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**(54) Ultrasonic probe for use in
ultrasonography**

(57) An ultrasonic probe for use in ultrasonography has a support 1 including a front end to be held against a human body, and a flat array of rectangular ultrasonic transducer elements 2 mounted on the front end. The support has a central groove 11 for guiding a puncture needle 10 used in biopsy. One or more ultrasonic transducer elements 20 adjacent the base of the groove 11 provide an image in a B-scan mode of a vertical line clear enough to enable the needle to be guided and a clear image of the needle end.

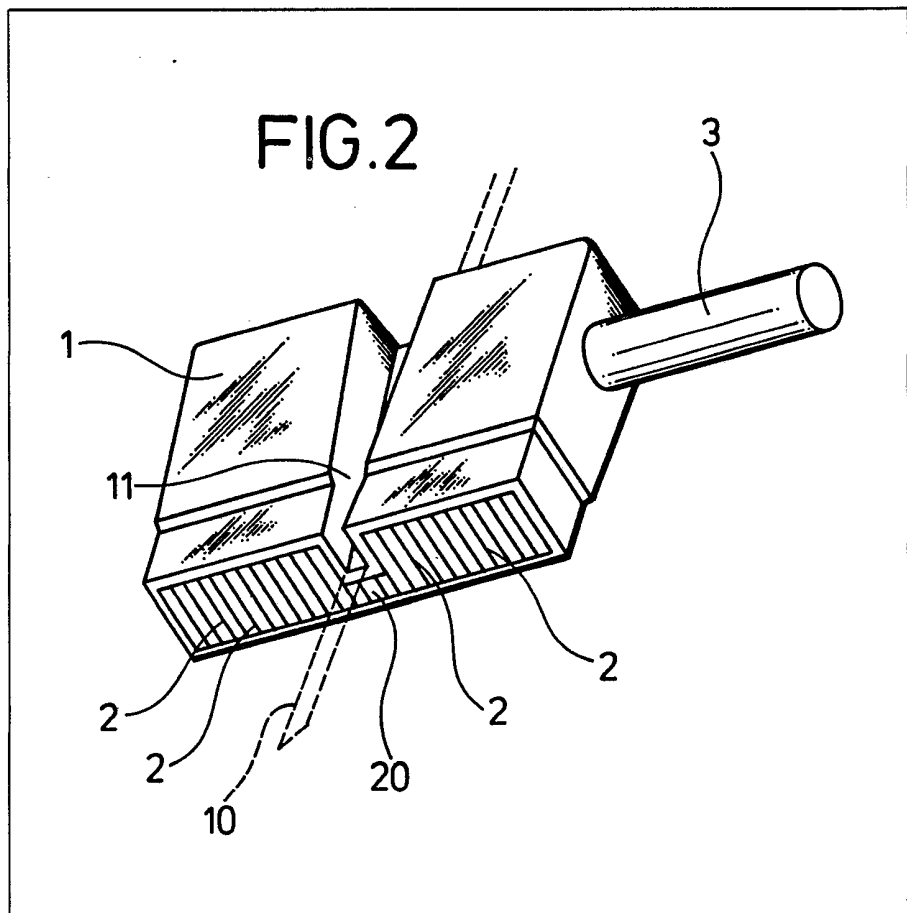


FIG.1

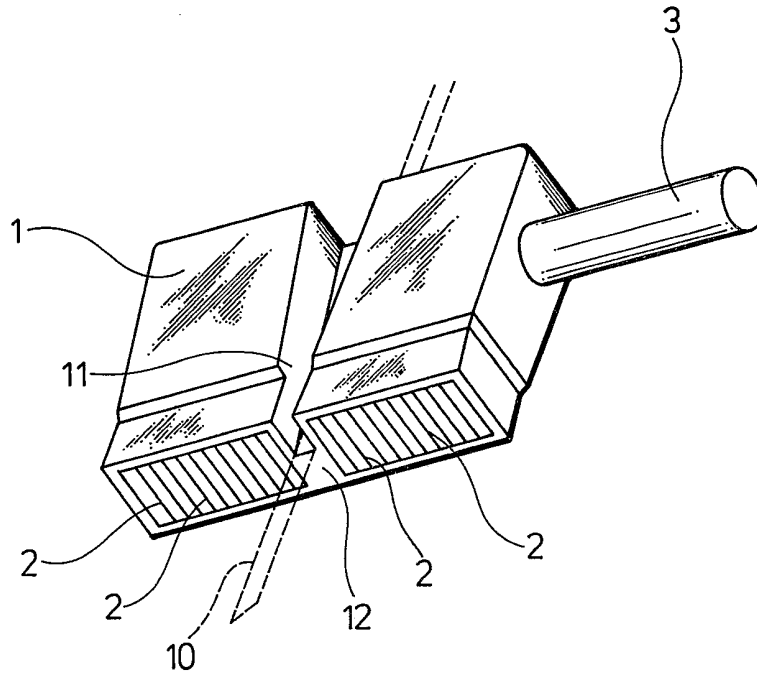
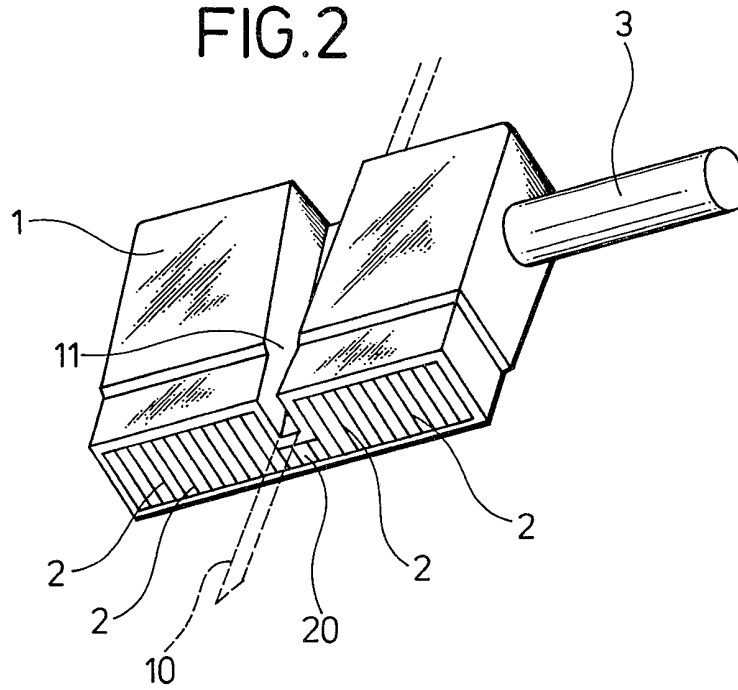


FIG.2



SPECIFICATION

Ultrasonic probe for use in ultrasonography

5 The present invention relates to an ultrasonic probe for use in biopsy, for example, in which a desired region of a body is penetrated with a puncture needle while an organ to be examined is being monitored by ultrasonography.

10 A conventional ultrasonic probe for use with a puncture needle has two separated arrays of ultrasonic transducers with a blank portion therebetween which is incapable of transmitting or receiving ultrasonic waves. Such a
15 blank portion causes a vertical blank line to appear centrally on a sectional image displayed on a screen during a B-scan mode, making the displayed image of the puncture needle, especially its pointed end, less clear
20 on the screen. Thus, the prior ultrasonic probe has a tendency to result in inaccurate biopsy.

It is an object of the present invention to provide an ultrasonic probe for use with a puncture needle in ultrasonography, which
25 ultrasonic probe is simple in construction and is capable of generating both the image of a vertical line serving as a guide for allowing the puncture needle to penetrate a body region at a desired position and the clear image
30 of the pointed end of the puncture needle.

