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Rosauer et al.

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[54] **ULTRASONIC DOPPLER DEVICE**

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[52] **U.S. Cl.** .....**340/1 R**, 179/179, 340/3 D, 340/8 S

[51] **Int. Cl.** **G01s 9/66**

[58] **Field of Search** .....340/1 R, 3 D, 3 R, 340/5 A, 5 T, 8 R, 8 S; 181/0.5 T; 179/179, 180

[56] **References Cited**

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[57] **ABSTRACT**

Portable self-contained ultrasonic doppler device including transmitting and receiving transducer means carried by a support structure, speaker means and electronic doppler circuitry connected to the transducer means and the speaker means, all mounted in a common housing. Attenuation means are provided between the housing and the speaker means and the support structure for attenuating transmission of audio frequency waves from the speaker to the transducer means and to minimize feedback effects.

7 Claims, 4 Drawing Figures

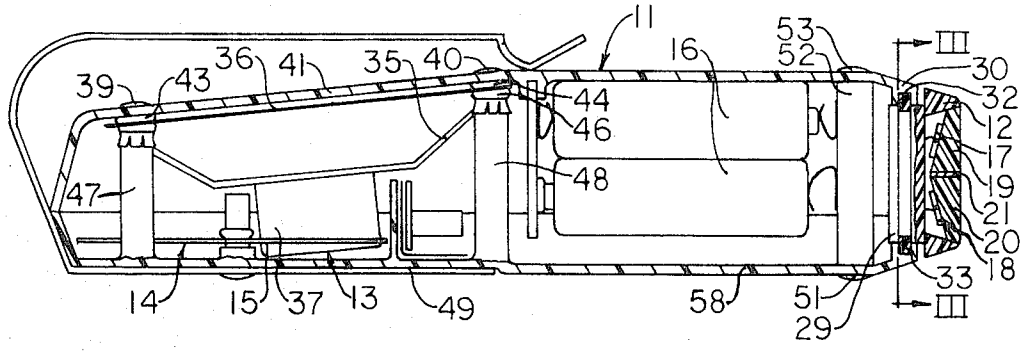


FIG 1

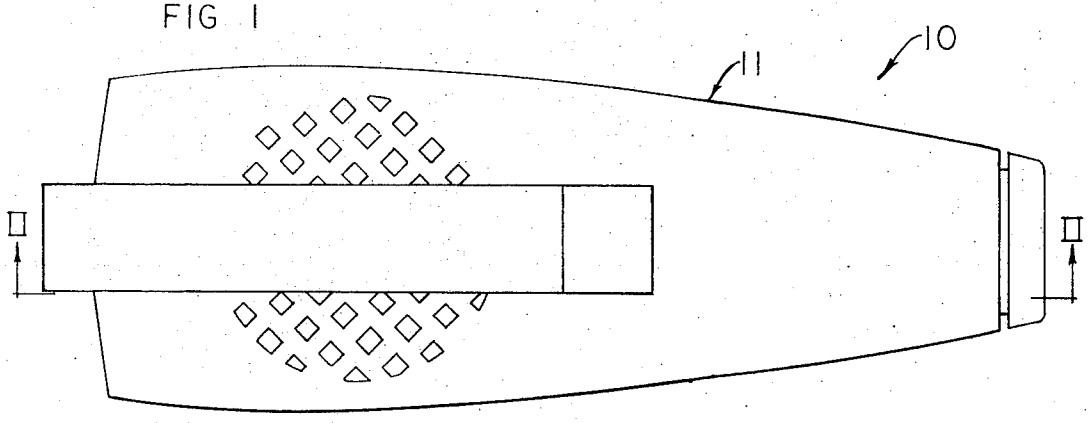


FIG 2

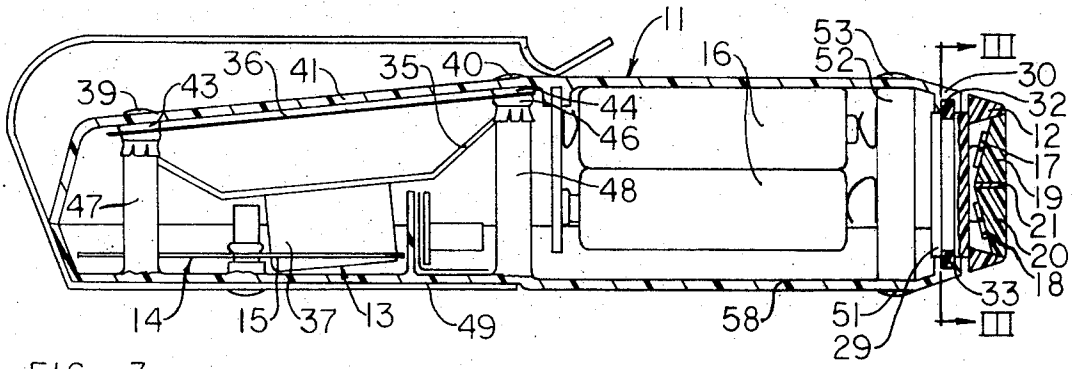
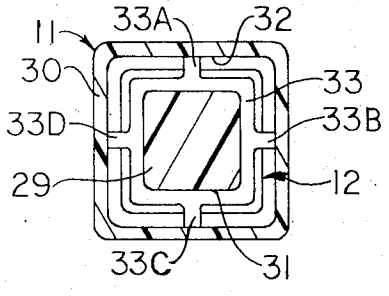


FIG 3



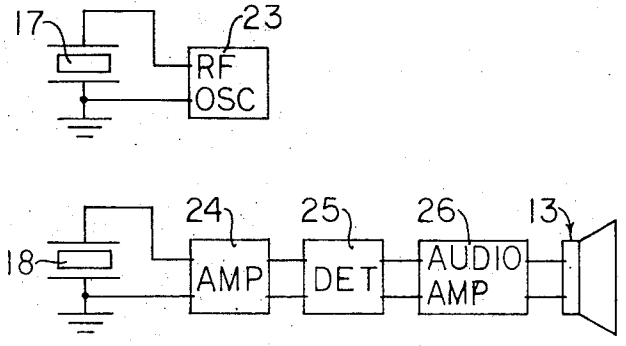


FIG 4

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ULTRASONIC DOPPLER DEVICE

This invention relates to an ultrasonic doppler device and more particularly to a portable self-contained doppler device for medical applications, designed for engagement with a living body to produce audible sound waves corresponding to blood flow and other movements within the body.

