United States Patent [19]

Baessler et al.

[11] **3,742,935**

[45] **July 3, 1973**

[54] **PALPATION METHODS**

[75] Inventors: **Lee R. Baessler**, Manhattan Beach; **James G. Gerard**, La Palma; **Harvey F. Glassner**, Los Angeles, all of Calif.; **T. James Waters**, Bethesda, Md.

[73] Assignee: **Humetrics Corporation**, Los Angeles, Calif.

[22] Filed: **Jan. 22, 1971**

[21] Appl. No.: **108,720**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 862,653, Oct. 1, 1969, abandoned.

[52] **U.S. Cl.** ..... **128/2 R**, 35/35 R, 128/2 K, 128/2.05 P, 128/2.05 S

[51] **Int. Cl.** **A61b 5/02**, A61b 5/10

[58] **Field of Search** ..... 128/2.05 P, 2.05 S, 128/2.05 R, 2 K, 2 S, 2 Z; 340/407, 384; 179/121 C, 181 F, 107 E, 1 ST, 1 B; 181/31 B; 35/35 A, 35 C

[56] **References Cited**

UNITED STATES PATENTS

1,733,605	10/1929	Jones	340/407
2,058,796	10/1936	Hogle	181/24
2,297,218	9/1942	Henrich et al.	179/181 F
2,582,277	1/1952	Powlison	340/407
3,110,770	11/1963	Howell	128/2.05 S
3,187,832	6/1965	Broadley	181/31.1
3,247,324	4/1966	Cefaly et al.	128/2.05 S X
3,283,181	11/1966	Johanson	128/2.05 S X
3,285,364	11/1966	Cohen	181/31.1
3,378,639	4/1968	Dufendach et al.	179/1 B X
3,453,749	7/1969	Snedeker, Jr.	35/35 C

