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(57) **ABSTRACT**

An adjustment apparatus is used for ultrasound examination of a subject by transmitting ultrasound to the subject and receiving the ultrasound reflected from the subject. The apparatus includes: a change unit configured such that one end is connected to a suction pump and the other end is provided at a portion of a channel leading to a contact portion with the subject, to change suction force of the suction pump on the other end; and a damper for suppressing change in the suction force. The change unit includes: a cylinder having first and second portions for communicating with one end side and the other end side of the channel, respectively; a piston slidable in the cylinder to change a communication state between the first and second portions; and a spring for biasing the piston toward a direction of causing the first and second portions not to communicate with each other.

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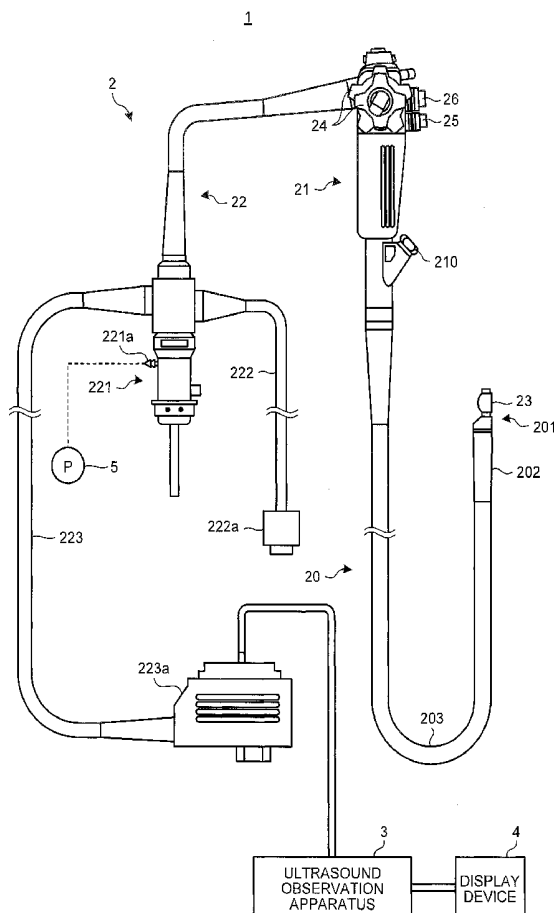


FIG.1

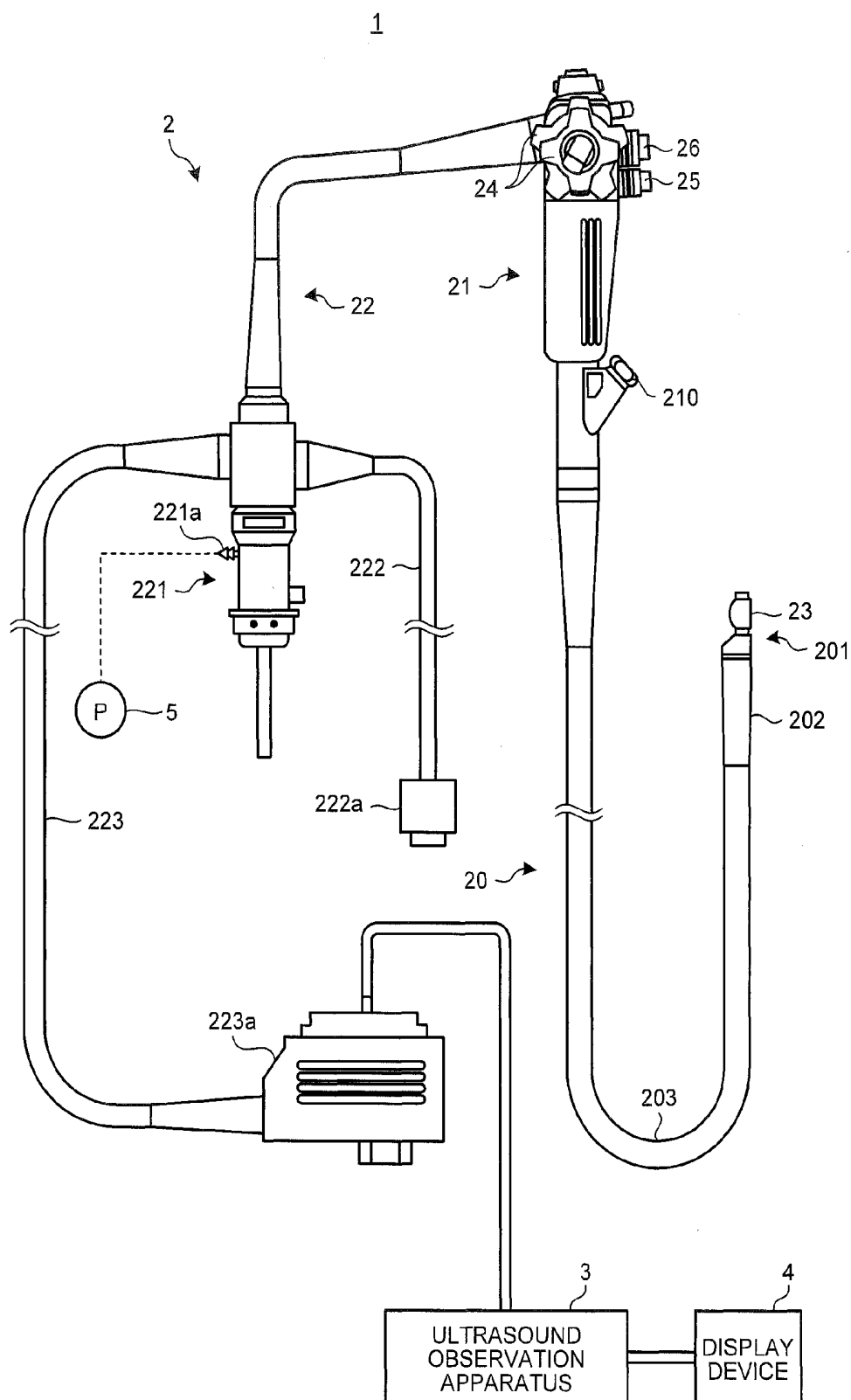
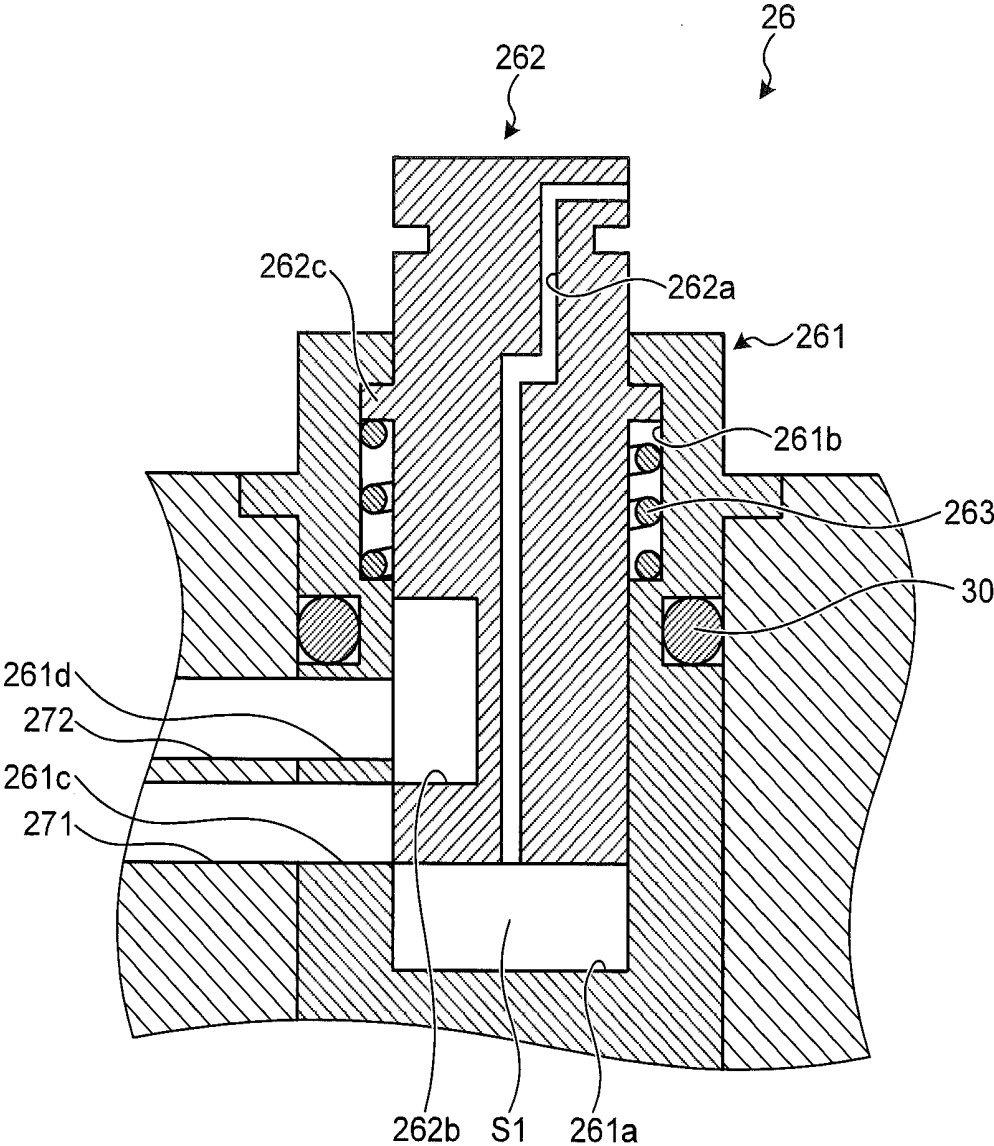


