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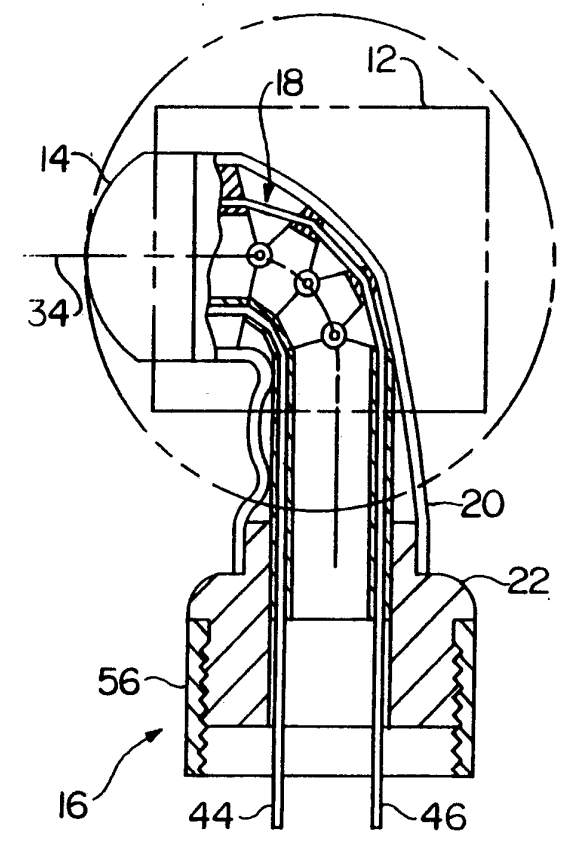
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(54) Title: ULTRASONIC PROBE ASSEMBLY

(57) Abstract
 An ultrasonic probe assembly (10) in which the disposition of the scan plane of an ultrasonic transducer unit (12), introduced into a human body, can be selected to image a body part in different ways. The scan plane is selected by operation of a remote control unit (36) by which the ultrasonic array is moved. The ultrasonic array (12) is connected to a base unit (16) by means of a flexible coupling (18) and is steered by the action of cables (44, 46) which are controlled by the remote control unit (36).



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ULTRASONIC PROBE ASSEMBLY

BACKGROUND OF THE INVENTION

The present invention relates, in general, to ultrasonic imaging and, in particular, to a probe in which the scan plane of an ultrasonic transducer unit can be changed, so that a body organ, such as the heart, which is being imaged can be viewed in different ways (i.e. in longitudinal and transverse sections or any section inbetween). Such a probe often is referred to as a "multi-plane" probe by those skilled in the art.

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Many different ultrasonic multi-plane probes have been suggested or put into actual use in the past. Typically, in these probes, the ultrasonic transducer unit is positioned in a cavity in a housing with the cavity filled with a fluid and covered by a membrane. The ultrasonic probes described and illustrated in U.S. 4,543,960 and U.S. 4,930,515 are representative of such probes. The scan plane of the ultrasonic array in the probe in U.S. 4,543,960, for example, is changed by operating a cable and pulley mechanism.

There are at least four shortcomings with the prior art ultrasonic multi-plane probes known to applicant. One is size. Although, these probes are small to begin with, even smaller probes are highly desirable.

A second problem with the prior art ultrasonic multi-plane probes known to applicant is the very presence of the fluid in the cavity and the potential damage to the ultrasonic array caused by swelling or corrosion due to the presence of the fluid in the cavity. The fluid is provided in such probes to establish the proper acoustic coupling from the array into the membrane.

A third problem with the prior art ultrasonic multi-plane probes known to applicant is that the membrane cover, which is an added component in the acoustic path, can attenuate and distort sound waves in a manner which reduces ultrasound system resolution.

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A fourth problem with such prior art ultrasonic multi-plane probes is that the positioning mechanism passes through sliding seals which are susceptible to leakage of body fluids into the probe cavity to contaminate the fluid in the probe cavity possibly leading to corrosion and acoustic problems. Leakage of the probe cavity fluid into the patient also can occur, but this problem is overcome by using a biocompatible fluid in the probe cavity.

SUMMARY OF THE INVENTION

An ultrasonic probe assembly, constructed in accordance with the present invention, includes ultrasonic transducer means for scanning in a scan plane and movable through a positioning angle which extends in a plane perpendicular to the scan plane to change the disposition of the scan plane. The ultrasonic probe assembly of the present invention further includes a base unit, a flexible coupling extending between the base unit and the ultrasonic transducer means and a flexible tube also extending between the base unit and the ultrasonic transducer means and within which the flexible coupling extends. Also included in the ultrasonic probe assembly of the present invention are a remote control unit for selecting an angular position of the ultrasonic transducer means corresponding to a selected disposition of the scan plane and position control means extending from the remote control unit through the base unit and the flexible tube to the ultrasonic transducer means and responsive to the remote control unit for moving the

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ultrasonic transducer means to the selected angular position.

In one preferred embodiment of the present invention which is described in this application, the ultrasonic transducer means include an ultrasonic array and an array mount upon which the ultrasonic array is mounted. It will be understood, however, that the underlying concept of the present invention can be applied to probes having transducers which are scanned mechanically.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side view, partially in section, of the probe portion of one preferred embodiment of an ultrasonic probe assembly constructed in accordance with the present invention.

Figure 2 includes a horizontal section taken along line 2-2 of Figure 1 and a plan view of the remote control unit portion of a preferred embodiment of an ultrasonic probe assembly constructed in accordance with the present invention.