FOREIGN PATENTS OR APPLICATIONS

921,396	3/1963	Great Britain	128/2.05 S

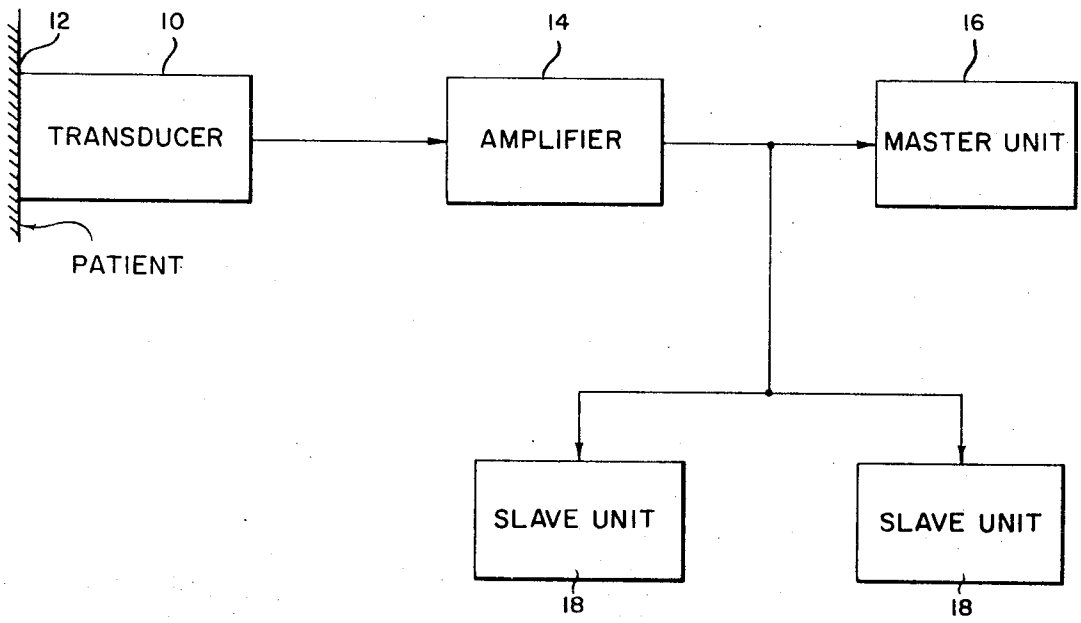
Primary Examiner—Kyle L. Howell

Attorney—Burns, Doane, Swecker & Mathis

[57] **ABSTRACT**

A method for simultaneous palpation by a plurality of individuals in which the physical displacement of a sensor may be amplified and simultaneously reproduced at a plurality of remote locations. The physical displacement signal from a transducer in pressural engagement with the patient's skin is amplified and utilized to drive a palpation platform which is tactually engaged by the physician to aid in the diagnosis. Additional palpation platforms may be slaved to the physician's unit and the slave units utilized for instruction purposes. The palpation platform may include a speaker cone substantially filled with a solid material and covered by a material approximating human skin. The method may take the form of a physician's diagnostic aid, or as a medical teaching aid. Use, including self-instruction, of the equipment for speech therapy is also disclosed.