Ultrasonic instruments have heretofore been provided for transmitting ultrasonic energy into a body and receiving reflected energy which is frequency-shifted, due to movement of a reflecting surface within the body, according to the Doppler principle. In general, such instruments have included a probe unit connected by means of a cable to an indicating and energizing unit including a speaker. In operation, the probe is placed against a body to be examined and the speaker produces a whishing sound in response to flowing blood or throbbing sounds in response to pulsations of blood vessels or movement of other interfaces within the body.

This invention was evolved with the general object of providing a portable self-contained device in which the ultrasonic transducer means, electronic circuitry and speaker are all mounted in a small portable housing which may be held in the hand to contact the body and to produce the audible sounds.

An important aspect of the invention is in the discovery that in attempting to support the ultrasonic transducer means and the speaker means on a common relatively small housing, feedback oscillations are produced. This is contrary to what might be expected because the ultrasonic waves are transmitted and received at relatively high frequencies, on the order of 2.5 MHz, by way of example, whereas the speaker produces vibrations in the audible range and it would not be expected that any feedback problem would be encountered. It is found, however, that there is a serious feedback problem and although the exact reasons for the problem are not known with certainty, it has been further found that by attenuating the transmission of audio frequency sounds from the speaker to the transducer means, the feedback oscillations can be minimized.