Figures 3, 4 and 5 are plan views, on an enlarged scale and partially in section, of three angular positions of the probe portion of the ultrasonic probe assembly of Figures 1 and 2.

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Figure 6 is a plan view of an endoscope in which the ultrasonic probe assembly of Figures 1 through 5 can be incorporated.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Figures 1 through 5, one preferred embodiment of an ultrasonic probe assembly, constructed in accordance with the present invention, includes an ultrasonic array unit 10 which, in turn, includes an ultrasonic array 12 and an array mount 14 upon which the ultrasonic array is mounted. Ultrasonic array 12 can be of conventional construction and operation, preferably a multi-element phased array ultrasonic transducer, which emits an ultrasonic beam which is scanned in a plane projecting out of the paper for Figures 3, 4 and 5. Ultrasonic array 12 is shown by dot-dash lines in Figures 3, 4 and 5. As shown in Figure 2, array mount 14 is, for the embodiment of the invention being described, in the form of a right-angle elbow.

Ultrasonic array unit 10 is movable through a positioning angle which extends in a plane perpendicular to the scan plane of ultrasonic array 12, namely in the plane of the paper for Figures 3, 4 and 5, to change the disposition of the scan plane. As shown most clearly in Figures 3, 4 and 5, for the embodiment of the invention being described, ultrasonic array 12 can move ninety degrees to the left (Figure 3) from its center position (Figure 4) and ninety degrees to the right (Figure 5) from its center position. This movement of ultrasonic

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array 12 is generally rotational (i.e. clockwise or counterclockwise).

An ultrasonic probe assembly, constructed in accordance with the present invention, also includes a base unit 16, a flexible coupling 18 and a flexible tube 20. Base unit 16 is in the form of an externally threaded fitting 22 which can be one end of an endoscope, such as the one illustrated in Figure 6.

Flexible coupling 18 extends between fitting 22 of base unit 16 and elbow 14 of ultrasonic array unit 10 and provides the means by which the ultrasonic array unit and, therefore, ultrasonic array 12, is connected to the base unit. Flexible coupling 18 is composed of a plurality of pivotally connected links which pivot relative to one another about axes disposed perpendicular to the plane in which the positioning angle of ultrasonic array 12 extends, namely out of the paper for Figures 3, 4 and 5. Specifically, a first link 26, at a first end of flexible coupling 18, is press-fit into fitting 22 to rigidly attach the flexible coupling to base unit 16 and a second link 28, at a second end of the flexible coupling, is press-fit into elbow 14 to rigidly attach the flexible coupling to ultrasonic array unit 10. For the embodiment of the invention being described, flexible coupling 18 has two additional links 30 and 32. More or less links can be used depending upon the mechanical considerations of the desired design.

As shown in Figures 3, 4 and 5, the pivot axes of the pivotally connected links 26, 28, 30 and 32 are

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disposed along a center line 34 which is: (a) straight when ultrasonic array unit 10 is at the center of the positioning angle of ultrasonic array 12 (Figure 4); (b) curved in a first direction when ultrasonic array 12 is to a first (i.e. left) side of the center of the positioning angle (Figure 3); and (c) curved in a second direction opposite to the first direction when ultrasonic array 12 is to a second (i.e. right) side of the center of the positioning angle (Figure 5).

Flexible tube 20 also extends between fitting 22 of base unit 16 and elbow 14 of ultrasonic array unit 10. The opposite ends of flexible tube 20 are attached by suitable means, such as a water resistant adhesive, to fitting 22 and elbow 14 to totally seal, among other things, flexible coupling 18 which extends through the flexible tube from outside fluids.

An ultrasonic probe assembly, constructed in accordance with the present invention, further includes a remote control unit 36 for selecting an angular position of ultrasonic array unit 10 corresponding to a selected disposition of the scan plane of ultrasonic array 12. For the embodiment of the invention being described, remote control unit 36 includes a knob 38, a pulley 40 and a shaft 42 on which the knob and the pulley are rotatably mounted, so that upon turning the knob to a selected position, the position of the pulley is controlled and the pulley will be turned a corresponding amount.

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An ultrasonic probe assembly, constructed in accordance with the present invention, further includes position control means for moving ultrasonic array unit 10 to a selected angular position in response to the setting of remote control unit 36. For the embodiment of the invention being described, the position control means include a first cable 44 slidable within a jacket 45 and a second cable 46 slidable within a jacket 47. The lengths of cables 44 and 46, within flexible coupling 18, extend in a plane parallel to the plane in which the positioning angle of the ultrasonic array extends. A first end 48 of cable 44 is attached to pulley 40 of remote control unit 36 and a second end 50 of cable 44 is attached to elbow 14. A first end 52 of cable 46 is attached to pulley 40 of remote control unit 36 and a second end 54 of cable 46 is attached to elbow 14. Cable 44 extends through fitting 22 of base unit 16 and through links 26, 28, 30 and 32 engaging the links at a first side of center line 34, while cable 46 also extends through fitting 22 of base unit 16 and through links 26, 28, 30 and 32 engaging the links at a second and opposite side of center line 34. Jackets 45 and 47 of cables 44 and 46, respectively, are attached to fitting 22 and a wall 55 of remote control unit 36.