16 Claims, 5 Drawing Figures

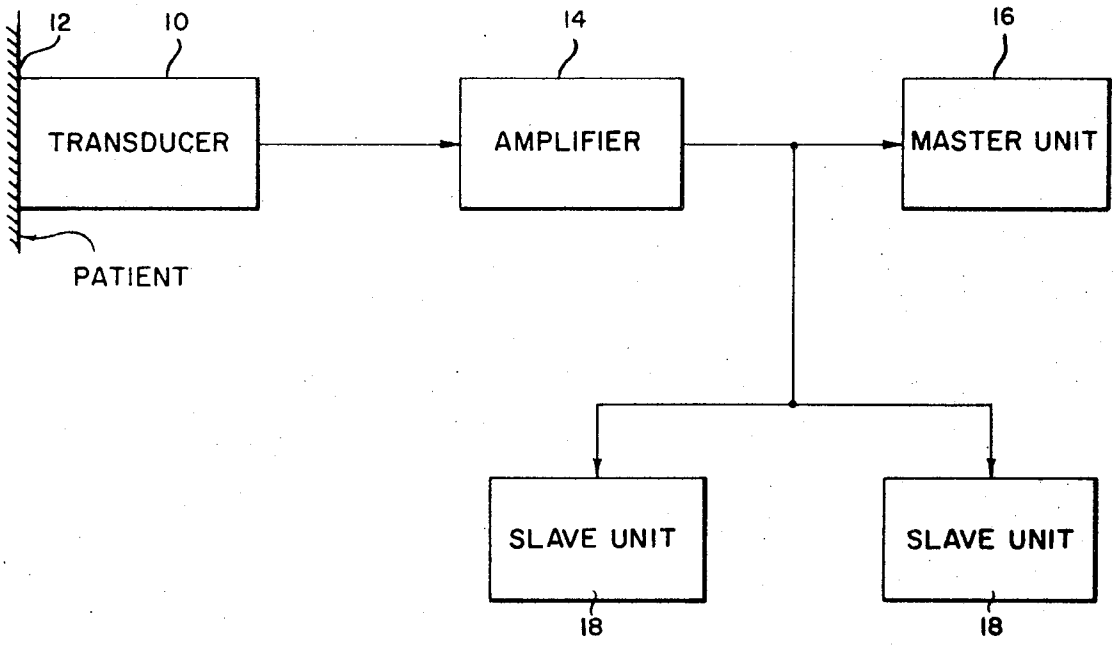


PATENTED JUL 3 1973

3,742,935

SHEET 1 OF 3

Fig. 1



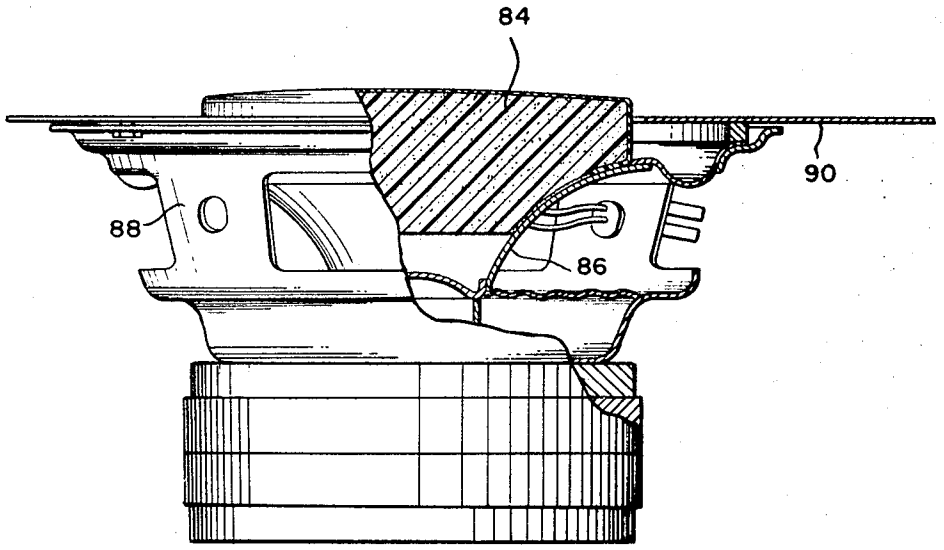


Fig. 3

INVENTORS
LEE R. BAESSLER
JAMES G. GERARD
HARVEY F. GLASSNER
T. JAMES WATERS

Burns, Doane, Swecker & Mathis

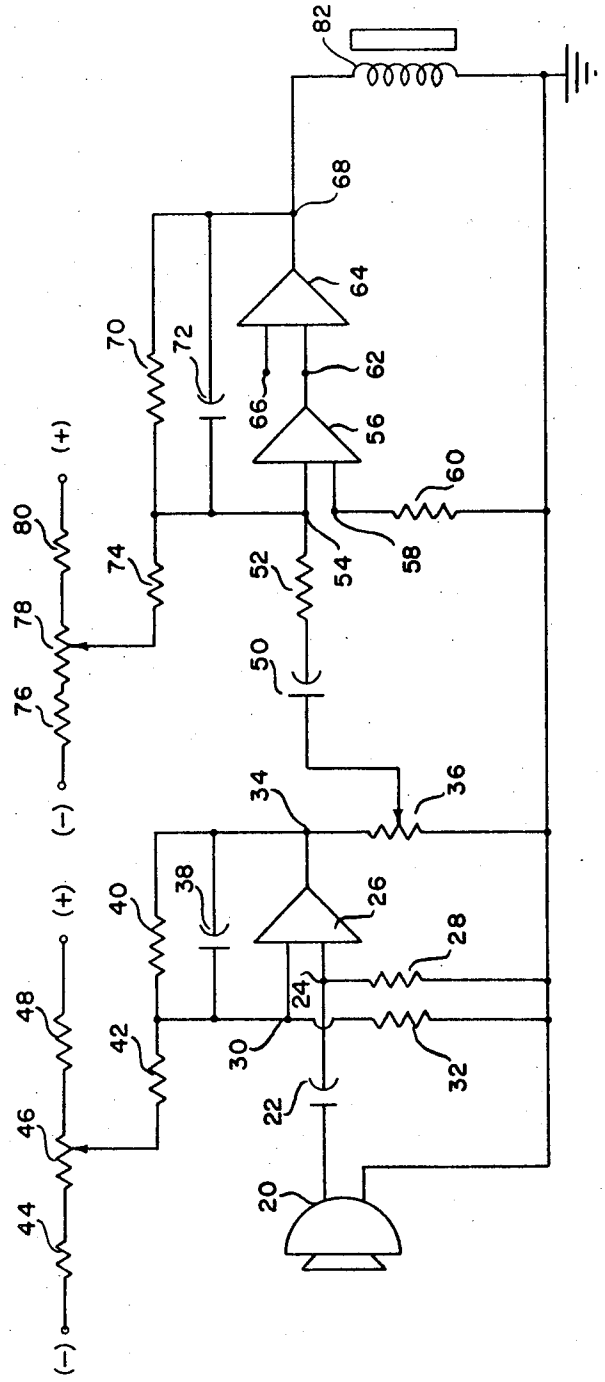

82
68
64
70
72
62
66
56
60
(+)
80
74
52
54
58
78
50
76
(-)
34
36
(+)
40
38
26
28
48
24
42
30
32
46
22
20
44
(-)