FIG.2



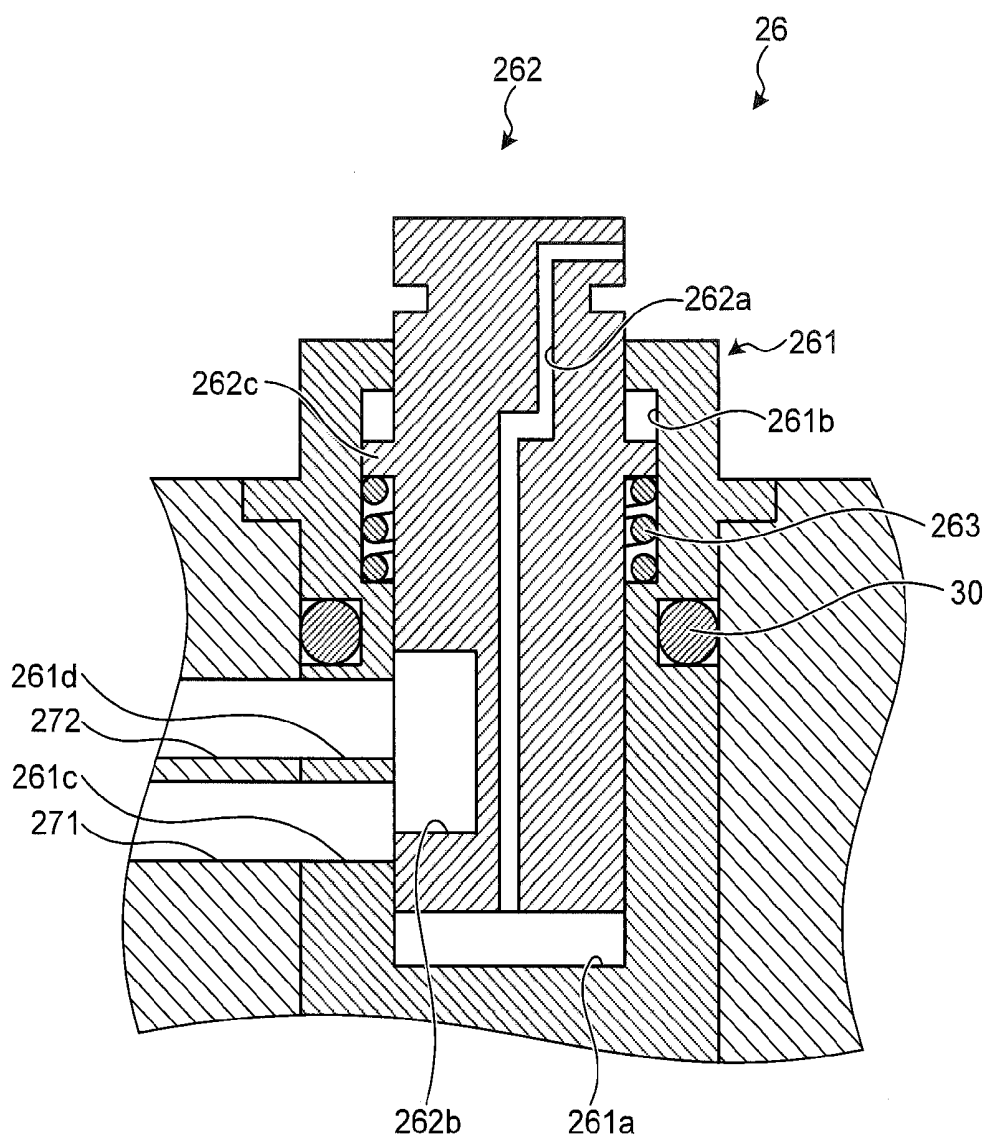
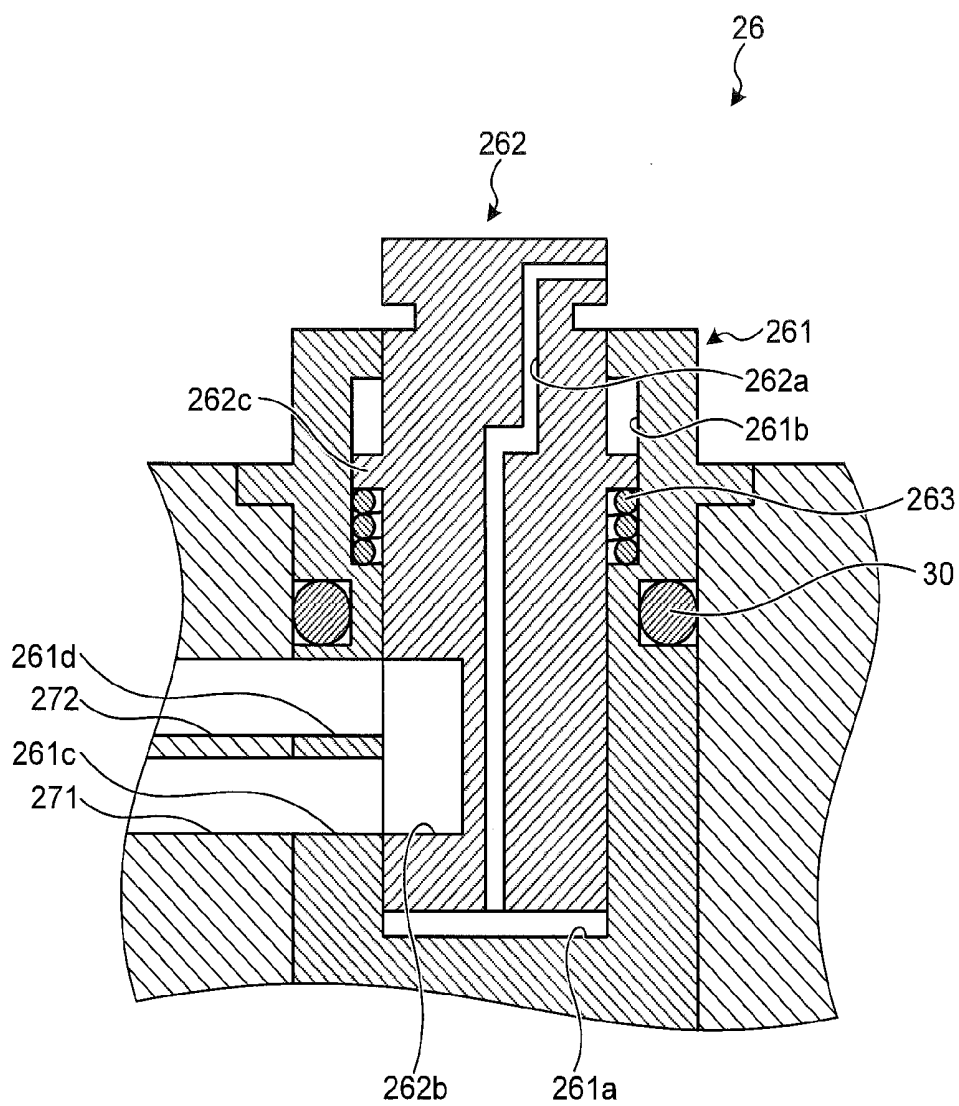