As knob 38 is turned in a first direction (i.e. clockwise), cables 44 and 46, engaging the links at opposite sides of center line 34, steer ultrasonic array unit 10 in the generally rotational first direction (i.e. clockwise) and as knob 38 is turned in a second and opposite direction (i.e. counterclockwise), cables 44 and 46 steer ultrasonic array unit 10 in the generally

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rotational second and opposite direction (i.e. counterclockwise). In this way, ultrasonic array 12 can be moved to any position between the positions shown in Figures 3 and 5 to image a selected body part at a selected scan plane.

Figure 6 illustrates the ultrasonic probe assembly of Figures 1 through 5 incorporated in an endoscope. Ultrasonic array unit 10 and base unit 16 are connected mechanically to remote control unit 36 by cables 44 and 46 (not shown in Figure 6) and jackets 45 and 47 (not shown in Figure 6) which extend within a flexible endoscope shaft 56, one end of which is threadedly attached to fitting 22 as shown in Figure 2. Electrical signals are conducted to and from ultrasonic array unit 10 by wires (also not shown in Figure 6) which also extend within flexible endoscope shaft 56 and a cable 58 having a connector 60 at one end which is adapted for connection into suitable signal processing and imaging equipment. A second knob 62 on remote control unit 36 controls bending of the end of flexible endoscope shaft 56 upward, downward and sideways to permit the end of the endoscope shaft to make turns as it is passed through the throat.

The foregoing has set forth an exemplary and preferred embodiment of the present invention. It will be understood, however, that various other alternative embodiments will occur to those of ordinary skill in the art with departure from the spirit and scope of the present invention.

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What is Claimed:

1. An ultrasonic probe assembly comprising:

an ultrasonic array unit including an ultrasonic array for scanning in a scan plane and an array mount upon which said ultrasonic array is mounted, said ultrasonic array unit movable through a positioning angle extending in a plane perpendicular to said scan plane to change the disposition of said scan plane;

a base unit;

a flexible coupling extending between said base unit and said ultrasonic array unit;

a flexible tube extending between said base unit and said ultrasonic array unit and within which said flexible coupling extends;

a remote control unit for selecting an angular position of said ultrasonic array unit corresponding to a selected disposition of said scan plane of said ultrasonic array;

and position control means extending from said remote control unit through said base unit and said flexible tube to said ultrasonic array unit and responsive to said remote control unit for moving said ultrasonic array unit to said selected angular position.

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2. An ultrasonic probe assembly according to claim 1 wherein said flexible coupling includes a plurality of pivotally connected links which pivot relative to one another about axes disposed perpendicular to said plane in which said positioning angle extends.

3. An ultrasonic probe assembly according to claim 2 wherein a first of said pivotally connected links at a first end of said flexible coupling is rigidly attached to said base unit and a second of said pivotally connected links at a second end of said flexible coupling is rigidly attached to said ultrasonic array unit.

4. An ultrasonic probe assembly according to claim 3 wherein said pivot axes of said pivotally connected links are disposed along a center line which is:

- (a) straight when said ultrasonic array unit is at the center of said positioning angle,
- (b) curved in a first direction when said ultrasonic array unit is to a first side of said center of said positioning angle, and
- (c) curved in a second direction opposite to said first direction when said ultrasonic array unit is to a second side of said center of said positioning angle opposite to said first side.

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5. An ultrasonic probe assembly according to claim 4 wherein said position control means include first and second cables extending through said flexible coupling in a plane parallel to said plane in which said positioning angle extends:

- (a) said first cable extending from said remote control unit to said array mount and engaging said pivotally connected links at a first side of said center line, and
- (b) said second cable extending from said remote control unit to said array mount and engaging said pivotally connected links at a second side of said center line opposite from said first side of said center line.

6. An ultrasonic probe assembly according to claim 5 wherein said array mount includes a right-angle elbow to which said first and said second cables, said second pivotally connected link and said flexible tube all are attached.

7. An ultrasonic probe assembly according to claim 6 wherein said remote control unit includes:

- (a) a rotatably mounted pulley to which said first and said second cables are connected, and

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(b) a knob connected to said pulley to control the position of said pulley.

8. An endoscope comprising:

an ultrasonic array unit including an ultrasonic array for scanning in a scan plane and an array mount upon which said ultrasonic array is mounted, said ultrasonic array unit movable through a positioning angle extending in a plane perpendicular to said scan plane to change the disposition of said scan plane;

a base unit;

a flexible coupling extending between said base unit and said ultrasonic array unit;

a flexible tube extending between said base unit and said ultrasonic array unit and within which said flexible coupling extends;

a remote control unit for selecting an angular position of said ultrasonic array unit corresponding to a selected disposition of said scan plane of said ultrasonic array;

position control means extending from said remote control unit through said base unit and said flexible tube to said ultrasonic array unit and responsive to said remote control unit for moving said ultrasonic array unit to said selected angular position;

and means for connecting said remote control unit to signal processing and imaging equipment.

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9. An endoscope according to claim 8 wherein said flexible coupling includes a plurality of pivotally connected links which pivot relative to one another about axes disposed perpendicular to said plane in which said positioning angle extends.

10. An endoscope according to claim 9 wherein a first of said pivotally connected links at a first end of said flexible coupling is rigidly attached to said base unit and a second of said pivotally connected links at a second end of said flexible coupling is rigidly attached to said ultrasonic array unit.

11. An endoscope according to claim 10 wherein said pivot axes of said pivotally connected links are disposed along a center line which is:

- (a) straight when said ultrasonic array unit is at the center of said positioning angle,
- (b) curved in a first direction when said ultrasonic array unit is to a first side of said center of said positioning angle, and
- (c) curved in a second direction opposite to said first direction when said ultrasonic array unit is to a second side of said center of said positioning angle opposite to said first side.