In accordance with an important feature of the invention, the ultrasonic transducer means are carried by a support structure separate from the housing and attenuation means are provided between the transducer support structure and the housing. In a preferred embodiment, the transducer support structure has an outwardly facing annular groove and an open end portion of the housing as an inwardly facing annular groove with a damping member being seated in the outwardly facing annular groove and extending into the inwardly facing annular groove. Most preferrably, the damping member is of medium density sponge rubber or the equivalent and has a plurality of angularly spaced portions extending into the inwardly facing annular groove of the open end portion of the housing.

Another important feature relates to the provision of attenuation means between the speaker frame and the housing, which may most preferably comprise rubber grommets or the like.

This invention contemplates other objects, features and advantages which will become fully apparent from the following detailed description taken in conjunction with the accompanying drawing which illustrates a preferred embodiment and in which:

FIG. 1 is a top plan view of a ultrasonic doppler device constructed in accordance with the principles of this invention;

FIG. 2 is a cross-sectional view taken substantially along line II—II of FIG. 1;

FIG. 3 is a cross-sectional view taken substantially along line III—III of FIG. 2; and

FIG. 4 is a schematic electrical diagram.

Reference numeral **10** generally designates an ultrasonic doppler device constructed in accordance with the principles of this invention. In general, the device **10** comprises a housing **11**, a transducer support **12** at one end of the housing **11**, a speaker **13** supported within the housing **11** and electronic circuitry **14** which may be supported on a circuit board **15** in the housing **11**. Batteries **16** are disposed within the housing **11** for energizing the electronic circuitry.

A transmitting transducer **17** and a receiving transducer **18** are mounted on the back faces of wedge blocks **19** and **20** which are secured within a cavity in the end face of the support structure **12**. Preferably, the wedge blocks **19** an **20** are acoustically isolated by a layer **21** of attenuating material which may include an epoxy material and which may serve to secure the wedge blocks **19** and **20** together.

In oppration, the outer faces of the wedge blocks **19** and **20** are engaged with the skin of a patient, preferably with a thin layer of a coupling jelly on the surfaces of the blocks **19** and **20** to efficiently couple ultrasonic waves.

As shown in FIG. **4**, the transmitting transducer **17** is energized from a R.F. oscillator **23** which may be operative at 2.5 MHz, by way of example. The receiving transducer **18** is connected to the input of an amplifier **24** having an output connected to a detector **25** which functions to produce audio frequency signals in response to frequency-shifted components of the received signals, such audio frequency signals being amplified by an audio amplifier **26** and being applied to the speaker **13**.

When, for example, the unit is placed in proximity to an artery, a characteristic whishing sound is produced in response to the flowing blood. Also, throbbing sounds may be produced in response to movements of the walls of blood vessels or in response to movements of other interfaces such as from the heart, for example.

In accordance with an important feature of the invention, the support structure, **12** has an inner end portion **29** disposed within an open end portion **30** of the housing **11**, such portions respectively being formed with an outwardly facing annular groove **31** and an inwardly facing annular groove **32**. A damping member **33** is disposed in the groove **31** and extends into the groove **32**. Preferably, the damping member may be formed to provide a plurality of angularly spaced portions **33***a*, **33***b*, **33***c* and **33***d* projecting radially outwardly into the groove **32**, as shown in FIG. **3**. The member **33** is preferably of a medium density sponge rubber or the equivalent. The damping member **33** forms attenuation means which minimizes transmission of audio frequency waves from the housing **11** to the transducer support structure **12** and minimizes feedback effects.

Another important feature is in the provision of attenuation means in the support of the speaker **13** from the housing **11**. The illustrated speaker **13** has a con-

ventional frame **35**, having a peripheral flange **36**. The speaker **35** also includes a conventional cone or diaphragm the periphery of which is supported from the frame **35** and having a cone connected to the central portion thereof and movable in a magnetic air gap, a magnet **37** being supported on the central part of the frame **35**.

