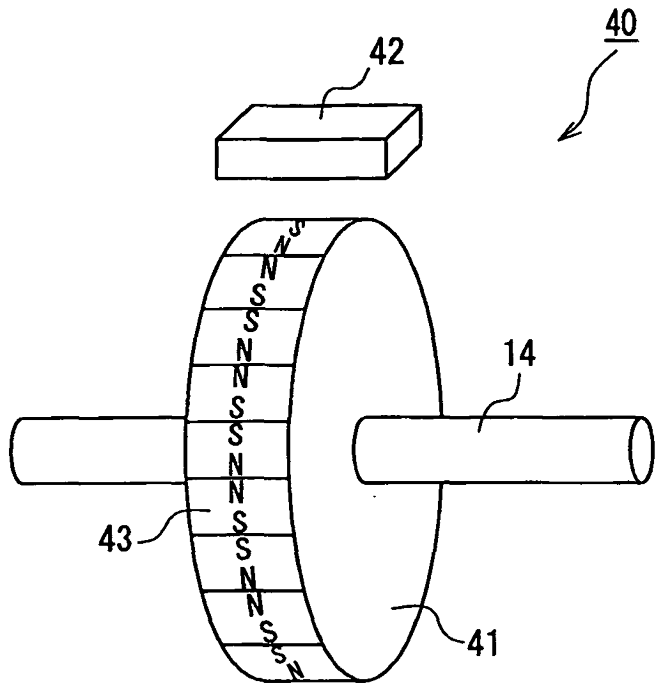


FIG. 6

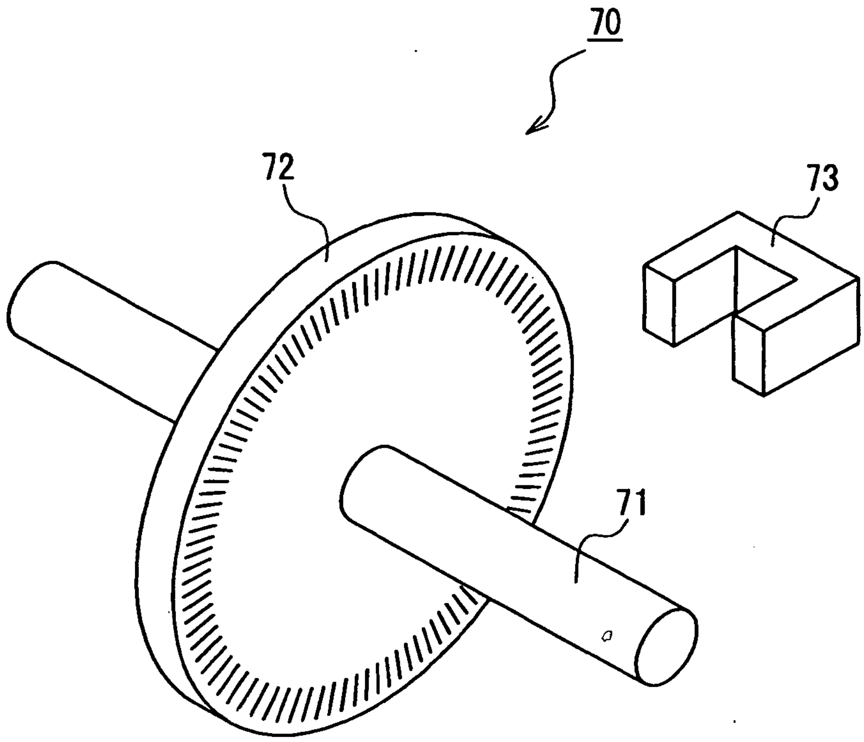


FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3184532 A **[0004]**
- US 5759155 A **[0006]**

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专利名称(译)	超声波探头		
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外部链接	Espacenet		

摘要(译)

本发明的超声波探头包括用于发送和接收超声波的超声波元件单元，用于使超声波元件单元振荡的振荡机构和用于检测超声波元件单元的振荡的检测器。检测器检测超声波元件单元的振荡角度和振荡原点，并且当超声波元件单元的振荡范围在其振荡原点被分成正区域和负区域的两个区域时，检测器检测哪个区域超声波元件单元位于。在使用超声波探头时，基于检测器的检测结果，执行用于使超声波元件单元返回其振荡原点的原点返回的控制。

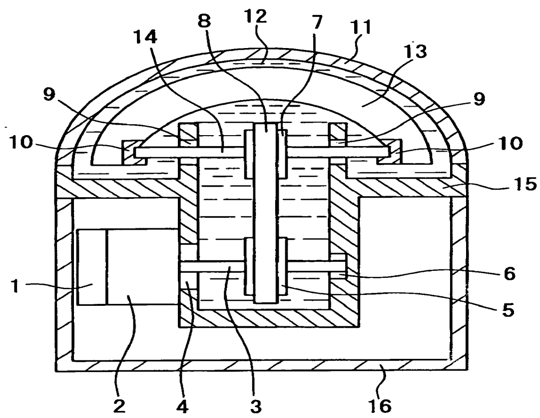

FIG. 1