Fig. 2

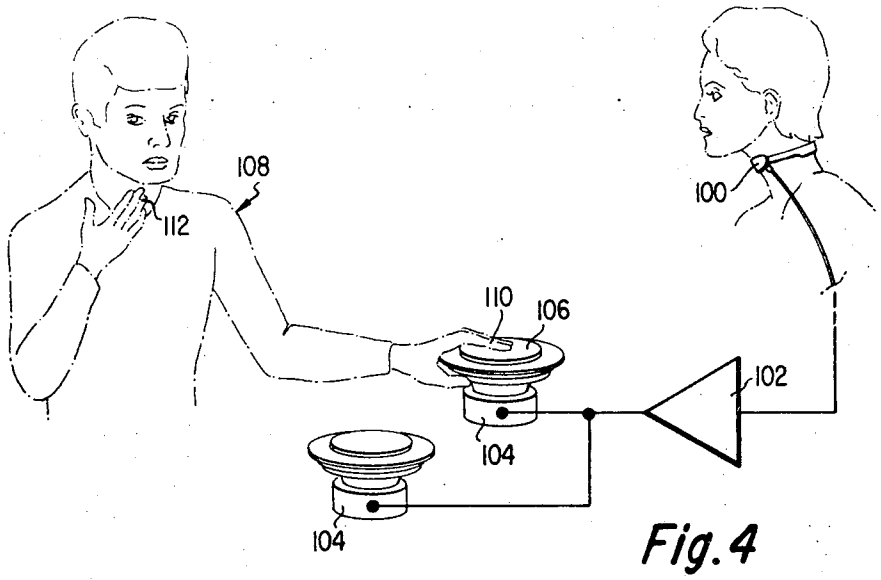

108
112
110
106
100
102
104
104

Fig. 4

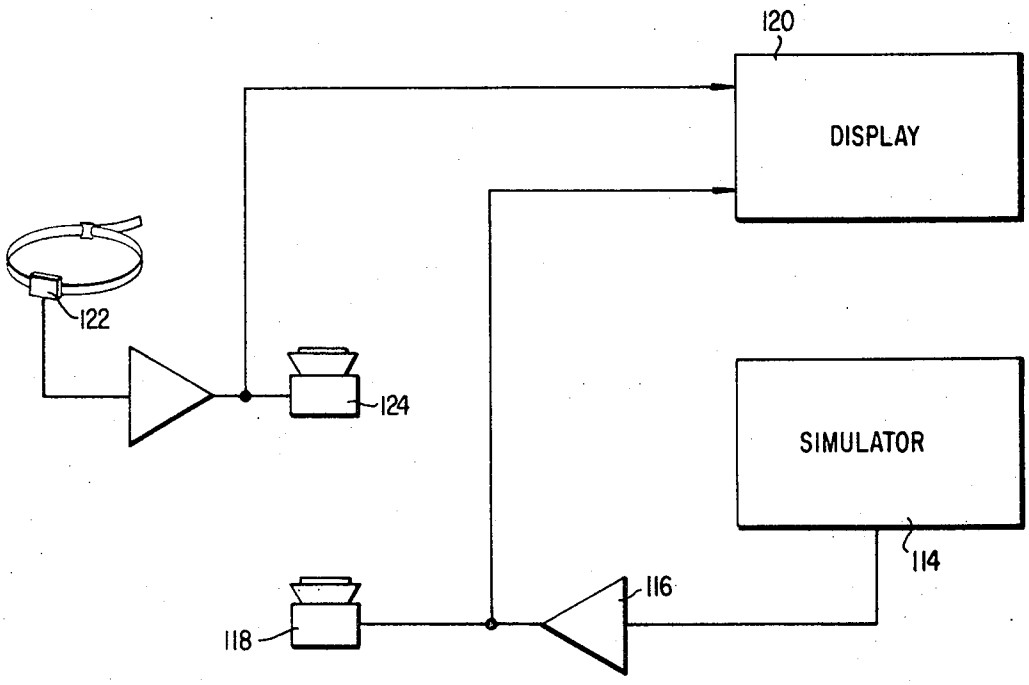

120
DISPLAY
122
124
SIMULATOR
114
116
118

Fig. 5

PALPATION METHODS

RELATED APPLICATIONS

This application is a continuation-in-part application of application Ser. No. 862,653 entitled "Palpation Method and Apparatus," filed Oct. 1, 1969, now abandoned and assigned to the assignee of the present invention.