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12. An endoscope according to claim 11 wherein said position control means include first and second cables extending through said flexible coupling in a plane parallel to said plane in which said positioning angle extends:

- (a) said first cable extending from said remote control unit to said array mount and engaging said pivotally connected links at a first side of said center line, and
- (b) said second cable extending from said remote control unit to said array mount and engaging said pivotally connected links at a second side of said center line opposite from said first side of said center line.

13. An endoscope according to claim 12 wherein said array mount includes a right-angle elbow to which said first and said second cables, said second pivotally connected link and said flexible tube all are attached.

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14. An endoscope according to claim 13 wherein said remote control unit includes:

- (a) a rotatably mounted pulley to which said first and said second cables are connected, and
- (b) a knob connected to said pulley to control the position of said pulley.

15. An ultrasonic probe assembly comprising:

ultrasonic transducer means for scanning in a scan plane and movable through a positioning angle extending in a plane perpendicular to said scan plane to change the disposition of said scan plane;

a base unit;

a flexible coupling extending between said base unit and said ultrasonic transducer means;

a flexible tube extending between said base unit and said ultrasonic transducer means and within which said flexible coupling extends;

a remote control unit for selecting an angular position of said ultrasonic transducer means corresponding to a selected disposition of said scan plane;

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and position control means extending from said remote control unit through said base unit and said flexible tube to said ultrasonic transducer means and responsive to said remote control unit for moving said ultrasonic transducer means to said selected angular position.

16. An ultrasonic probe assembly according to claim 15 wherein said flexible coupling includes a plurality of pivotally connected links which pivot relative to one another about axes disposed perpendicular to said plane in which said positioning angle extends.

17. An ultrasonic probe assembly according to claim 16 wherein said pivot axes of said pivotally connected links are disposed along a center line which is:

- (a) straight when said ultrasonic array unit is at the center of said positioning angle,
- (b) curved in a first direction when said ultrasonic array unit is to a first side of said center of said positioning angle, and
- (c) curved in a second direction opposite to said first direction when said ultrasonic array unit is to a second side of said center of said positioning angle opposite to said first side.

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18. An ultrasonic probe assembly according to claim 17 wherein said position control means include first and second cables extending through said flexible coupling in a plane parallel to said plane in which said positioning angle extends:

- (a) said first cable extending from said remote control unit to said array mount and engaging said pivotally connected links at a first side of said center line, and
- (b) said second cable extending from said remote control unit to said array mount and engaging said pivotally connected links at a second side of said center line opposite from said first side of said center line.

19. An ultrasonic probe assembly according to claim 5 wherein said position control means further include first and second cable jackets within which said first and said second cables, respectively, are slidable and said first and said second cable jackets extend between said base unit and said remote control unit.

20. An ultrasonic probe assembly according to claim 17 wherein said position control means further include first and second cable jackets within which said first and said second cables, respectively, are slidable and said first and said second cable jackets extend between said base unit and said remote control unit.

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21. An ultrasonic probe assembly comprising:

ultrasonic transducer means for forming and scanning an ultrasound beam and movable through a positioning angle extending in a plane perpendicular to the scanning of said ultrasound beam to change the disposition of the scanning of said ultrasound beam;

a base unit;

a flexible coupling extending between said base unit and said ultrasonic transducer means;

a flexible tube extending between said base unit and said ultrasonic transducer means and within which said flexible coupling extends;

a remote control unit for selecting an angular position of said ultrasonic transducer means corresponding to a selected disposition of the scanning of said ultrasound beam;

and position control means extending from said remote control unit through said base unit and said flexible tube to said ultrasonic transducer means and responsive to said remote control unit for moving said ultrasonic transducer means to said selected angular position.

AMENDED CLAIMS

[received by the International Bureau on 23 September 1992 (23.09.92); original claims 1,8,15,21 amended; new claims 22-24 added; remaining claims unchanged (10 pages)]

1. (Amended) An ultrasonic probe assembly comprising:

an ultrasonic array unit including an ultrasonic array for scanning in a scan plane and an array mount upon which said ultrasonic array is mounted, said ultrasonic array unit movable through a positioning angle extending in a plane perpendicular to said scan plane to change the disposition of said scan plane;

a base unit;

a flexible coupling extending between said base unit and said ultrasonic array unit;

a flexible tube extending between said base unit and said ultrasonic array unit and within which said flexible coupling extends;

a remote control unit for selecting an angular position of said ultrasonic array unit corresponding to a selected disposition of said scan plane of said ultrasonic array;

and position control means, including flexible connecting means, extending from said remote control unit through said base unit and said flexible tube to said ultrasonic array unit and responsive to said remote control unit for moving said ultrasonic array unit to said selected angular position, said flexible connecting means having a length which permits positioning said base unit and said ultrasonic array unit within a body cavity of a patient while said remote control unit remains outside the body of the patient.

(b) a knob connected to said pulley to control the position of said pulley.

8. (Amended) An endoscope comprising:

an ultrasonic array unit including an ultrasonic array for scanning in a scan plane and an array mount upon which said ultrasonic array is mounted, said ultrasonic array unit movable through a positioning angle extending in a plane perpendicular to said scan plane to change the disposition of said scan plane;

a base unit;

a flexible coupling extending between said base unit and said ultrasonic array unit;

a flexible tube extending between said base unit and said ultrasonic array unit and within which said flexible coupling extends;

a remote control for selecting an angular position of said ultrasonic array unit corresponding to a selected disposition of said scan plane of said ultrasonic array;

position control means, including flexible connecting means, extending from said remote control unit through said base unit and said flexible tube to said ultrasonic array unit and responsive to said remote control unit for moving said ultrasonic array unit to said selected angular position, said flexible connecting means having a length which permits positioning said base unit and said ultrasonic array unit within a body cavity of a patient while said remote control unit remains outside the body of the patient;

and means for connecting said remote control unit to signal processing and imaging equipment.