FIG. 4



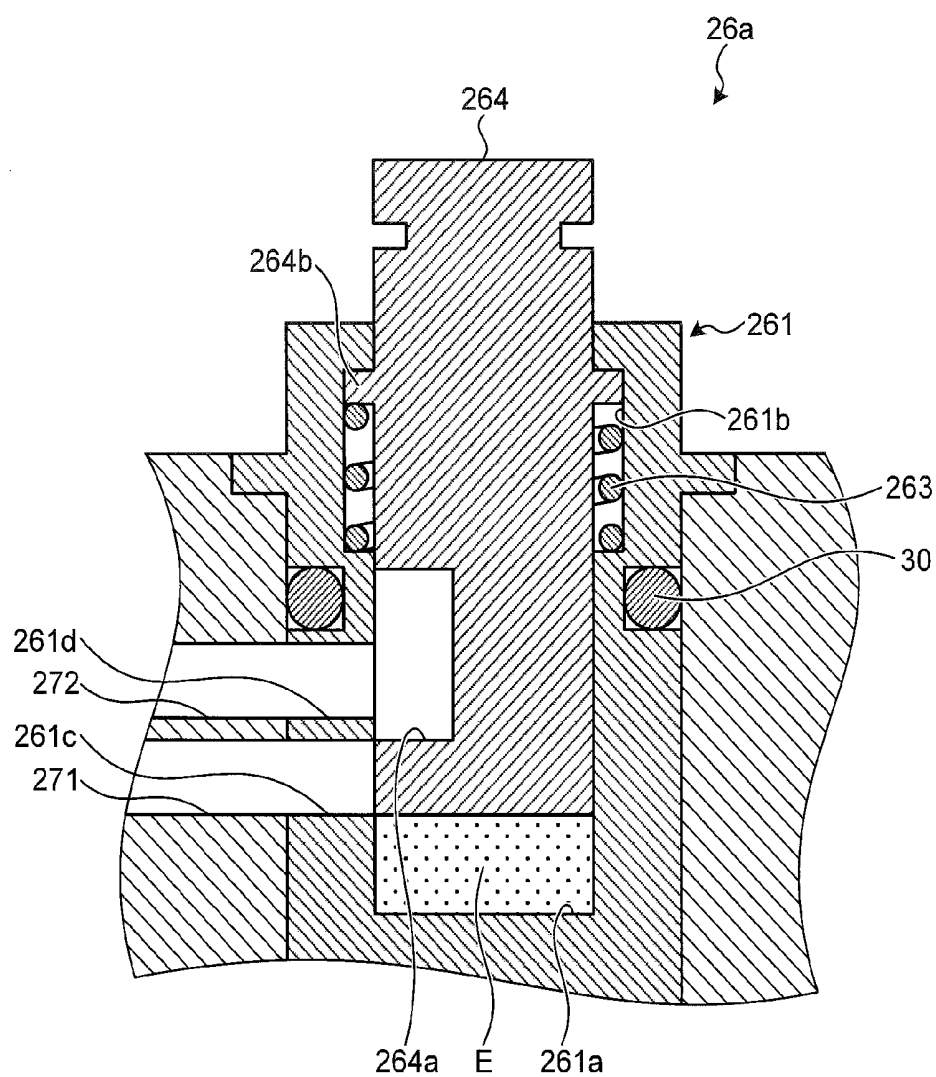


FIG.6

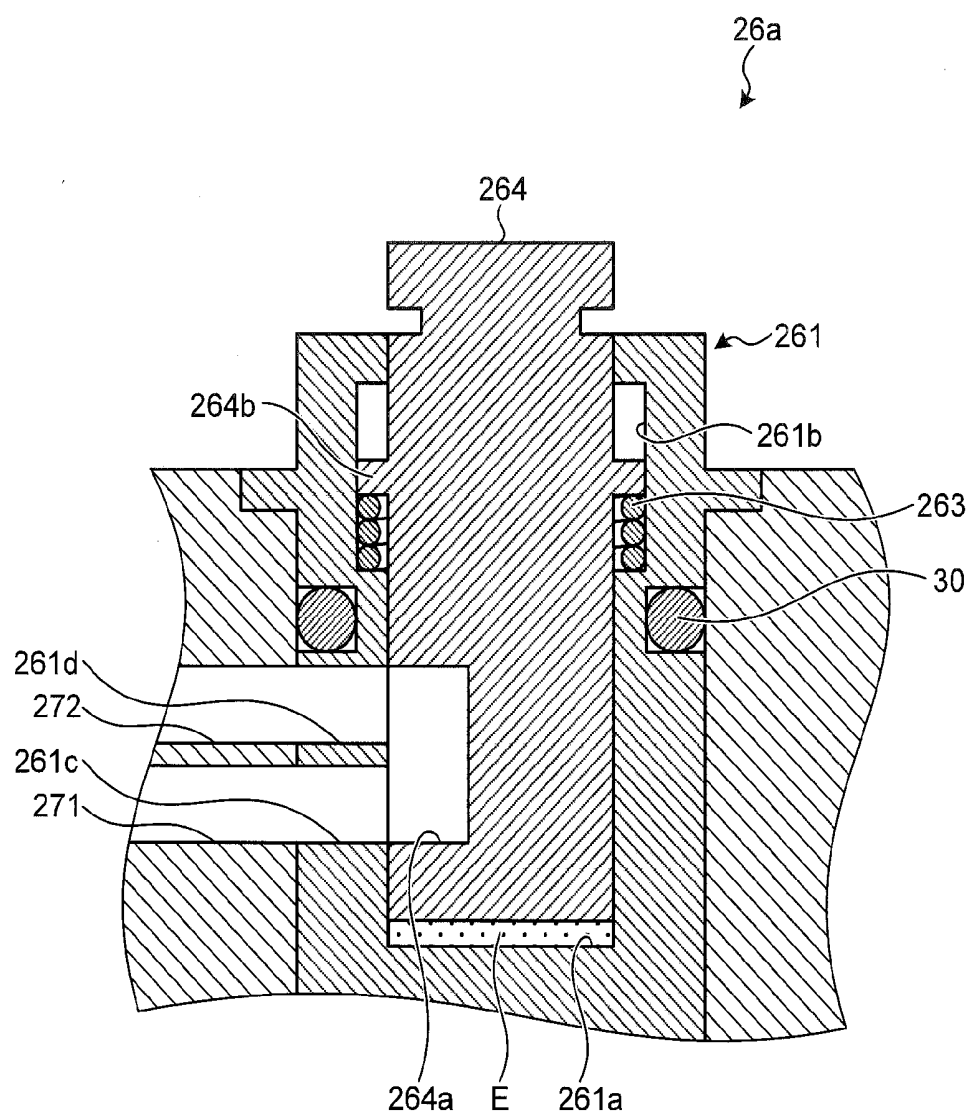
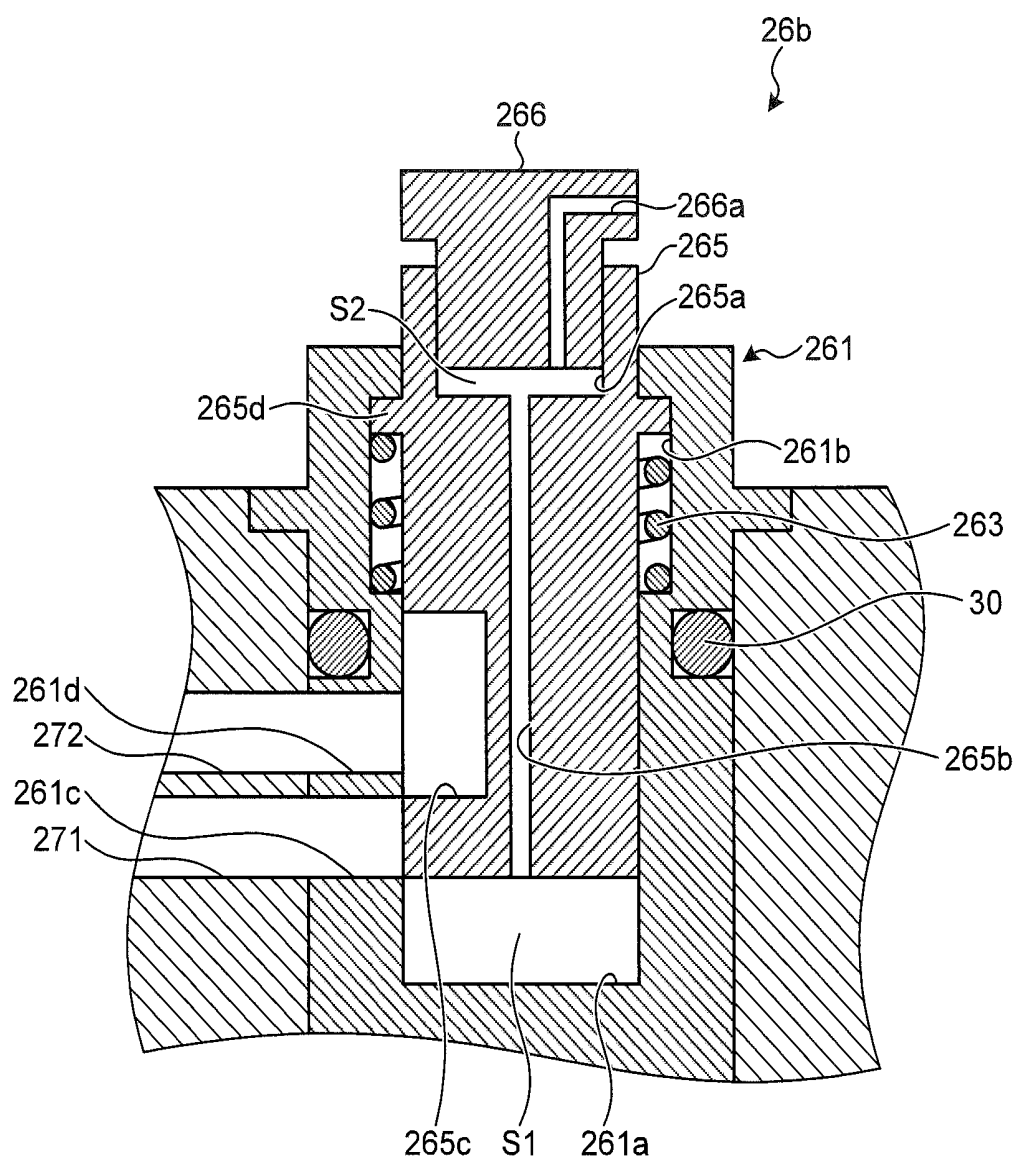