For support of the speaker **35**, screws **39** and **40** extend through holes in a top wall **41** of the housing thence through a pair of rubber grommets **43** and **44**, thence through holes in the peripheral flange **36** of the speaker frame **35**, thence through another pair of grommets **45** and **46** and thence into the upper ends of a pair of support posts **47** and **48** which extend upwardly from a lower wall **49** of the housing and which may preferably be integral therewith. The grommets **43–46** serve as attenuation means to minimize transmission of audio frequency waves from the speaker frame to the housing **11**, to further minimize the transmission of the waves to the transducer support structure **12** and to further minimize feedback effects.

It is noted that the top wall **41** and the bottom wall **49** are separate and the screws **39** and **40** serve the additional function of securing the same together. For access to the battery compartment, the lower wall of the housing may be in two parts, the part **49** which underlies the speaker **13** and the circuitry **14** and a part **50** which underlies the batteries **16**. Part **50** of the bottom wall is secured by a screw **51** to one end of a post **52**, the opposite end of post **52** being secured to the top wall **41** by a screw **53**. Thus, by removal of the screw **51**, the bottom wall part **50** may be removed, for access to the battery compartment. Also, it permits access to the damping member **33** for inspection and cleaning or replacement thereof. In tyis connection, it is important that there be no connection from the support structure **12** to the housing **11** other than through the damping member **33** and it is particularly important that there be no fluid therebetween, which would cause transmission of the audio frequency waves.

It will be understood that modifications and variations may be effected without departing from the spirit and scope of the novel concepts of this invention.

We claim as our invention:

1. In an ultrasonic doppler device, transmitting and receiving transducer means for transmitting ultrasonic energy at a high transmission frequency into a body and for producing received signals at high frequencies shifted from said high transmission frequency in response to reflections from moving interfaces within said body, transmitting and receiving circuitry for energizing said transducer means and for amplifying said frequency-shifted received signals, detector circuitry responsive to said amplified received signals to produce a low frequency signal in the audible frequency range, speaker means responsive to said audio frequency signal to develop corresponding audio frequency compressional waves, compact housing means of a solid material enclosing said transmitting and receiving circuitry and said detector circuitry and adapted to be held in one hand for positioning said transducer means against a body, a support structure for said transmitting and receiving transducer means, first support means supporting said support structure from said housing means, and second support means supporting said speaker means in said housing means, at least one of said first and second support means including attenuation means for attenuating transmission of said audio frequency compressional waves from said speaker means through said solid material of said housing means to said support structure to prevent movement of said transducer means in response to said audio frequency compressional waves.

2. In a device as defined in claim **1**, said attenuation means including first attenuation means in said first support means and second attenuation means in said second support means, said second attenuation means being arranged to highly attenuate transmission of said audio frequency compressional waves from said speaker means to said solid material of said housing means and said first attenuation means being arranged to highly attenuate the transmission of any remaining compression waves from said solid material to said transducer means.

3. In a device as defined in claim **1**, said housing means having an open end portion, said support structure including an inner portion disposed within said open end portion of said housing means, and said attenuation means including a damping member disposed between the outer surface of said inner portion of said support structure and an inner surface of said open end portion of said housing means.

4. In a device as defined in claim **3**, said outer surface of said inner portion of said support structure having an outwardly facing annular groove therein, and said inner surface of said open end portion of said housing means having an inwardly facing annular groove therein, said damping member being seated in said outwardly facing annular groove and extending into said inwardly facing annular groove.

5. In a device as defined in claim **4**, said damping member having a plurality of angularly spaced radially extending portions extending into said inwardly facing annular groove.

6. In a device as defined in claim **1**, said attenuation means including a member of medium density sponge rubber or the equivalent.

7. In a device as defined in claim **1**, said speaker including a frame having a peripheral flange portion, and said attenuation means including rubber grommet means supporting said annular flange portion of said speaker frame from said housing means.

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