BACKGROUND OF THE INVENTION

The present invention relates to the art of palpation and more specifically to the method for diagnostic and instructional aid in the art.

Palpation is the application of the hand or fingers to the surface of the body as a means of physically diagnosing the state of the structures beneath the skin. The act of palpation is of great significance, for example, in the determination of the integrity of the cardiovascular system. In such an examination, the pressure phenomenon of blood vessels and vibration or thrills of the precordium, when properly interpreted via palpation, is a significant aid to the physician in his diagnosis.

It is, of course, a physical impossibility for a group of physicians to simultaneously physically examine a specific point on a given patient e.g., neck pulsations and chest vibrations. Since the palpations are by their very nature transitory, it is difficult to determine whether or not the diagnosis of different doctors is based on the same physical stimuli.

This problem of identifying the stimuli upon which a diagnosis is based is particularly acute in teaching the art of palpation to medical students during hospital rounds or at teaching or consultation sessions. While medical students are generally instructed in the art of palpation at these bedside teaching sessions, the instructor may experience difficulty in determining whether or not the student is palpating the desired location on the patient and whether or not the student is palpating with the required finger pressure. In addition, some pulsations are of short duration and small amplitude, thereby increasing the difficulty in determining whether or not the student is, in fact, receiving the physical stimuli.

A further problem in the recognition of pulsations of short duration and/or small amplitude exists in the instruction of patients with hearing defects. It is a practice, for example, in teaching the deaf to speak, for the student to place the fingers of one hand on the throat or cheek of the instructor and the fingers of the other hand in the corresponding location on his own body. The student then attempts to reproduce the tactile sensations produced by the instructor in voicing certain sounds.

It is, accordingly, an object of the present invention to provide a novel palpation method.

It is another object of the present invention to obviate the aforementioned diagnostic difficulties and to provide a method by which a plurality of physicians may simultaneously palpate a given area of the patient.

It is another object of the present invention to provide a novel method by which short duration and small amplitude pressure phenomenon and vibrations may be amplified to increase the facility of detection and evaluation by a physician.

It is still another object of the present invention to provide a novel method by which an instructor may properly position a detector on the patient and monitor the physical stimuli simultaneously received by a plurality of students.

A further object of the present invention is to provide a novel method for teaching speech to people with defective hearing and/or speech impediments.

A still further object of the present invention is to provide a novel method by which a number of persons with defective hearing may simultaneously be taught by a single instructor.

Yet a further object of the present invention is to provide a novel method for self-instruction in speech therapy.

These and other objects and advantages of the present invention will be readily apparent to one skilled in the art to hich the invention pertains from a perusal of the appended claims and the following detailed description when read in conjunction with the appended drawings.

THE DRAWINGS

Reference may now be had to the drawings in which:

FIG. **1** is a block diagram of the present invention as adapted for monitoring the cardiovascular palpation of a patient;

FIG. **2** is a schematic circuit diagram of the block diagram of FIG. **1**;

FIG. **3** is a view in elevation of the master unit of FIG. **1** partially broken away to illustrate the construction of the movable palpation platform;

FIG. **4** is a pictorial view of the present invention as adapted for teaching speech; and,

FIG. **5** is a block diagram of the present invention as a self-teaching device.

THE DETAILED DESCRIPTION

Referring now to FIG. **1** of the drawings, a transducer **10** is shown in pressural engagement with the skin **12** of a patient. The transducer may be directly connected through an amplifier **14** to a master unit or palpation platform **16.** The master unit **16** may contain controls for the amplifier **14** whereby the response of the master unit to the cardiovascular or other displacement sensed by the transducer **10** may be adjusted. The amplifier **14** may also be connected to a plurality of slave units **18** through suitable power amplifiers (not shown).