FIG. 7



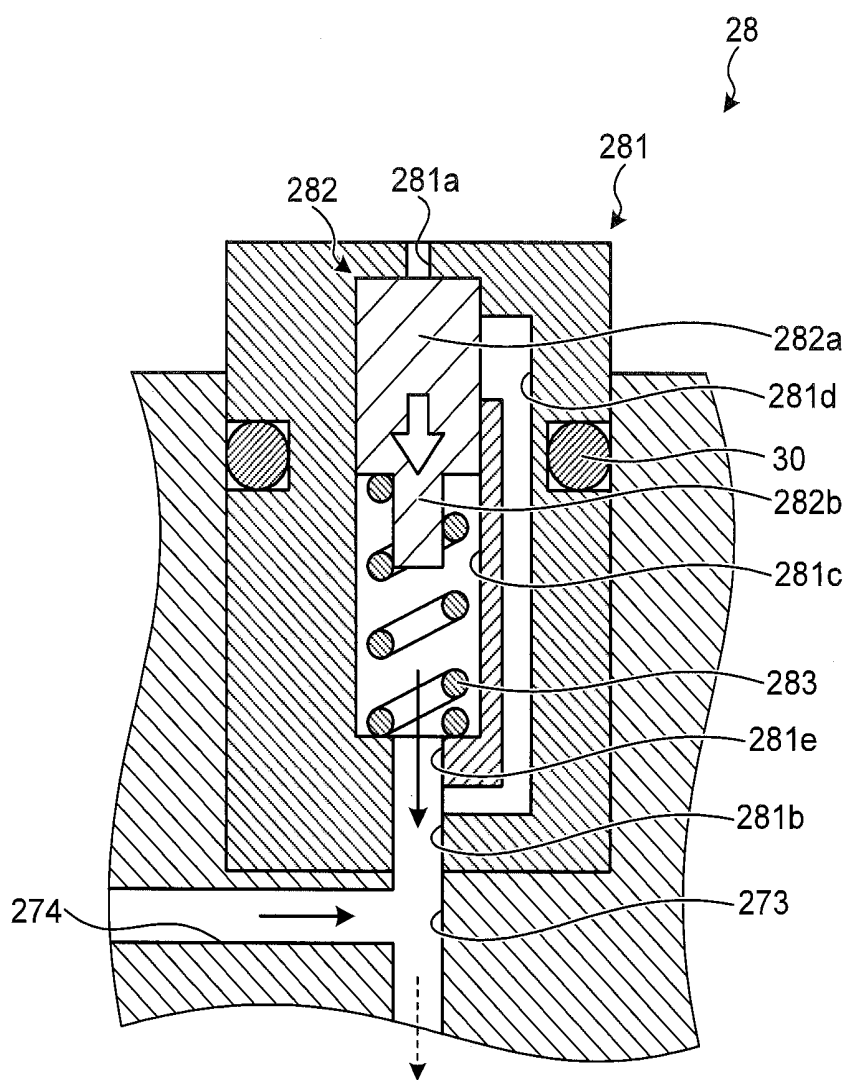


FIG.9

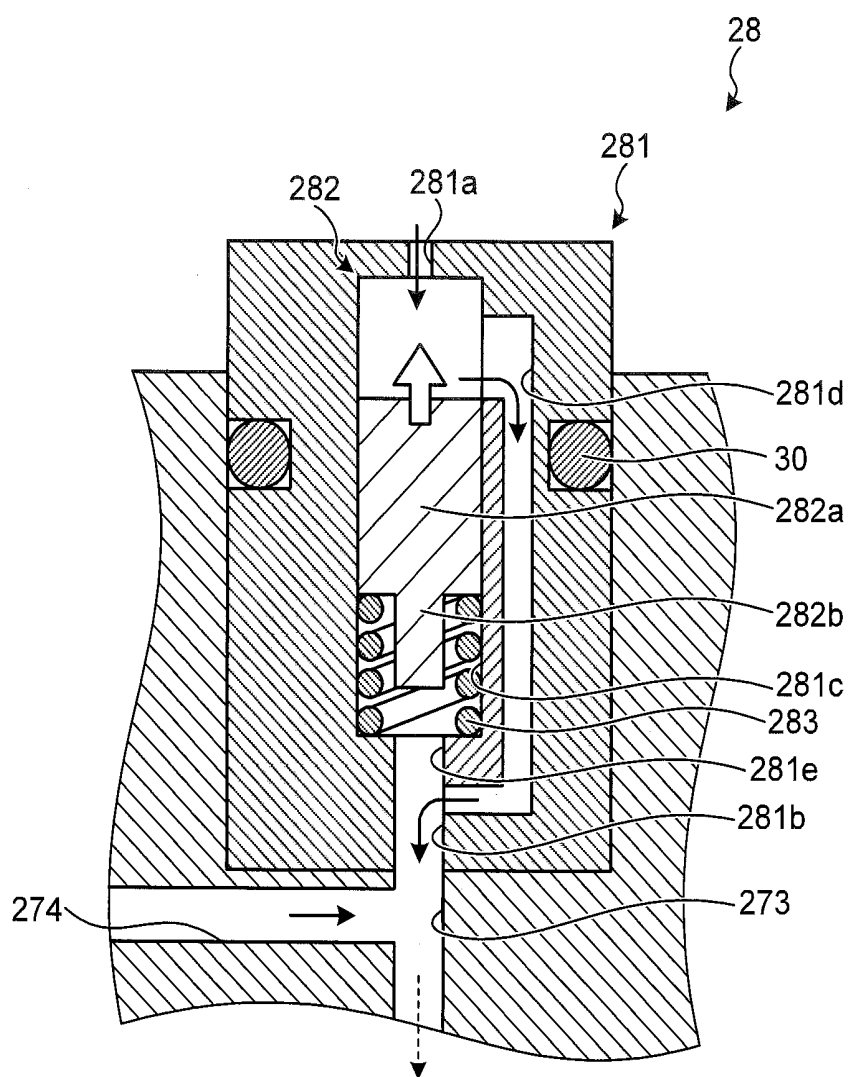


FIG.10

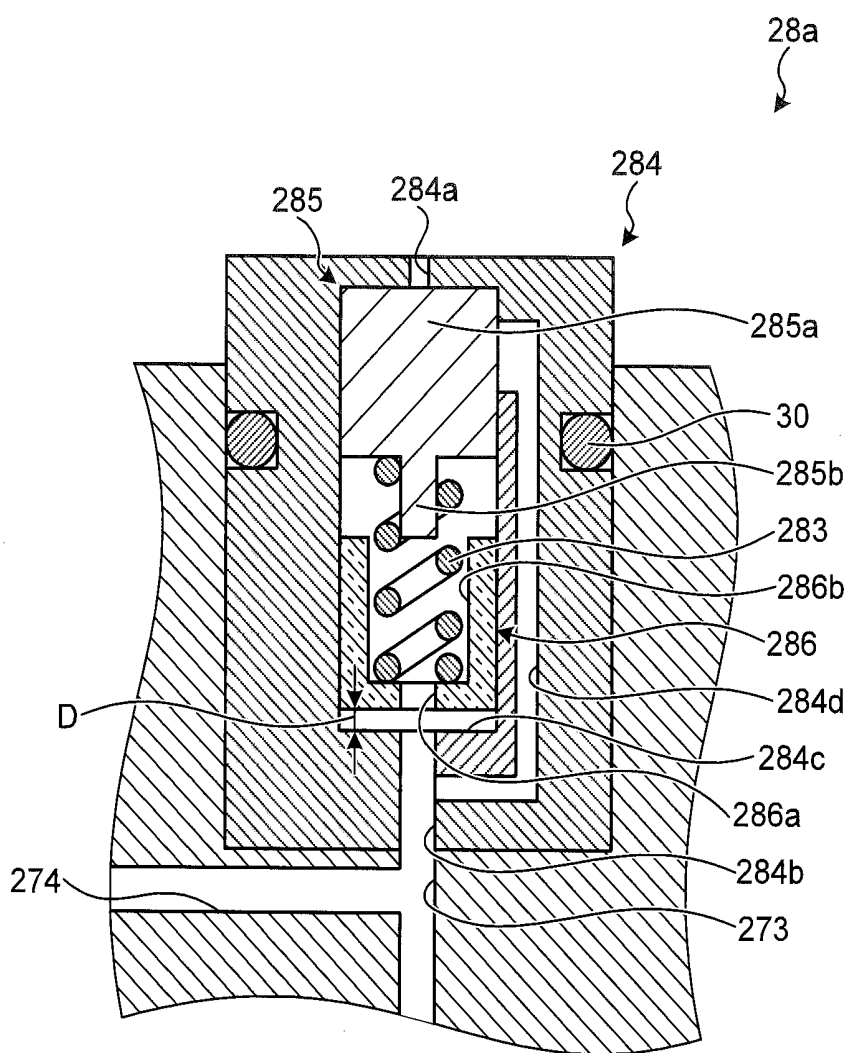
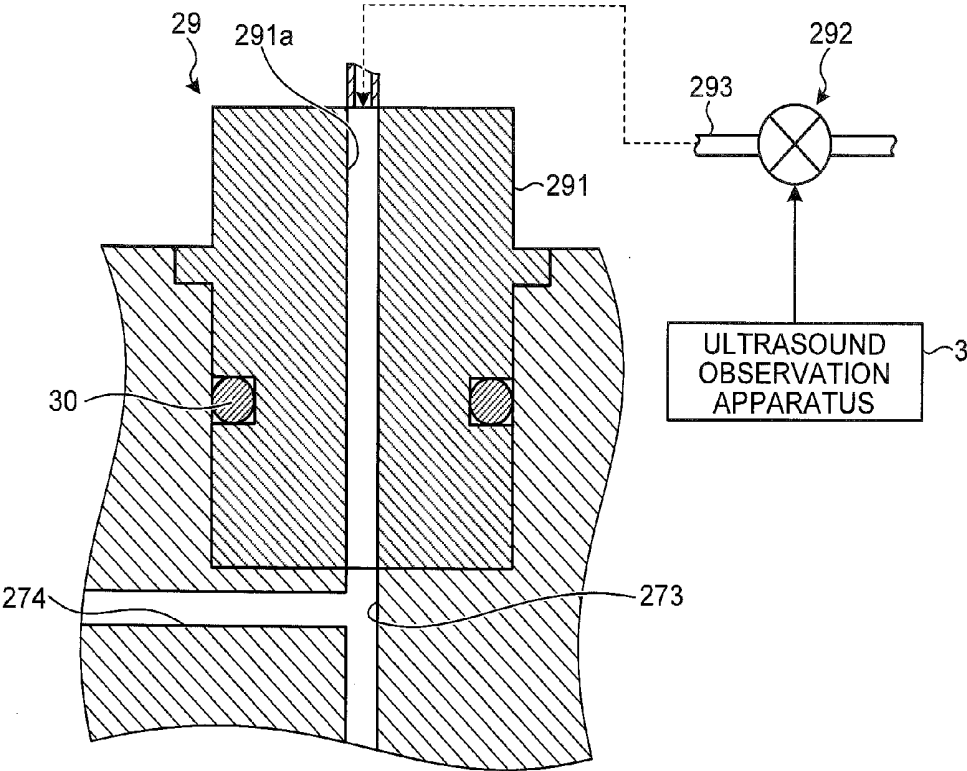


FIG.11



**SUCTION FORCE ADJUSTMENT
APPARATUS FOR ULTRASOUND
EXAMINATION, AND ULTRASOUND
ENDOSCOPE**

**CROSS REFERENCES TO RELATED
APPLICATIONS**

[0001] This application is a continuation of PCT international application Ser. No. PCT/JP2015/079968, filed on Oct. 23, 2015 which designates the United States, incorporated herein by reference, and which claims the benefit of priority from Japanese Patent Application No. 2015-042378, filed on Mar. 4, 2015, incorporated herein by reference.

BACKGROUND

[0002] 1. Technical Field

[0003] The disclosure relates to a suction force adjustment apparatus for ultrasound examination and relates to an ultrasound endoscope, used for observation of tissues as an observation target using ultrasound.

[0004] 2. Related Art

[0005] Ultrasound is applied in some case for observing characteristics of a living tissue or material as an observation target. Specifically, ultrasound transmitted toward the observation target is reflected as an ultrasound echo from the observation target, and signal processing is performed on the reflected ultrasound echo, whereby information related to the observation target is obtained.

[0006] In recent years, as an exemplary technique to obtain characteristics of an observation target using ultrasound, elastography that displays stiffness of a living tissue has been brought into practice (for example, refer to JP 2012-81295 A). With the elastography technology, for example, a pressed state of an ultrasound probe toward an ultrasound-detectable organ is changed into a plurality of different states, whereby a change (displacement) of the deformation state of the living tissue is measured. Subsequently, spatial differentiation is performed on this change so as to detect strain, from which an elastographic image is formed. Applying this elastography technique to an ultrasound endoscope having an ultrasound transducer on a distal end of an insertion unit, for example, would enhance the detection rate for lesions in deep organs.

SUMMARY

[0007] In some embodiments, a suction force adjustment apparatus is used for ultrasound examination of an observation target by transmitting ultrasound to the observation target and receiving the ultrasound reflected from the observation target. The apparatus includes: a suction force change unit configured such that one end is configured to be connected to a suction pump and the other end is provided at a portion of a channel leading to a contact portion with the observation target, and configured to change suction force of the suction pump on the other end; and a damper unit configured to suppress a change in the suction force by the suction force change unit. The suction force change unit includes: a cylinder unit having a cylindrical shape bottomed on one side, and having a first communicating portion for communicating with one end side of the channel and a second communicating portion for communicating with the other end side of the channel and with the first communicating portion; a piston unit slidable with respect to the

cylinder unit, and configured to change a communication state between the first communicating portion and the second communicating portion according to a movement with respect to the cylinder unit; and a spring unit configured to bias the piston unit toward a direction of causing the first communicating portion and the second communicating portion not to communicate with each other.

[0008] In some embodiments, an ultrasound endoscope includes: the suction force adjustment apparatus for ultrasound examination; an insertion unit; and an ultrasound transducer provided at a distal end of the insertion unit and configured to transmit ultrasound to the observation target and to receive the ultrasound reflected from the observation target.

[0009] In some embodiments, a suction force adjustment apparatus is used for ultrasound examination of an observation target by transmitting ultrasound to the observation target and receiving the ultrasound reflected from the observation target. The apparatus includes: a suction force change unit configured such that one end is configured to be connected to a suction pump and the other end is provided at a portion of a channel leading to a contact portion with the observation target, and configured to change suction force of the suction pump on the other end; and a damper unit configured to suppress a change in the suction force by the suction force change unit. The suction force change unit includes: a cylinder unit having a hollow cylindrical shape, and having a first opening portion disposed on one end in a height direction to communicate with outside and a second opening portion disposed on the other end in the height direction to communicate with the channel; a piston unit provided in a hollow portion of the cylinder unit and slidable between the one end and the other end of the cylinder unit; and a spring unit configured to bias the piston unit from the other end of the cylinder unit toward the one end of the cylinder unit. The damper unit is a bypass tube passage provided in the cylinder unit to allow communication between the one end and the other end of the cylinder unit. The piston unit is configured to slide with respect to the cylinder unit in accordance with one of pressure change due to the suction force and biasing force of the spring unit, thereby to open or close one end side of the bypass tube passage.

[0010] In some embodiments, an ultrasound endoscope includes: the suction force adjustment apparatus for ultrasound examination; an insertion unit; an ultrasound transducer provided at a distal end of the insertion unit and configured to transmit ultrasound to the observation target and to receive the ultrasound reflected from the observation target; and a valve configured such that one end leads to the suction pump and the other end is connected to a portion of a channel leading to the distal end of the insertion unit via the bypass tube passage, and configured to adjust a discharge of gas in the bypass tube passage under control of an external control apparatus.

[0011] The above and other features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a schematic diagram illustrating an ultrasound diagnosis system according to a first embodiment of the present invention;

[0013] FIG. 2 is a schematic diagram illustrating a configuration of a suction button included in an ultrasound endoscope in the ultrasound diagnosis system according to the first embodiment of the present invention;

[0014] FIG. 3 is a schematic diagram illustrating a configuration of the suction button included in the ultrasound endoscope in the ultrasound diagnosis system according to the first embodiment of the present invention;

[0015] FIG. 4 is a schematic diagram illustrating a configuration of the suction button included in the ultrasound endoscope in the ultrasound diagnosis system according to the first embodiment of the present invention;

[0016] FIG. 5 is a schematic diagram illustrating a configuration of a suction button included in an ultrasound endoscope in an ultrasound diagnosis system according to a modification of the first embodiment of the present invention;

[0017] FIG. 6 is a schematic diagram illustrating a configuration of the suction button included in the ultrasound endoscope in the ultrasound diagnosis system according to the modification of the first embodiment of the present invention;

[0018] FIG. 7 is a schematic diagram illustrating a configuration of a suction button included in an ultrasound endoscope in an ultrasound diagnosis system according to a second embodiment of the present invention;

[0019] FIG. 8 is a schematic diagram illustrating a configuration of a suction button included in an ultrasound endoscope in an ultrasound diagnosis system according to a third embodiment of the present invention;

[0020] FIG. 9 is a schematic diagram illustrating a configuration of the suction button included in the ultrasound endoscope in the ultrasound diagnosis system according to the third embodiment of the present invention;

[0021] FIG. 10 is a schematic diagram illustrating a configuration of a suction button included in an ultrasound endoscope in an ultrasound diagnosis system according to a fourth embodiment of the present invention; and

[0022] FIG. 11 is a schematic diagram illustrating a configuration of a suction force adjustment unit included in an ultrasound endoscope in an ultrasound diagnosis system according to a fifth embodiment of the present invention.

DETAILED DESCRIPTION

[0023] Hereinafter, modes for carrying out the present invention (hereinafter, referred to as embodiment(s)) will be described with reference to the attached drawings.

First Embodiment

[0024] FIG. 1 is a schematic diagram illustrating an ultrasound diagnosis system according to a first embodiment of the present invention. An ultrasound diagnosis system 1 illustrated in the diagram includes an ultrasound endoscope 2, an ultrasound observation apparatus 3, a display device 4, and a suction pump 5. The ultrasound endoscope 2 transmits ultrasound to a subject as an observation target and receives the ultrasound reflected from the subject. The ultrasound observation apparatus 3 generates an ultrasound image based on an ultrasound signal obtained by the ultrasound

endoscope 2. The display device 4 displays the ultrasound image generated by the ultrasound observation apparatus 3. The suction pump 5 generates a suction force to perform suction of body fluids and suction of a wall surface inside the subject.