14. An endoscope according to claim 13 wherein said remote control unit includes:

- (a) a rotatably mounted pulley to which said first and said second cables are connected, and
- (b) a knob connected to said pulley to control the position of said pulley.

15. (Amended) An ultrasonic probe assembly comprising:

ultrasonic transducer means for scanning in a scan plane and movable through a positioning angle extending in a plane perpendicular to said scan plane to change the disposition of said scan plane;

a base unit;

a flexible coupling extending between said base unit and said ultrasonic transducer means;

a flexible tube extending between said base unit and said ultrasonic transducer means and within which said flexible coupling extends;

a remote control for selecting an angular position of said ultrasonic transducer means corresponding to a selected disposition of said scan plane;

and position control means, including flexible connecting means, extending from said remote control unit through said base unit and said flexible tube to said ultrasonic transducer means and responsive to said remote control unit for moving said ultrasonic transducer means to said selected angular position, said flexible connecting means having a length which permits positioning said base unit and said ultrasonic array unit

within a body cavity of a patient while said remote control unit remains outside the body of the patient.

16. An ultrasonic probe assembly according to claim 15 wherein said flexible coupling includes a plurality of pivotally connected links which pivot relative to one another about axes disposed perpendicular to said plane in which said positioning angle extends.

17. An ultrasonic probe assembly according to claim 16 wherein said pivot axes of said pivotally connected links are disposed along a center line which is:

- (a) straight when said ultrasonic array unit is at the center of said positioning angle,
- (b) curved in a first direction when said ultrasonic array unit is to a first side of said center of said positioning angle, and
- (c) curved in a second direction opposite to said first direction when said ultrasonic array unit is to a second side of said center of said positioning angle opposite to said first side.

21. (Amended) An ultrasonic probe assembly comprising:

ultrasonic transducer means for forming and scanning an ultrasound beam and movable through a positioning angle extending in a plane perpendicular to the scanning of said ultrasound beam to change the disposition of the scanning of said ultrasound beam;

a base unit;

a flexible coupling extending between said base unit and said ultrasonic transducer means;

a flexible tube extending between said base unit and said ultrasonic transducer means and within which said flexible coupling extends;

a remote control unit for selecting an angular position of said ultrasonic transducer means corresponding to a selected disposition of the scanning of said ultrasound beam;

and position control means, including flexible connecting means, extending from said remote control unit through said base unit and said flexible tube to said ultrasonic transducer means and responsive to said remote control unit for moving said ultrasonic transducer means to said selected angular position, said flexible connecting means having a length which permits positioning said base unit and said ultrasonic array unit within a body cavity of a patient while said remote control unit remains outside the body of the patient.

22. (Newly added) An ultrasonic probe assembly comprising:

a base unit;

an ultrasonic array unit including an ultrasonic array for scanning in a scan plane and an array mount upon which said ultrasonic array is mounted;

means for mounting said ultrasonic array unit to said base unit with said ultrasonic array external to said base unit for movement of said ultrasonic array unit through a positioning angle extending in a plane perpendicular to said scan plane of said ultrasonic array to change the disposition of said scan plane;

a remote control unit for selecting an angular position of said ultrasonic array unit corresponding to a selected disposition of said scan plane of said ultrasonic array;

and position control means, including flexible connecting means, extending from said remote control unit through said base unit to said ultrasonic array unit and responsive to said remote control unit for moving said ultrasonic array unit to said selected angular position, said flexible connecting means having a length which permits positioning said base unit and said ultrasonic array unit within a body cavity of a patient while said remote control unit remains outside the body of the patient.

23. (Newly added) An ultrasonic probe assembly according to claim 22 wherein said mounting means include:

- (a) a flexible coupling extending between said base unit and said ultrasonic array unit, and
- (b) a flexible tube extending between said base unit and said ultrasonic array unit and within which said flexible coupling extends.

24. (Newly added) An endoscope comprising:

a base unit;

an ultrasonic array unit including an ultrasonic array for scanning in a scan plane and an array mount upon which said ultrasonic array is mounted;

means for mounting said ultrasonic array unit to said base unit with said ultrasonic array external to said base unit for movement of said ultrasonic array unit through a positioning angle extending in a plane perpendicular to said scan plane of said ultrasonic array to change the disposition of said scan plane;

a remote control unit for selecting an angular position of said ultrasonic array unit corresponding to a selected disposition of said scan plane of said ultrasonic array;

position control means, including flexible connecting means, extending from said remote control unit through said base unit to said ultrasonic array unit and responsive to said remote control unit for moving said ultrasonic array unit to said selected angular position, said flexible connecting means having a length which permits positioning said base unit and said ultrasonic

array unit within a body cavity of a patient while said remote control unit remains outside the body of the patient;

and means for connecting said remote control unit to signal processing and imaging equipment.

25. (Newly added) An endoscope according to claim 24 wherein said mounting means include:

- (a) a flexible coupling extending between said base unit and said ultrasonic array unit, and
- (b) a flexible tube extending between said base unit and said ultrasonic array unit and within which said flexible coupling extends.