In operation as a device for monitoring the cardiovascular displacements beneath the skin **12** of the patient, the arterial or venus pulses or motions of the heart are sensed by the transducer **10** and then amplified to drive the palpation platform of the master unit **16.** The palpation platform, of course, may be a mechanical replica of the surface of the body and the movement thereof reflects the cardiovascular displacement sensed by the transducer **10.** Adjustment of the amplifier **14** in a conventional manner will also control the amplitude of the signals applied to the slave units **18** and thus the response of the palpation platforms contained therein to the cardiovascular displacement of the patient sensed by the transducer **10.**

In this manner, an instructor may personally place the transducer **10** on the skin of the patient, thereby obviating the difficulty as to ascertaining whether or not the student is palpating the desired location of the patient with the required finger pressure. Once the master unit has been adjusted by the instructor for maximum performance, a plurality of students may simultaneously observe the cardiovascular displacement

sensed by the transducer **10** by pressural engagement with the palpation platform of the slave units **18.**

A circuit of the block diagram of FIG. **1** is shown schematically in FIG. **2** wherein the transducer of FIG. **1** comprises a pulsewave microphone **20.** The microphone **20** may be conventional in construction and operation and may be, for example, of the type manufactured by Hewlett-Packard as part of a pulsewave Kit No. 21051-D. The reference microphone has a 3 db frequency response from 0.03 to 40 hertz and a sensitivity of 25 mV per mm of water. Other types of transducers may be utilized and may vary in sensitivity and configuration as desired to accommodate the physical area of the subject from which the palpations are to be sensed.

The output signal from the microphone **20** is fed through a coupling capacitor **22** to one input terminal **24** of an operational amplifier **26.** The input terminal **24** is separated from ground potential by a resistor **28** as is the second input terminal **30** by a resistor **32.** The output terminal **34** of the amplifier **26** is also separated from ground potential by a resistor **36** and is connected to the second input terminal **30** thereof by way of a capacitor **38** and a resistor **40** in parallel. The input terminal **30** is also connected through a resistor **40** in parallel. The input terminal **30** is also connected through a resistor **42** to the slide wire contact of a potentiometer comprising resistors **44, 46** and **48** to provide a voltage offset adjustment for the operational amplifier **26.**

The output signal of the amplifier **26** thus appears across the resistor **36** which may also be provided with a slide wire contact or variable pick-off for service as a gain control potentiometer. The signal thus picked off the resistor **36** is fed through a coupling capacitor **50** and a resistor **52** to one input terminal **54** of a second operational amplifier **56** whose other input terminal **58** is connected to ground by way of an offset current compensating resistor **60.**

The output signal from the amplifier **56** is directly connected to one input terminal **62** of a third operational amplifier **64** whose other input terminal **66** is open-circuited. The output terminal **68** of the amplifier **64** may be directly connected to the input terminal **54** of the amplifier **56** by way of a resistor **70** and capacitor **72** in parallel circuit. The input terminal **54** may also be connected through a resistor **74** to the slide wire or variable contact of a potentiometer comprising resistors **76, 78** and **80** to provide a voltage offset adjustment.

The output terminal **68** of the amplifier **64** may be directly connected to the speaker coil **82** of the high fidelity, low frequency response speaker which comprises the palpation platform of the master unit **16** of the block diagram of FIG. **1.** The speaker desirably has a very good low frequency response from direct current to 100 Hz and may, by way of example, be Monarch Model SP-50X having a frequency response from d.c. to over 10 KHz, although any DC displacement transducer may be suitable.

In operation, the signal derived from the microphone **20** on pressural engagement with the skin of the patient is coupled through the capacitor **22** to the operational amplifier **26,** and the output signal therefrom is fed back to the other input terminal **30** thereof and is coupled to the input terminal **54** of the amplifier **56** which acts, in conjunction with amplifier **64,** as a single operational amplifier. The output signal of the operational amplifier comprising amplifiers **56** and **64** is fed back through capacitor **72** and resistor **70** to the input terminal **54** of the amplifier **56.**

The adjustment of the sliding contact of the potentiometer resistor **46** enables a voltage offset adjustment for the operational amplifier which might occur due to a mismatch in the transistors in the operational amplifier. A zero-volt steady-state is, of course, desired.