[0025] The ultrasound endoscope 2 includes an insertion unit 20, an operating unit 21, and a universal cord 22. The insertion unit 20 has a thin and elongated shape and is inserted into the subject. The operating unit 21 is provided at a proximal end of the insertion unit 20. The universal cord 22 extends from a side portion of the operating unit 21.

[0026] A connector 221 is arranged at a proximal end portion of the universal cord 22. The connector 221 is connected to a light source apparatus (not illustrated). Cables 222 and 223 extend from the connector 221. The cable 222 is connected to a camera control unit (not illustrated) via a connector 222a. The cable 223 is removably connected to the ultrasound observation apparatus 3 via a connector 223a. The ultrasound endoscope 2 is connected with the ultrasound observation apparatus 3 via the connector 223a. The ultrasound endoscope 2 is further connected with the display device 4 via the ultrasound observation apparatus 3.

[0027] The connector 221 includes a suction cap 221a as a suction port of a suction channel (passage) extending to the distal end of a distal end portion 201. The suction cap 221a is connectable to the suction pump 5. The ultrasound endoscope 2 can suck the body fluids and suck a wall surface inside the subject, via the suction pump 5.

[0028] Main portions of the insertion unit 20 include, in the order from the distal end side, a distal end rigid portion (hereinafter, referred to as a distal end portion) 201, a bending portion 202, and a flexible tube portion 203. The bending portion 202 is located at a rear end of the distal end portion 201. The flexible tube portion 203 is long and flexible portion having a small diameter, located at a rear end of the bending portion 202, and extends to the operating unit 21.

[0029] An ultrasound transducer 23 is arranged on the distal end side of the distal end portion 201. Located on the proximal end side of the ultrasound transducer 23, the distal end portion 201 includes an illumination lens forming an illumination optical system, an observing lens in an observing optical system (both lenses not illustrated), and a forceps port, namely, a distal end opening combining a treatment tool insertion passage outlet and a suction port.

[0030] The operating unit 21 includes an angle knob 24, an air/water feeding button 25, a suction button 26 (suction force adjustment apparatus), and a treatment tool insertion port 210. The angle knob 24 controls bending of the bending portion 202 in a desired direction. The air/water feeding button 25 performs air/water feeding operation. The suction button 26 is located at a portion of the suction channel (passage) and performs suction operation. The treatment tool insertion port 210 is an entrance of treatment tools to be introduced into the body.

[0031] The ultrasound transducer 23 may be any of a convex transducer, a linear transducer, and a radial transducer. The ultrasound endoscope 2 may cause the ultrasound transducer 23 to perform mechanical scan, or may provide, as the ultrasound transducer 23, a plurality of elements in an array, and may cause the ultrasound transducer to perform electronic scan by electronically switching elements related

to transmission/reception or imposing delay onto transmission/reception of each of elements.

[0032] The ultrasound endoscope 2 typically includes imaging optics and imaging elements. The ultrasound endoscope 2 can be inserted into gastrointestinal tracts (esophagus, stomach, duodenum, and large intestine) or respiratory organs (trachea, bronchus) of the subject and can image gastrointestinal tract, respiratory organs, and their surrounding organs (pancreas, gall bladder, bile duct, biliary tract, lymph nodes, mediastinal organs, blood vessels, or the like). The ultrasound endoscope 2 includes a light guide that guides illumination light emitted to the subject at the time of imaging. The light guide is configured such that a distal end portion thereof reaches a distal end of an insertion unit of the ultrasound endoscope 2 into the subject, while a proximal end thereof is connected to a light source device that generates illumination light.

[0033] The ultrasound observation apparatus 3 controls the entire ultrasound diagnosis system 1. The ultrasound observation apparatus 3 includes a CPU having calculation/control functions, various calculation circuits, or the like. The ultrasound observation apparatus 3 integrally controls the ultrasound observation apparatus 3 by reading information stored in a storage unit (not illustrated) and executing various types of calculation processing related to an operation method of the ultrasound observation apparatus 3.

[0034] The ultrasound observation apparatus 3 is electrically connected with the ultrasound endoscope 2, transmits a transmission signal (pulse signal) formed with a high-voltage pulse to the ultrasound transducer 23 on the basis of a predetermined waveform and transmission timing, and together with this, receives an echo signal, namely, an electrical reception signal, from the ultrasound transducer 23, and generates image data including an ultrasound image on the basis of the received echo signal. The ultrasound observation apparatus 3 generates, as an exemplary ultrasound image, a B-mode image, that is, a gray-scale image in which values of R (red), G (green) and B (blue), which are variables when the RGB color system is employed as a color space, match with one another.

[0035] Moreover, on the basis of a difference between a signal obtained when the ultrasound endoscope 2 is pressed against an observation target and a signal obtained when the ultrasound endoscope 2 is not pressed against the observation target, for example, the ultrasound observation apparatus 3 obtains information related to stiffness of the observation target in a set region, superposes color information corresponding to the stiffness, onto the B-mode image, and generates an elastographic image.

[0036] Subsequently, the suction button 26 that performs suction operation will be described with reference to the drawings. FIG. 2 is a schematic diagram illustrating a configuration of the suction button included in the ultrasound endoscope in the ultrasound diagnosis system according to the first embodiment, illustrating a state where pressing force is not applied to a piston unit 262. The suction button 26 includes a cylinder unit 261, the piston unit 262, and a spring unit 263.

[0037] The cylinder unit 261 has a cylindrical shape bottomed on one side. The cylinder unit 261 includes a housing unit 261a, a locking unit 261b, a first communicating portion 261c, and a second communicating portion 261d. The housing unit 261a forms a columnar hollow space capable of forward/backward movably housing the piston

unit 262. The locking unit 261b is formed by enlarging a portion of the housing unit 261a and can be locked with the piston unit 262. The first communicating portion 261c allows communication between the inside/outside of the housing unit 261a and is connected to a first suction tube 271. The second communicating portion 261d allows communication between the inside/outside of the housing unit 261a and is connected with a second suction tube 272. In the first embodiment, the first suction tube 271 forms a portion of a suction channel (passage), one end communicating with the first communicating portion 261c, the other end connecting with the suction pump 5. The second suction tube 272 forms a portion of a suction channel (passage), one end communicating with the second communicating portion 261d, the other end communicating with the outside via the distal end portion 201.

[0038] The cylinder unit 261 is attached onto the operating unit 21 by fitting, for example. At this time, an O-ring 30 is provided between the operating unit 21 and the cylinder unit 261. With the O-ring 30, sealability and slip prevention between the operating unit 21 and the cylinder unit 261 can be maintained. The cylinder unit 261 may be fixed with a screw or adhesive such as sealant, other than fitting.

[0039] The piston unit 262 has a substantially columnar shape extending in accordance with the shape of the cross-section corresponding to the housing unit 261a. The piston unit 262 includes a communication hole 262a formed to allow communication between one end portion in the longitudinal direction (forward/backward direction with respect to the cylinder unit 261) and the other end portion. The communication hole 262a allows communication between a hollow space S1 (hollow portion) formed by the cylinder unit 261 (the housing unit 261a) and by the piston unit 262, and the outside. In the first embodiment, the suction button 26 except the communication hole 262a configures a suction force change unit.

[0040] The piston unit 262 includes a recess 262b and a flange unit 262c. The recess 262b is formed by cutting a portion of a side surface. The flange unit 262c is a portion protruding in a direction orthogonal to the longitudinal direction of the piston unit 262. The recess 262b includes an opening that allows communication between the first communicating portion 261c and the second communicating portion 261d.

[0041] The flange unit 262c is housed in the locking unit 261b, its moving range being regulated by the locking unit 261b. In addition, the spring unit 263 is provided at a portion between the flange unit 262c and the locking unit 261b, at a distal end side in the insertion direction of the piston unit 262.

[0042] The spring unit 263 is formed with a coil spring, for example. As described above, the spring unit 263 is provided between the flange unit 262c and the locking unit 261b, being arranged to be capable of biasing in the direction of causing the piston unit 262 to move out from the cylinder unit 261. Accordingly, in a case where force such as pressing force (force except gravity, or the like) is not applied, the piston unit 262 is maintained, by the biasing force of the spring unit 263, in a state where the flange unit 262c is locked with an outer end portion of the locking unit 261b, namely, a state where the piston unit 262 protrudes from the cylinder unit 261.

[0043] In a state where the piston unit 262 protrudes from the cylinder unit 261 (refer to FIG. 2), while the piston unit

262 includes an opening of the second communicating portion **261d** within a region formed by the opening of the recess **262b** and allows communication between the recess **262b** and the second communicating portion **261d**, the piston unit **262** closes the first communicating portion **261c** by the side wall of the piston unit **262**. Accordingly, the first suction tube **271** and the second suction tube **272** do not communicate with each other, causing no suction force by the suction pump **5**, on the distal end portion **201**.

[0044] FIGS. 3 and 4 are schematic diagrams illustrating a configuration of the suction button included in the ultrasound endoscope in the ultrasound diagnosis system according to the first embodiment, illustrating a state where pressing force is applied to the piston unit **262**. Pressing the piston unit **262** causes the piston unit **262** to be inserted into the cylinder unit **261**. At this time, the gas inside the hollow space **S1** illustrated in FIG. 2 is discharged to the outside via the communication hole **262a**. When insertion operation is continued and the opening of the recess **262b** comes to include the first communicating portion **261c** and the second communicating portion **261d** (facing each of the communicating portions) (refer to FIG. 3), a communication state is established between the first communicating portion **261c** and the second communicating portion **261d**, and as a result, communication is established between the first suction tube **271** and the second suction tube **272**. Thereafter, pressing the piston unit **262** would allow the whole region of the opening of the first communicating portion **261c**, which has been closed by the recess **262b**, to be in an open state (refer to FIG. 4). Movement of the piston unit **262** opens the opening of the first communicating portion **261c**, and this generates suction force by the suction pump **5** on the distal end portion **201**, and thus, an internal wall surface of the subject, or the like, is sucked via the distal end portion **201**.

[0045] In the first embodiment, in a case where the pressing force is not applied to the piston unit **262** (in a case where the piston unit **262** is not pressed into the cylinder unit **261**), the communication between the first suction tube **271** and the second suction tube **272** is not established. Accordingly, the distal end portion **201** comes into either a contact or separate state with respect to the internal wall surface of the subject. In contrast, the pressing force is applied to the piston unit **262** (in a case where the piston unit **262** is pressed into the cylinder unit **261**), communication between the first suction tube **271** and the second suction tube **272** is established via the recess **262b**. Accordingly, the distal end portion **201** comes into a press-contact state while sucking the internal wall surface of the subject.

[0046] In addition, by adjusting the discharge of gas inside the hollow space **S1** to the outside by decreasing the cross-section area of a portion orthogonal to the communication direction, on the communication hole **262a**, it is possible to generate force that opposes insertion of the piston unit **262**, and thus, to suppress an increase in the insertion speed. In addition, in a case where the pressing force applied to the piston unit **262** is released, the flowrate of the gas flowing into the hollow space **S1** is limited by the communication hole **262a**, causing the piston unit **262** to gradually retreat from the housing unit **261a**. In this manner, the communication hole **262a** functions as a damper unit to suppress the forward/backward movement speed of the piston unit **262**. Due to this function as the damper unit, the piston unit **262** performs forward/backward operation in a substantially fixed speed with respect to the cylinder unit.