According to the present invention, an ultrasonic probe for use with a puncture needle in ultrasonography comprises a support having an end and a groove defined in a side thereof
35 and extending from said end for guiding the puncture needle, said groove opening at said end; and

an array of ultrasonic transducer elements successively mounted flatwise on said end,
40 one or more of said ultrasonic transducer elements being located adjacent to the base of said groove opening at said end. Thus the one or more of the ultrasonic transducer elements located adjacent to the open end of the
45 groove can be arranged to leave substantially no blank portion on the front end of the support.

The above and other objects, features and advantages of an example of the present
50 invention will become more apparent from the following description when taken in conjunction with the accompanying drawings, in which:

Figure 1 is a perspective view of a conventional ultrasonic probe; and

Figure 2 is a perspective view of an ultrasonic probe embodying the present invention.

Fig. 1 illustrates a known ultrasonic probe which comprises a support 1 and two separated arrays of ultrasonic transducer elements 2 for transmitting and receiving ultrasonic waves, the ultrasonic transducer elements 2 being each of a rectangular shape and lying flatwise on and joined to a front end of the
65 support 1. The support 1 has in a side thereof

a central groove 11 for guiding a puncture needle 10 to move therethrough. The groove 11 opens at the front end of the support 1, which will be held against a human body, and 70 diverges or progressively increases in width away from the front end of the support. Thus the groove 11 is defined by wall surfaces extending substantially perpendicularly to the front end of the support 1 for guiding the
75 puncture needle 10 to penetrate a desired region of the human body without the risk of being displaced out of an area in which ultrasonic energy is radiated. The groove 11 is substantially V-shaped, when viewed in side
80 elevation, to permit the puncture needle 10 to be smoothly advanced in a certain range of puncture angles.