26. (Newly added) An ultrasonic probe assembly comprising:

ultrasonic transducer means for scanning in a scan plane;

a base unit;

means for mounting said ultrasonic transducer means to said base unit with said ultrasonic transducer means external to said base unit for movement of said ultrasonic transducer means through a positioning angle extending in a plane perpendicular to said scan plane to change the disposition of said scan plane;

a remote control unit for selecting an angular position of said ultrasonic transducer means corresponding to a selected disposition of said scan plane;

and position control means, including flexible connecting means, extending from said remote control unit through said base unit to said ultrasonic transducer means and responsive to said remote control unit for moving said ultrasonic transducer means to said selected angular position, said flexible connecting means having a length which permits positioning said base unit and said ultrasonic array unit within a body cavity of a patient while said remote control unit remains outside the body of the patient.

27. (Newly added) An ultrasonic probe assembly according to claim 26 wherein said mounting means include:

- (a) a flexible coupling extending between said base unit and said ultrasonic transducer means, and
- (b) a flexible tube extending between said base unit and said ultrasonic transducer means and within which said flexible coupling extends.

28. (Newly added) An ultrasonic probe assembly according to claim 1 wherein said ultrasonic array is mounted on said array mount at an edge of said ultrasonic array remote from said base unit.

29. (Newly added) An endoscope according to claim 8 wherein said ultrasonic array is mounted on said array mount at an edge of said ultrasonic array remote from said base unit.

30. (Newly added) An ultrasonic probe assembly according to claim 23 wherein said ultrasonic array is mounted on said array mount at an edge of said ultrasonic array remote from said base unit.

31. (Newly added) An endoscope according to claim 25 wherein said ultrasonic array is mounted on said array mount at an edge of said ultrasonic array remote from said base unit.