[0047] When the piston unit **262** performs gradual forward/backward operation from the housing unit **261a** by the above-described damper unit, the opening area of the opening of the first suction tube **271** formed by the recess **262b** of the piston unit **262** also gradually increases. Accordingly, also the suction force acting on the second suction tube **272** gradually increases in accordance with the opening state of the opening of the first suction tube **271**.

[0048] As described above, according to the presence or absence of the pressing force applied to the piston unit **262**, it is possible to easily switch the contact state of the distal end portion **201** toward the subject, and the press-contact state of the distal end portion **201** toward the subject, induced by suction by the distal end portion **201**. Moreover, since the communication hole **262a** controls the forward/backward movement speed of the piston unit **262**, it is possible to periodically switch the contact state at a more fixed interval, toward the subject. By periodically switching the contact state, it is possible to stably obtain an echo signal in each of the states, and thus to generate a good elastographic image.

[0049] According to the above-described first embodiment, with the piston unit **262** configured to be inserted into the cylinder unit **261** and to retreat from the cylinder unit **261** by the biasing force of the spring unit **263**, the communication hole **262a** is provided to allow communication between the housing unit **261a** and the outside so as to suppress the forward/backward movement speed of the piston unit **262**. With this configuration, it is possible to stably obtain a good elastographic image with a simple configuration without increasing the size of the distal end portion.

[0050] The above-described first embodiment assumes that the locking unit **261b** is provided at portions surrounding the housing unit **261a**. Alternatively, however, in order to prevent rotation of the piston unit **262** around the longitudinal-axis, with respect to the cylinder unit **261**, the locking unit **261b** may have a groove-like shape extending in the forward/backward direction of the piston unit **262**, may house a plurality of flange units formed corresponding to the groove-like shape, and together with this, each of the locking units **261b** may house a spring unit (e.g., coil spring that can be housed in each of the grooves) and perform biasing.

Modification of First Embodiment

[0051] Next, a modification of the first embodiment of the present invention will be described. FIG. 5 is a schematic diagram illustrating a configuration of a suction button included in an ultrasound endoscope in an ultrasound diagnosis system according to the modification of the first embodiment, illustrating a state where pressing force is not applied to a piston unit **264**. The same reference signs are used to designate the same elements as those of the above-described embodiment. The above-described first embodiment assumes that the piston unit **262** includes the communication hole **262a** as a damper unit. In the modification, however, the piston unit **264** includes an elastic member **E** as a damper unit.

[0052] A suction button **26a** according to the modification includes the cylinder unit **261**, the piston unit **264**, the spring unit **263**, and the elastic member **E**. The piston unit **264** includes a recess **264a** and a flange unit **264b**. The recess **264a** is formed by cutting a portion of a side surface. The

flange unit **264b** is a portion protruding in a direction orthogonal to the longitudinal direction of the piston unit **264**. The recess **264a** includes an opening that allows communication between the first communicating portion **261c** and the second communicating portion **261d**.

[0053] The flange unit **264b** is housed in the locking unit **261b**, its moving range being regulated by the locking unit **261b**. In addition, the spring unit **263** is provided at a portion between the flange unit **264b** and the locking unit **261b**, at a distal end side in the insertion direction of the piston unit **264**.

[0054] In a state where the piston unit **264** protrudes from the cylinder unit **261**, the piston unit **264**, while the piston unit **264** includes an opening of the second communicating portion **261d** within a region formed by the opening of the recess **264a** and allows communication between the recess **264a** and the second communicating portion **261d**, the piston unit **264** closes the first communicating portion **261c** by the side wall of the piston unit **264**. Accordingly, the first suction tube **271** and the second suction tube **272** do not communicate with each other, causing no suction force by the suction pump **5**, on the distal end portion **201**.

[0055] The elastic member **E** is arranged at a hollow space formed by the cylinder unit **261** (housing unit **261a**) and the piston unit **264**, and fills the hollow space. The elastic member **E** is formed, for example, with elastomer having elastomeric quality, and resin having a predetermined elastic force.

[0056] FIG. 6 is a schematic diagram illustrating a configuration of the suction button included in the ultrasound endoscope in the ultrasound diagnosis system according to the modification, illustrating a state where pressing force is applied to the piston unit **264**. Pressing the piston unit **264** causes the piston unit **264** to be inserted into the cylinder unit **261** as illustrated in FIG. 6. When insertion operation is continued and the opening of the recess **264a** comes to include the first communicating portion **261c** and the second communicating portion **261d** (facing each of the communicating portions), a communication state is established between the first communicating portion **261c** and the second communicating portion **261d**, and as a result, communication is established between the first suction tube **271** and the second suction tube **272**. As a result, a suction force by the suction pump **5** is generated on the distal end portion **201**, and thus, an internal wall surface of the subject, or the like, is sucked via the distal end portion **201**.

[0057] In the modification, in a case where the pressing force is not applied to the piston unit **264** (in a case where the piston unit **264** is not pressed into the cylinder unit **261**), the communication between the first suction tube **271** and the second suction tube **272** is not established. Accordingly, the distal end portion **201** comes into either a contact or separate state with respect to the internal wall surface of the subject. In contrast, the pressing force is applied to the piston unit **264** (in a case where the piston unit **264** is pressed into the cylinder unit **261**), communication between the first suction tube **271** and the second suction tube **272** is established via the recess **264a**. Accordingly, the distal end portion **201** comes in a press-contact state while sucking the internal wall surface of the subject.

[0058] Moreover, the elastic member **E** is arranged between the cylinder unit **261** (housing unit **261a**) and the piston unit **264**, making it possible to suppress an increase in the insertion speed of the piston unit **264** by the elastic

force of the elastic member **E**. In addition, in a case where the pressing force on the piston unit **264** is released, a force (restoring force) acting on the elastic member **E** to return to an original shape causes the piston unit **264** to gradually retreat from the housing unit **261a**.

[0059] As described above, according to the presence or absence of the pressing force applied to the piston unit **264**, it is possible to easily switch the contact state of the distal end portion **201** toward the subject, and the press-contact state of the distal end portion **201** toward the subject, induced by suction by the distal end portion **201**. Moreover, since the elastic member **E** controls the forward/backward movement speed of the piston unit **264**, it is possible to periodically switch the contact state at a more fixed interval, toward the subject. By periodically switching the contact state, it is possible to stably obtain an echo signal in each of the states, and thus to generate a good and stable elastographic image. As described above, according to the modification, with the piston unit **264** configured to be inserted into the cylinder unit **261** and to retreat from the cylinder unit **261** by the biasing force of the spring unit **263**, the elastic member **E** is arranged at a hollow space formed by the cylinder unit **261** (housing unit **261a**) and the piston unit **264** so as to suppress the forward/backward movement speed of the piston unit **264** by the elastic force of the elastic member **E**. With this, it is possible to stably obtain a good elastographic image with a simple configuration without increasing the size of the distal end portion.

Second Embodiment

[0060] Next, a second embodiment of the present invention will be described. FIG. 7 is a schematic diagram illustrating a configuration of a suction button included in an ultrasound endoscope in an ultrasound diagnosis system according to the second embodiment, illustrating a state where pressing force is not applied to a piston unit **265**. The same reference signs are used to designate the same elements as those of the above-described embodiment. The above-described first embodiment assumes that the piston unit **262** includes the communication hole **262a** as a damper unit. In the second embodiment, however, the piston unit **265** includes a diaphragm mechanism to change the cycle of reciprocation of the piston unit **265**.

[0061] A suction button **26b** according to the second embodiment includes the cylinder unit **261**, the piston unit **265**, and the spring unit **263**. The piston unit **265** has a substantially columnar shape. The piston unit **265** includes an opening portion **265a** and a first communication hole **265b**. The opening portion **265a** is provided at an insertion-side rear end portion toward the cylinder unit **261**. The first communication hole **265b** allows communication between the opening portion **265a** and an insertion-side distal end portion toward the cylinder unit **261**. The piston unit **265** includes a recess **265c** and a flange unit **265d**. The recess **265c** is formed by cutting a portion of a side surface. The flange unit **265d** is a portion protruding in a direction orthogonal to the longitudinal direction of the piston unit **265**.

[0062] The opening portion **265a** can be screwed to an adjustment member **266** as an adjustment mechanism for changing the cycle of reciprocation of the piston unit **265**. The adjustment member **266** includes a second communication hole **266a** that allows communication between one

end side and the other end side, of the direction of inserting into the opening portion **265a** by screwing.

[0063] The recess **265c** includes an opening that allows communication between the first communicating portion **261c** and the second communicating portion **261d**.

[0064] The flange unit **265d** is housed in the locking unit **261b**, its moving range being regulated by the locking unit **261b**. In addition, the spring unit **263** is provided at a portion between the flange unit **265d** and the locking unit **261b**, at a distal end side in the insertion direction of the piston unit **265**.

[0065] In a state where the piston unit **265** protrudes from the cylinder unit **261**, while the piston unit **265** is configured such that the opening of the recess **265c** is allowed to communicate with the second communicating portion **261d**, the first communicating portion **261c** is blocked by the side wall of the piston unit **265**. Accordingly, the first suction tube **271** and the second suction tube **272** do not communicate with each other, causing no suction force by the suction pump **5**, on the distal end portion **201**.

[0066] In addition, by adjusting the discharge of gas inside the hollow space **S1** to the outside by the communication hole to be formed by the first communication hole **265b** and the second communication hole **266a**, it is possible to generate force that opposes insertion of the piston unit **265**, and thus, to suppress an increase in the insertion speed. In addition, in a case where the pressing force on the piston unit **265** is released, the flowrate of the gas flowing into the hollow space **S1** is limited by the first communication hole **265b** and the second communication hole **266a**, causing the piston unit **265** to gradually retreat from the housing unit **261a**. In this manner, each of the first communication hole **265b** and the second communication hole **266a** functions as a damper unit to suppress the forward/backward movement speed of the piston unit **265**.

[0067] By changing the volume of a hollow space **S2** to be formed between the adjustment member **266** and the opening portion **265a** by rotating the adjustment member **266**, it is possible to change the discharge of gas inside the hollow space **S1** to the outside. With this configuration, it is possible to adjust the force that opposes insertion of the piston unit **265**, change the insertion speed of the piston unit **265**, and change the retreat speed of the piston unit **265** from the housing unit **261a**.

[0068] As described above, according to the presence or absence of the pressing force applied to the piston unit **265**, it is possible to easily switch the contact state of the distal end portion **201** toward the subject, and the press-contact state of the distal end portion **201** toward the subject, induced by suction by the distal end portion **201**. Moreover, since the damper unit controls the forward/backward movement speed of the piston unit **265**, it is possible to periodically switch the contact state toward the subject at a more fixed interval. By periodically switching the contact state, it is possible to stably obtain an echo signal in each of the states, and thus to generate a good and stable elastographic image.

[0069] As described above, according to the second embodiment, with the piston unit **265** configured so as to be inserted into the cylinder unit **261** and to retreat from the cylinder unit **261** by the biasing force of the spring unit **263**, and with the adjustment member **266**, the damper unit is formed to allow communication between the housing unit **261a** and the outside so as to suppress the forward/backward

movement speed of the piston unit **265**. With this, it is possible to stably obtain a good elastographic image with a simple configuration without increasing the size of the distal end portion.