The ultrasonic probe 1 is electrically connected by a conductor wire 3 to an ultrasono-
85 graphic diagnosing apparatus (not shown). The conductor wire 3 is also electrically coupled with the ultrasonic transducer elements 2 within the support 1.

For effecting biopsy with the ultrasonic
90 probe, the front end of the support 1 on which the ultrasonic transducer elements 2 are mounted is brought into abutment against a surface of a test body, and the ultrasonic transducer elements 2 are linearly scanned to
95 transmit and receive ultrasonic waves. While an organ to be examined is being thus monitored, the puncture needle 10 is inserted through the guide groove 11 into the test body.

100 The front end of the support 1 has a central blank portion 12 by which the two arrays of ultrasonic transducer elements 2 are separated. Since the blank portion 12 has no ultrasonic transducer elements thereon, it is
105 incapable of transmitting and receiving ultrasonic waves. In a B-scan mode, the central blank portion 12 appears as a vertical blank line centrally on a sectional image displayed on a screen, with the result that the displayed
110 image of the puncture needle, especially its pointed end, is rendered less clear on the screen. Therefore, inaccurate biopsy tends to result from the prior ultrasonic probe.

The present invention will now be described
115 with reference to Fig. 2. An ultrasonic probe according to the present invention differs from that shown in Fig. 1 in that one or more ultrasonic transducer elements 20 are located adjacent to the base of the open end of the
120 guide groove 11. The ultrasonic transducer elements 20 are shorter than the other ultrasonic transducer elements 2, and are capable of transmitting and receiving ultrasonic waves. The ultrasonic transducer elements 20 are
125 positioned in successive relation to the ultrasonic transducer elements 2 so that there is no blank portion on the front end of the support 1.

When the ultrasonic transducer elements 2
130 and 20 are linearly scanned, a central portion

of a displayed sectional image is relatively dark and less clear as the ultrasonic transducer elements 20 are of lower sensitivity than that of the ultrasonic transducer elements

2. However, an echo image of the pointed end of the puncture needle 10 can be displayed more clearly than when the conventional ultrasonic probe is used to display the puncture needle 10. With the ultrasonic probe according to the present invention, the central vertical black line on the screen can be lightened sufficiently, but remains effective as a marking or guide for positioning the puncture needle 10 upon puncture. Such a lightened central vertical line allows a portion of the sectional image to be displayed thereon.

The ultrasonic transducer elements 20 may be of a different width than the width of the other ultrasonic transducer elements 2. A receiver circuit for the ultrasonic transducer elements 20 may be adjusted in gain such that all of the ultrasonic transducer elements 2 and 20 will be of the same sensitivity for ultrasonographic diagnosis. The gain of such a receiver circuit may also be changed dependent on whether the puncture needle 10 is to be inserted or not.

With the ultrasonic probe shown in Fig. 2, one or more less sensitive ultrasonic transducer elements are located adjacent to the central needle guide groove, so that an array of uninterrupted ultrasonic transducer elements is mounted on the front end of the support. This arrangement allows the pointed end of the puncture needle to be displayed as a clearer echo image than when the prior ultrasonic transducer probe is employed. A central vertical line remains on a displayed image with a sufficient darkness to serve as a visual guide to position the puncture needle, but to fail to obscure the image on the vertical line. Accordingly, the ultrasonic probe of the present invention is of great practical advantage in that it can effect accurate biopsy.

Although a certain preferred embodiment has been shown and described, it should be understood that many changes and modifications may be made therein without departing from the scope of the appended claims.

CLAIMS

1. An ultrasonic probe for use with a puncture needle in ultrasonography, comprising:

a support having an end and a groove defined in a side thereof and extending from said end for guiding the puncture needle, said groove opening at said end; and

an array of ultrasonic transducer elements successively mounted flatwise on said end, one or more of said ultrasonic transducer elements being located adjacent to the base of said groove opening at said end.

2. An ultrasonic probe according to Claim

1, wherein said groove diverges as a V-shaped configuration away from said end and has a constant depth.

3. An ultrasonic probe according to claim 1 or Claim 2, wherein said one or more of said ultrasonic transducer elements are equal in width to other ultrasonic transducer elements, and different therefrom in length in a direction normal to the direction in which said array of ultrasonic transducer elements is arranged.

4. An ultrasonic probe substantially as hereinbefore described with reference to Fig. 2 of the accompanying drawings.

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