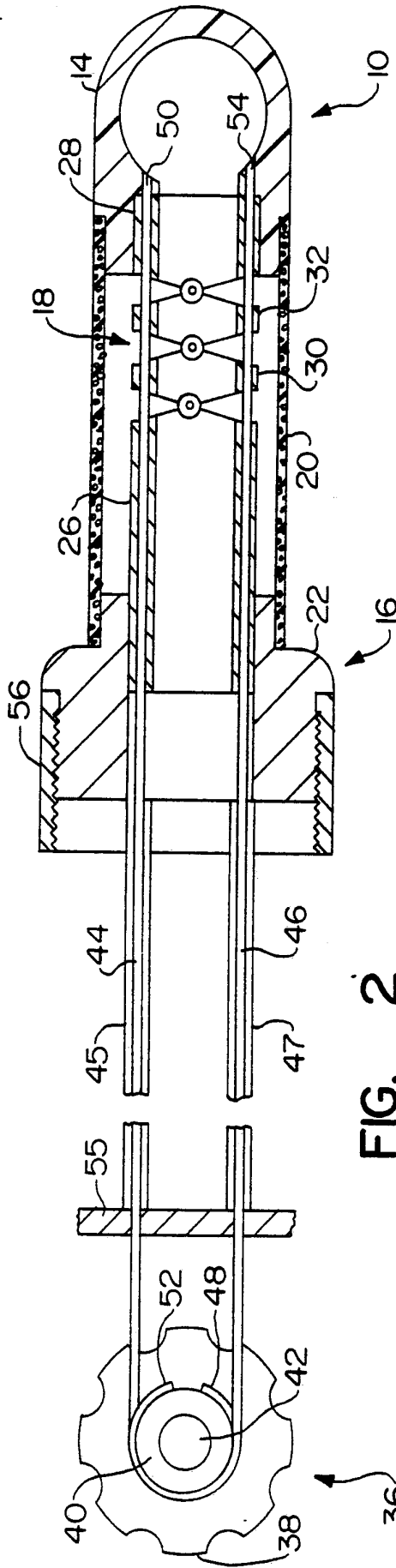


FIG. 2

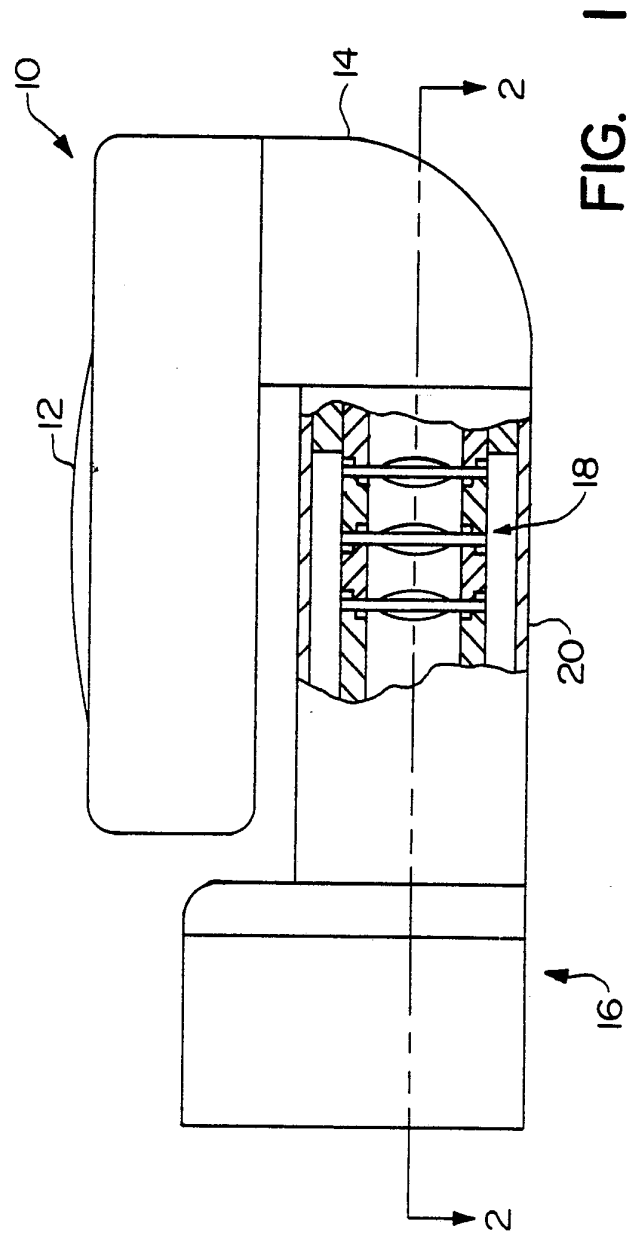


FIG. 1

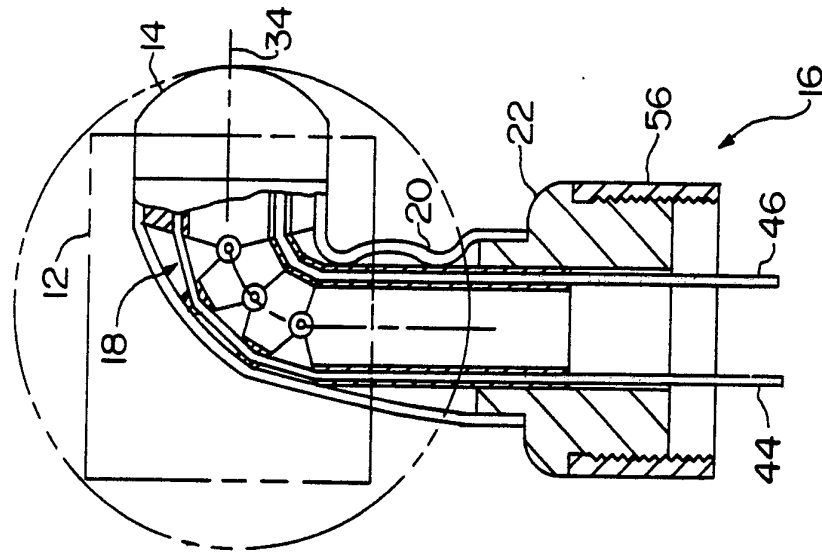


FIG. 5

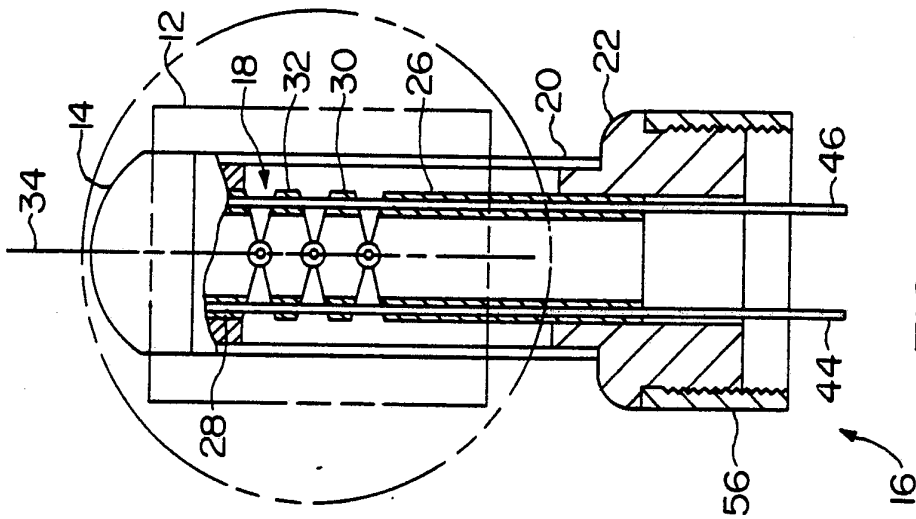


FIG. 4

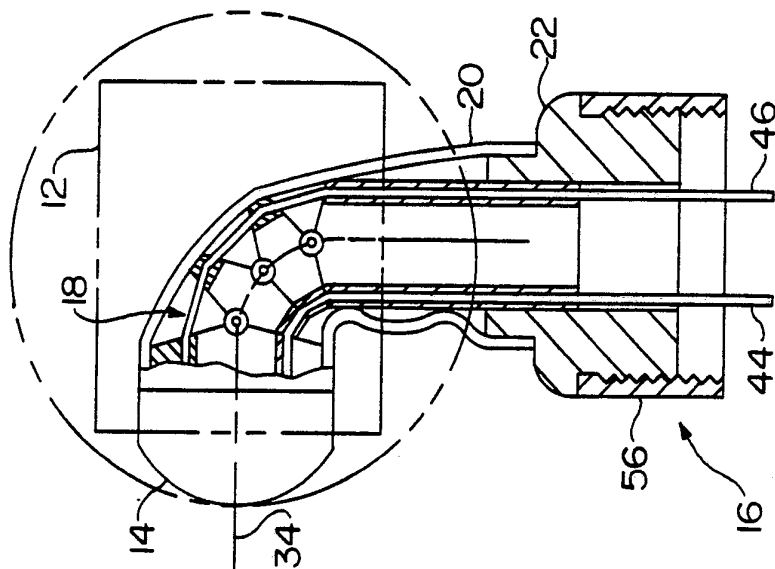


FIG. 3

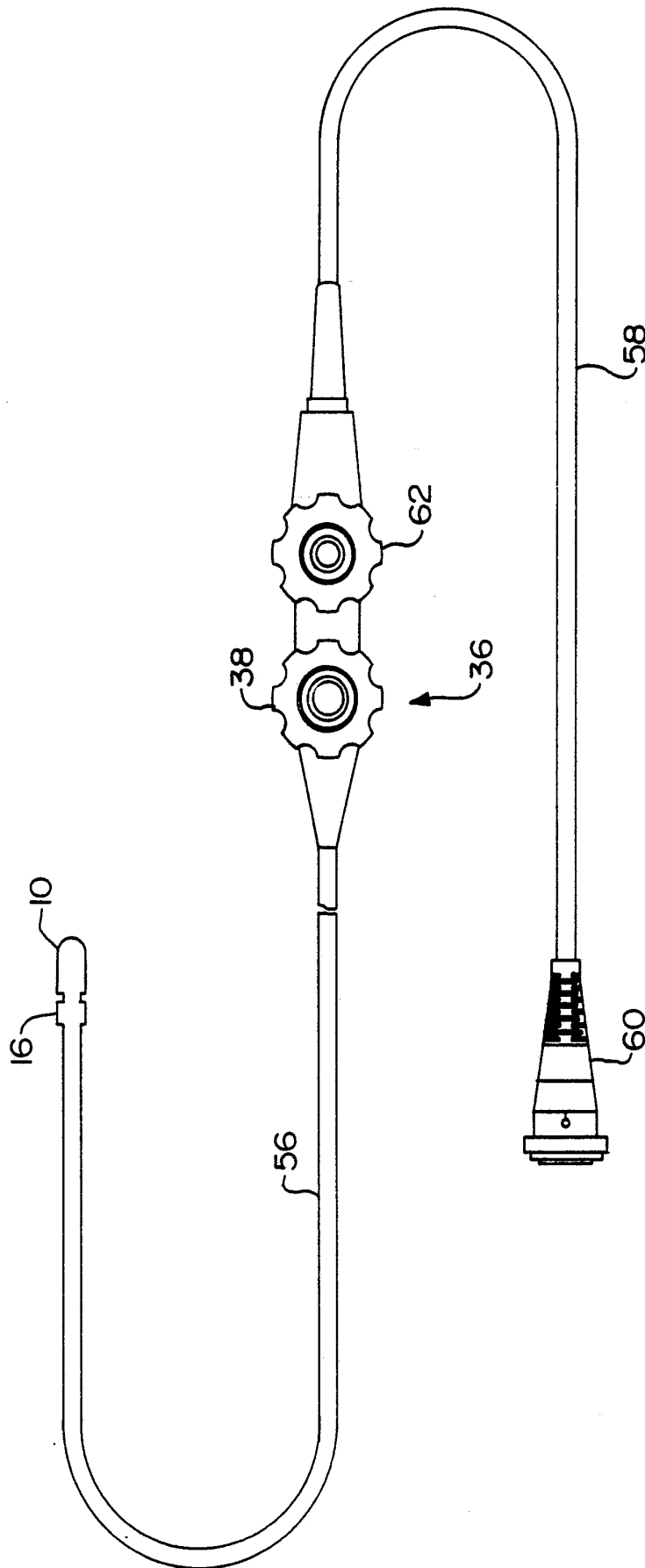



FIG. 6

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US 92/03255

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl. 5 A61B8/12; A61B1/00		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int. Cl. 5	A61B	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	WO,A,9 002 520 (KONTRON ELEKTRONIK) 22 March 1990	1-5,7-12
X	see page 2, line 24 - page 3, line 33 see page 9, line 9 - page 11, line 21 see page 14, line 24 - page 15, line 28 ---	14-21
X	ULTRASOUND IN MEDICINE AND BIOLOGY vol. 12, no. 12, December 1986, PERGAMON JOURNALS, LTD. (US) pages 965 - 975; R.W. MARTIN ET AL.: 'An Endoscopic Micromanipulator for Multiplanar Transesophageal Imaging' "Abstract" and "General Design Description" see page 965 - page 967; figures 1-3 "General Design Description" see page 966 - page 967 --- -/--	1,5,8,9, 12,14, 15,18,21
<p>¹⁰ Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
28 JULY 1992	11. 08. 92	
International Searching Authority EUROPEAN PATENT OFFICE	Signature of Authorized Officer RIEB K.D. 	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category ^a	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	US,A,4 834 102 (J. SCHWARZSCHILD ET AL.) 30 May 1989	1-5,7-12
A	see column 4, line 18 - line 45; figures 1,2 see column 6, line 57 - column 7, line 18 see column 10, line 25 - line 47 ---	14-18,21
P,X	US,A,5 050 610 (F.B. OAKS ET AL.) 24 September 1991	1-5,7-12
P,X	see column 2, line 53 - column 3, line 20 ---	14-18,21

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. US 9203255
SA 60274**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 28/07/92

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A-9002520	22-03-90	DE-A- 3829603	15-03-90
		EP-A- 0433306	26-06-91
		US-A- 5105819	21-04-92
US-A-4834102	30-05-89	US-A- 4977898	18-12-90
US-A-5050610	24-09-91	EP-A- 0486270	20-05-92