[0070] In addition, according to the above-described second embodiment, the discharge of gas inside the hollow space **S1** to the outside is changed by changing the volume of the hollow space **S2** formed between the adjustment member **266** and the opening portion **265a** by rotating the adjustment member **266**. With this configuration, it is possible to adjust the force that opposes insertion of the piston unit **265**, change the insertion speed of the piston unit **265**, and change the retreat speed of the piston unit **265** from the housing unit **261a**.

[0071] The above-described second embodiment assumes that the piston unit **265** and the adjustment member **266** are screwed with each other. Alternatively, however, the adjustment member **266** may be press-fitted into the piston unit **265**. In this case, it would be allowable to configure such that a protrusion (or recess) is provided on an inner peripheral surface of the opening portion **265a** and that a recess (or protrusion) is provided on an outer peripheral surface of the adjustment member **266**, and that gradual positioning of the adjustment member **266** is performed with respect to the opening portion **265a**.

Third Embodiment

[0072] Next, a third embodiment of the present invention will be described. FIG. **8** is a schematic diagram illustrating a configuration of a suction button included in an ultrasound endoscope in an ultrasound diagnosis system according to the third embodiment of the present invention. The same reference signs are used to designate the same elements as those of the above-described embodiments. The above-described first embodiment assumes that suction operation is performed by applying pressing force to the piston unit **262**. In the third embodiment, however, suction operation by the distal end portion **201** is performed by using the suction force by the suction pump **5**.

[0073] A suction button **28** according to the third embodiment includes a cylinder unit **281**, a piston unit **282**, and a spring unit **283**.

[0074] The cylinder unit **281** has a hollow cylindrical shape (tubular shape bottomed on both sides), having opening portions **281a** and **281b** formed on the top and bottom surfaces, respectively. The cylinder unit **281** includes a housing unit **281c**, a bypass tube (bypass tube passage) **281d**, and a communicating portion **281e**. The housing unit **281c** communicates with the opening portions **281a** and **281b** at its both ends, respectively, and forms a columnar hollow space (hollow portion) that can movably house the piston unit **282**. The bypass tube **281d** extends from a side wall on the opening portion **281a** side of the housing unit **281c** and communicates onto the opening portion **281b**. The communicating portion **281e** allows communication between the opening portion **281b** and the housing unit **281c**. In the third embodiment, a first suction tube **273** forms a portion of a suction channel (passage), one end communicating with the opening portion **281b**, the other end connecting to the suction pump **5** (not illustrated). A second suction tube **274** forms a portion of a suction channel (passage), one end connecting to the first suction tube **273**, the other end communicating with the outside via the distal end portion **201**. In the third embodiment, the opening

portion **281a** allows communication between the outside and the housing unit **281c**, and the opening portion **281b** allows communication between the housing unit **281c** and the first suction tube **273**.

[0075] The cylinder unit **281** is attached onto the operating unit **21** by fitting, for example. At this time, the O-ring **30** is provided between the operating unit **21** and the cylinder unit **281**. With the O-ring **30**, sealability and slip prevention between the operating unit **21** and the cylinder unit **281** can be maintained.

[0076] The piston unit **282** is slidably disposed inside the housing unit **281c**. The piston unit **282** includes a sliding unit **282a** and an extending portion **282b**. The sliding unit **282a** slides with respect to the housing unit **281c**. The extending portion **282b** having a cylindrical shape corresponds to one end of the sliding unit **282a** and extends from a surface facing the opening portion **281b**. The spring unit **283** is provided between an end portion on the extending portion **282b** side of the piston unit **282** and an end portion on the opening portion **281b** side of the housing unit **281c**.

[0077] The spring unit **283** is formed with a coil spring, for example. As described above, the spring unit **283** is provided between the extending portion **282b** and the housing unit **281c**, being arranged to be capable of biasing in the direction of causing the piston unit **282** to move out from the cylinder unit **281** (direction toward the opening portion **281a**). The spring unit **283** may be configured to be press-fitted into the extending portion **282b**, or to enclose the extending portion **282b** without being press-fitted into the extending portion **282b**. It would be sufficient that the extending portion **282b** can lock the spring unit **283** to prevent the spring unit **283** from tilting.

[0078] In a state where the piston unit **282** is positioned on the opening portion **281a** side of the cylinder unit **281**, the piston unit **282** closes the opening of the bypass tube **281d**. Accordingly, the first suction tube **273** does not communicate with the outside, causing the suction force by the suction pump **5** to act on the housing unit **281c**, at the distal end portion **201**. In a case where the first suction tube **273** does not communicate with the outside, the suction force by the suction pump **5** acts on the housing unit **281c** and on the second suction tube **274**. In other words, the suction force acts on the second suction tube **274**, whereby the internal wall surface of the subject or the like is sucked via the distal end portion **201**.

[0079] When the gas within the internal space of the housing unit **281c** is sucked by the suction pump **5** via the communicating portion **281e** and the opening portion **281b**, the internal pressure of the housing unit **281c** is lowered, whereby the piston unit **282** moves in the direction to decrease the volume of the housing unit **281c** (direction toward the opening portion **281b**). When the piston unit **282** moves toward the opening portion **281b** side, the bypass tube **281d** comes in communication with the outside via the opening portion **281a** and the housing unit **281c**.

[0080] FIG. 9 is a schematic diagram illustrating a configuration of a suction button included in the ultrasound endoscope in the ultrasound diagnosis system according to the third embodiment, illustrating a state where the piston unit **282** has moved to the opening portion **281b** side. As illustrated in FIG. 9, when the piston unit **282** moves to the opening portion **281b** side by the suction force by the suction pump **5**, the bypass tube **281d** comes in communication with the outside, and then, the suction force by the suction pump

5 begins to act on the second suction tube **274** and together with this, act as suction force to suck the outside gas. With this action, the suction force by the distal end portion **201** via the second suction tube **274** decreases compared with a case where the bypass tube **281d** does not communicate with the outside (refer to FIG. 8).

[0081] In the third embodiment, in a case where the first suction tube **273** does not communicate with the outside (in a case where the piston unit **282** closes the bypass tube **281d**), the suction force by the second suction tube **274** is relatively great, and thus, the distal end portion **201** comes in a press-contact state while sucking the internal wall surface of the subject. In contrast, in a case where the first suction tube **273** is in a communication state with the outside (case where the piston unit **282** opens the bypass tube **281d**), suction force by the second suction tube **274** is relatively small. Accordingly, the distal end portion **201** comes into either a contact or separate state with respect to the internal wall surface of the subject.

[0082] When the first suction tube **273** comes in communication with the outside, the housing unit **281c** that is in a low-pressure state gradually returns to a state of normal pressure. Accordingly, the piston unit **282** gradually moves again to the opening portion **281a** side by increased pressure and the biasing force of the spring unit **283**. Along with this movement of the piston unit **282**, the bypass tube **281d** that has been in an open state with the outside is blocked again. With this change, due to the suction operation of the suction pump **5**, the piston unit **282** reciprocates within the housing unit **281c**, while the suction state by the distal end portion **201** periodically changes. At this time, similarly to the above-described communication hole **262a**, the bypass tube **281d** can adjust the discharge to the outside, by decreasing the cross-section orthogonal to the communication direction. With this adjustment, the bypass tube **281d** generates force that opposes the movement of the piston unit **282**, and thus, functions as a damper unit to suppress the forward/backward movement speed of the piston unit **282**. Note that the diameter of the bypass tube **281d** is preferably smaller than the diameter of the first suction tube **273**. In the third embodiment, the suction button **28** except the bypass tube **281d** configures a suction force change unit.

[0083] According to the above-described third embodiment, the open state and closed state of the bypass tube **281d** toward the outside is changed by the piston unit **282** that is moved by the internal pressure of the housing unit **281c**, under the suction operation by the suction pump **5**, and together with this, the forward/backward movement speed of the piston unit **282** is suppressed by the bypass tube **281d**. With this configuration, it is possible to stably obtain a good elastographic image with a simple configuration without increasing the size of the distal end portion.

Fourth Embodiment

[0084] Next, a fourth embodiment of the present invention will be described. FIG. 10 is a schematic diagram illustrating a configuration of a suction button included in an ultrasound endoscope in an ultrasound diagnosis system according to the fourth embodiment of the present invention. The same reference signs are used to designate the same elements as those of the above-described embodiments. While the above-described third embodiment assumes that suction operation is performed by the distal end portion **201** using the suction force by the suction pump **5**, the fourth embodi-

ment includes a diaphragm mechanism to change the cycle of reciprocation of a piston unit **285**.

[0085] A suction button **28a** according to the fourth embodiment includes a cylinder unit **284**, the piston unit **285**, and the spring unit **283**.

[0086] The cylinder unit **284** has a hollow cylindrical shape, having opening portions **284a** and **284b** formed on the top and bottom surfaces, respectively. The cylinder unit **284** includes a housing unit **284c** and a bypass tube **284d**. The housing unit **284c** communicates with the opening portions **284a** and **284b** at its both ends, respectively, and includes a columnar hollow space that can movably house the piston unit **285**. The bypass tube **284d** extends from a side wall on the opening portion **284a** side of the housing unit **284c** and communicates onto the opening portion **284b**. In the fourth embodiment, the first suction tube **273** is formed such that one end communicates with the opening portion **284b**, the other end connecting to the suction pump **5** (not illustrated). In the fourth embodiment, the opening portion **284a** allows communication between the outside and the housing unit **284c**, while the opening portion **284b** allows communication between the housing unit **284c** and the first suction tube **273**.

[0087] As an adjustment mechanism for changing the cycle of reciprocation of the piston unit **285**, an adjustment member is provided inside the housing unit **284c**. The adjustment member **286** has a bottomed cylindrical shape, has an opening portion **286a** on the bottom, and includes a holding unit **286b** that can house and hold a portion of the piston unit **285** and the spring unit **283**. The adjustment member **286** can be screwed, on its outer peripheral surface, to the inner peripheral surface of the housing unit **284c**. When the adjustment member **286** rotates around the longitudinal-axis, the position of the adjustment member **286** relative to the housing unit **284c** changes.

[0088] Similarly to the cylinder unit **281**, the cylinder unit **284** is attached onto the operating unit **21** by fitting, for example. At this time, the O-ring **30** is provided between the operating unit **21** and the cylinder unit **284**.

[0089] The piston unit **285** is slidably disposed inside the housing unit **284c**. The piston unit **285** includes a sliding unit **285a** and an extending portion **285b**. The sliding unit **285a** slides with respect to the housing unit **284c**. The extending portion **285b** having a cylindrical shape corresponds to one end of the sliding unit **285a** and extends from a surface facing the opening portion **284b**. The above-described spring unit **283** is provided between an end portion on the extending portion **285b** side of the piston unit **285** and the bottom of the adjustment member **286**.

[0090] In the fourth embodiment, in a case where the first suction tube **273** does not communicate with the outside (in a case where the piston unit **285** closes the bypass tube **284d**), the suction force by the second suction tube **274** is relatively great, and thus, the distal end portion **201** comes in a press-contact state while sucking the internal wall surface of the subject. In contrast, in a case where the first suction tube **273** is in a communication state with the outside (case where the piston unit **285** opens the bypass tube **284d**), the suction force by the second suction tube **274** is relatively small. Accordingly, the distal end portion **201** comes into either a contact or separate state with respect to the internal wall surface of the subject.

[0091] When the first suction tube **273** comes in communication with the outside, the housing unit **284c** that is in a

low-pressure state gradually returns to a state of normal pressure. Accordingly, the piston unit **285** gradually moves again to the opening portion **284a** side by increased pressure and the biasing force of the spring unit **283**. Along with this movement of the piston unit **285**, the bypass tube **284d** that has been in an open state with the outside returns to a closed state. With this change, due to the suction operation of the suction pump **5**, the piston unit **285** reciprocates within the housing unit **284c**, while the suction state by the distal end portion **201** periodically changes. At this time, similarly to the above-described bypass tube **281d**, the bypass tube **284d** can adjust the discharge to the outside, by decreasing the cross-section orthogonal to the communication direction. With this adjustment, the bypass tube **284d** generates force that opposes the movement of the piston unit **285**, and thus, functions as a damper unit to suppress the forward/backward movement speed of the piston unit **285**.

[0092] By changing a distance **D** with respect to the housing unit **284c**, specifically, the distance between the outer surface of the bottom of the adjustment member **286** and the bottom surface of the housing unit **284c** by rotating the adjustment member **286**, a reciprocating distance (reciprocating cycle) of the piston unit **285** with respect to the housing unit **284c** changes, making it possible to change the speed of the reciprocation of the piston unit **285**.

[0093] As described above, by using the piston unit **285** that moves by the internal pressure of the housing unit **284c** under the suction operation by the suction pump **5**, it is possible to easily switch the contact state of the distal end portion **201** toward the subject, and the press-contact state of the distal end portion **201** toward the subject, induced by suction by the distal end portion **201**. Moreover, since the damper unit controls the forward/backward movement speed of the piston unit **285**, it is possible to periodically switch the contact state at a more fixed interval, toward the subject. By periodically switching the contact state, it is possible to stably obtain an echo signal in each of the states, and thus to generate a good and stable elastographic image.

[0094] According to the above-described fourth embodiment, the open state and closed state of the bypass tube **284d** toward the outside are changed by the piston unit **285** that is moved by the internal pressure of the housing unit **284c**, under the suction operation by the suction pump **5**, and together with this, the forward/backward movement speed of the piston unit **285** is suppressed by the bypass tube **284d**. With this configuration, it is possible to stably obtain a good elastographic image with a simple configuration without increasing the size of the distal end portion.

[0095] Moreover, according to the above-described fourth embodiment, the speed of the reciprocation of the piston unit **285** is to be changed by changing the distance **D** to the housing unit **284c** by rotating the adjustment member **286**. Accordingly, it is possible to change the insertion speed of the piston unit **285** and the retreat speed of the piston unit **285** from the housing unit **284c**.

[0096] The above-described first to fourth embodiments assume that the suction button is a button to operate the contact or press-contact state toward the internal wall surface of the body by the distal end portion **201**. In addition to this, the suction button can also be used to suck body fluid, or the like, when the piston unit is removed. It would be also allowable to arrange the suction button to operate the contact or press-contact state toward the internal wall surface of the body by the distal end portion **201** separately from the

suction button to perform operation for sucking the body fluid, or the like. In this case, it is allowable to configure such that the passage for suction of the body fluid, or the like, differs from the passage for suction for performing press-contact of the distal end portion **201** to the internal wall surface of the body.

Fifth Embodiment

[0097] Next, a fifth embodiment of the present invention will be described. FIG. 11 is a schematic diagram illustrating a configuration of a suction force adjustment unit included in an ultrasound endoscope in an ultrasound diagnosis system according to the fifth embodiment of the present invention. The same reference signs are used to designate the same elements as those of the above-described embodiments. While the above-described first to fourth embodiments assume that periodical suction operation is performed by reciprocation of the piston unit, the fifth embodiment includes a suction force adjustment unit **29** instead of the above-described suction button. The suction force adjustment unit **29** controls (adjusts) a suction state of the second suction tube **274** by a solenoid valve **292**.

[0098] The suction force adjustment unit **29** according to the fifth embodiment includes a main body unit **291**, the solenoid valve **292**, and piping **293**. The main body unit **291** is attached onto the operating unit **21** by fitting. At this time, the O-ring **30** is provided between the operating unit **21** and the main body unit **291**. The main body unit **291** includes a through-hole **291a**. The through-hole **291a** includes an opening on the external surface, while its other end is connected to the above-described first suction tube **273**.

[0099] The solenoid valve **292** is provided on the piping **293** and opens and closes the valve by moving a plunger by a magnetic force of an electromagnet under the control of an external control apparatus such as the ultrasound observation apparatus **3**. The piping **293** is configured such that its one end side is connected to the through-hole **291a** and the other end side is connected to the outside. With this configuration, when the solenoid valve **292** is in a closed state, the inside of the piping **293** comes into a closed state, and the first suction tube **273** does not communicate with the outside. Therefore, the suction force by the suction pump **5** via the first suction tube **273** acts on the second suction tube **274**. In contrast, when the solenoid valve **292** comes into an open state, the inside of the piping **293** is opened, and the first suction tube **273** comes into a communication state with the outside. Therefore the suction force by the suction pump **5** via the first suction tube **273** acts on the second suction tube **274**, and together with this, acts as suction force that sucks external gas. The solenoid valve **292** may be opened by the control of the ultrasound observation apparatus **3**, or may be controlled by a control apparatus other than the ultrasound observation apparatus **3**, for example, an apparatus that controls open/close operation using an input button or a dial electrically connected to the solenoid valve **292**.

[0100] Accordingly, when the solenoid valve **292** is in the closed state, the suction force by the suction pump **5** acts on the second suction tube **274**, and thus, the internal wall surface inside the body of the subject is sucked via the distal end portion **201**. In contrast, when the solenoid valve **292** comes into an open state, the suction force by the suction pump **5** acts on the second suction tube **274**, and together with this, acts as the suction force to suck the external gas.

Accordingly, the suction force by the second suction tube **274** becomes relatively small, and thus, the distal end portion **201** comes into either a contact or separate state with respect to the internal wall surface of the subject.

[0101] At this time, by decreasing the diameter of the piping **293**, it is possible to adjust the discharge of gas to the outside. By decreasing the discharge, it is possible to gently change the suction force of the second suction tube **274**. In this manner, the piping **293** functions as a damper unit that gently changes the suction force by the distal end portion **201**. Note that the diameter of the piping **293** is preferably smaller than the diameter of the first suction tube **273**. It is also allowable to provide the solenoid valve **292** and a portion of the piping **293**, inside the main body unit **291**.

[0102] According to the above-described fifth embodiment, the control by the solenoid valve **292** allows the open state and closed state of the first suction tube **273** to change toward the outside, and allows the suction force of the second suction tube **274** using the piping **293** to gently change, under the suction operation by the suction pump **5**. With this configuration, it is possible to stably obtain a good elastographic image with a simple configuration without increasing the size of the distal end portion.

[0103] It is also allowable to connect the piping **293** to the bypass tube **281d** using a combination of the above-described third and fifth embodiments.

[0104] Embodiments of the present invention have been described hereinabove, however, the present invention is not intended to be limited to the above-described embodiments. For example, while the above description assumes that the observation target is a living tissue, it is also applicable not only to the ultrasound endoscope but also to an endoscope that images inside the subject, and to an industrial endoscope for observing characteristics of a material. The endoscope according to the present invention is applicable both to external and internal portions of the body.

[0105] According to some embodiments, it is possible to stably obtain a good elastographic image without increasing the size of the distal end portion, with a simple configuration.

[0106] Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

What is claimed is:

1. A suction force adjustment apparatus used for ultrasound examination of an observation target by transmitting ultrasound to the observation target and receiving the ultrasound reflected from the observation target, the apparatus comprising:

- a suction force change unit configured such that one end is configured to be connected to a suction pump and the other end is provided at a portion of a channel leading to a contact portion with the observation target, and configured to change suction force of the suction pump on the other end; and
- a damper unit configured to suppress a change in the suction force by the suction force change unit, wherein

the suction force change unit comprises:

- a cylinder unit having a cylindrical shape bottomed on one side, and having a first communicating portion for communicating with one end side of the channel and a second communicating portion for communicating with the other end side of the channel and with the first communicating portion;
 - a piston unit slidable with respect to the cylinder unit, and configured to change a communication state between the first communicating portion and the second communicating portion according to a movement with respect to the cylinder unit; and
 - a spring unit configured to bias the piston unit toward a direction of causing the first communicating portion and the second communicating portion not to communicate with each other.
2. The suction force adjustment apparatus for ultrasound examination according to claim 1, wherein
- the damper unit is provided in the piston unit, and is a communication hole that allows communication between outside and a hollow portion formed by the cylinder unit and the piston unit.
3. The suction force adjustment apparatus for ultrasound examination according to claim 1, wherein
- the damper unit is an elastic member provided in a hollow portion formed by the cylinder unit and the piston unit.
4. The suction force adjustment apparatus for ultrasound examination according to claim 2, further comprising an adjustment member configured to adjust volume of a hollow space formed by the communication hole.
5. An ultrasound endoscope comprising:
- the suction force adjustment apparatus for ultrasound examination according to claim 1;
 - an insertion unit; and
 - an ultrasound transducer provided at a distal end of the insertion unit and configured to transmit ultrasound to the observation target and to receive the ultrasound reflected from the observation target.
6. A suction force adjustment apparatus used for ultrasound examination of an observation target by transmitting ultrasound to the observation target and receiving the ultrasound reflected from the observation target, the apparatus comprising:
- a suction force change unit configured such that one end is configured to be connected to a suction pump and the other end is provided at a portion of a channel leading

to a contact portion with the observation target, and configured to change suction force of the suction pump on the other end; and

- a damper unit configured to suppress a change in the suction force by the suction force change unit, wherein the suction force change unit comprises:

- a cylinder unit having a hollow cylindrical shape, and having a first opening portion disposed on one end in a height direction to communicate with outside and a second opening portion disposed on the other end in the height direction to communicate with the channel;

- a piston unit provided in a hollow portion of the cylinder unit and slidable between the one end and the other end of the cylinder unit; and

- a spring unit configured to bias the piston unit from the other end of the cylinder unit toward the one end of the cylinder unit,

the damper unit is a bypass tube passage provided in the cylinder unit to allow communication between the one end and the other end of the cylinder unit, and

the piston unit is configured to slide with respect to the cylinder unit in accordance with one of pressure change due to the suction force and biasing force of the spring unit, thereby to open or close one end side of the bypass tube passage.

7. The suction force adjustment apparatus for ultrasound examination according to claim 6, further comprising an adjustment member configured to adjust a movement range of the piston unit with respect to the cylinder unit.

8. An ultrasound endoscope comprising:

- the suction force adjustment apparatus for ultrasound examination according to claim 6;

- an insertion unit;

- an ultrasound transducer provided at a distal end of the insertion unit and configured to transmit ultrasound to the observation target and to receive the ultrasound reflected from the observation target; and

- a valve configured such that one end leads to the suction pump and the other end is connected to a portion of a channel leading to the distal end of the insertion unit via the bypass tube passage, and configured to adjust a discharge of gas in the bypass tube passage under control of an external control apparatus.

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专利名称(译)	用于超声检查的吸力调节装置和超声内窥镜		
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摘要(译)

调节装置用于通过向对象发射超声并接收从对象反射的超声来对对象进行超声检查。该装置包括：改变单元，其构造成使得一端连接到抽吸泵，另一端设置在通向与对象接触部分的通道的一部分处，以改变抽吸泵对另一端的吸力。结束;和用于抑制吸力变化的阻尼器。改变单元包括：圆柱体，具有分别与通道的一端侧和另一端侧连通的第一和第二部分;活塞可在气缸内滑动，以改变第一和第二部分之间的连通状态;弹簧用于使活塞偏向使第一和第二部分不相互连通的方向。