As earlier stated, the potentiometer **36** provides a gain adjustment at the input of the operational amplifier which comprises the amplifiers **56** and **64,** and the output signal from terminal **68** is fed directly to the speaker coil of the palpation platform of the master unit **16** of FIG. **1.**

By way of example the various circuit components of the circuit of FIG. **2** utilized in conjunction with plus 12 and minus 12 volt power supplies are as follows:

Operational Amplifier **26**	ZEL 134
Operational Amplifier **56**	ZEL 1
Operational Amplifier **64**	Philbrick 2001
Capacitor **22**	5 microfarads
Capacitor **38**	0.047 microfarads
Capacitor **50**	10 microfarads
Capacitor **72**	100 picofarads
Resistor **28**	4.7 M ohms
Resistor **32**	2.2 K ohms
Resistor **36**	25 K ohms
Resistor **40**	24 K ohms
Resistors **42, 44, 48, 76** and **80**	47 K ohms
Resistor **46**	25 K ohms
Resistor **52**	2.2 M ohms
Resistor **60**	1.8 M ohms
Resistors **70** & **74**	10 M ohms
Resistor **78**	25 K ohms

A preferred embodiment of the palpation platform of the master unit **16** of FIG. **1** is illustrated in FIG. **3** wherein a styrofoam block **84** is cemented to the speaker cone **86** for movement therewith. The speaker **88** is desirably mounted with respect to the enclosure **90** such that the plane of the exposed surface of the styrofoam filled cone is parallel to the plane of the enclosure. The exposed styrofoam and the surrounding enclosure may be covered by material having the color and texture of human flesh. A vinyl has been found suitable for this purpose although other materials may be satisfactory. The speaker may be horizontally or vertically orientated as desired for a particular adaptation

Referring now to FIG. **4,** the present invention also has great utility in teaching speech to persons having hearing defects. As schematically illustrated, a transducer such as a conventional throat microphone **100** may be secured in an appropriate manner to the throat of an instructor. The output signal from the microphone **100** is amplified in an amplifier **102** such as that illustrated in FIG. **2** and the amplified signal utilized to drive a plurality of palpation platforms **104.** The palpation platform may be of the type illustrated, for example, in FIG. **3.**

In operation, a student **108** with a hearing defect may place the fingers **110** of one hand on the surface **106** of the palpation platform **104** to sense the physical displacement of the instructor's throat as a specific sound is made. The fingers **112** of the other hand of the student **108** may be placed in a position on his own throat corresponding to the position of the microphone **100** on the throat of the instructor. The student is thus able to sequentially sense and thus compare the physical displacement of the instructor's throat when speaking and the physical displacement of his own throat in attempting to reproduce the sound.

In the self-teaching embodiment illustrated in FIG. 5, the instructor of FIG. 4 has been replaced by a suitable source 114 of the desired speech responsive signals. The source or simulator 114 may be, for example, of the magnetic tape or wire type. The output signal from the simulator 114 is amplified in an amplifier 116 and applied to a palpation platform 118 and to a visual display 120.

Also applied to the visual display 120 is the output signal from a throat microphone or other suitable transducer 122 attached to the throat, or cheek, as appropriate, of the student. The output signal from the transducer 122 may also be applied to a second palpation platform 124.

The display 120 may be any suitable conventional display for illustrating the two electrical signals for visual comparison purposes. The Model EI 100 from Masden Electronics at 2432 Grand Concourse, New York, N.Y. 10458 is exemplary of this type of display.

In operation, the signal from the simulator 114 may be simultaneously viewed and tactilely sensed by the student through the fingers of one hand. In attempting to reproduce the sound, the student can simultaneously view and tactilely sense the electrical signal from the microphone 122 positioned on his throat through the fingers of his other hand. The student may thus effect both a tactile and a visual comparison of the desired sound and his attempted reproduction thereof.

ADVANTAGES AND SCOPE OF THE INVENTION

While preferred embodiments have been illustrated and described in the foregoing specification, the substitution of components may readily be accomplished by one skilled in the art to which the invention pertains. For example, the electrical signals may be replaced by fluid pressure signals. The transducer may be varied in configuration and in method of operation, e.g., electromagnetic, electrostatic, pneumatic, hydrostatic, sonic, etc., depending on the configuration of the body surface and the part of the body to be sensed.

As a classroom or clinical instruction aid, several units may be slaved to a single transducer and a specific sound or cardiovascular movement simultaneously displayed to a plurality of students. By means of a master unit, the instructor may adjust the placement and sensitivity of the transducer to maximize identification.

As a self-teaching aid, a selected signal may be continuously reproduced for identification and is of great value to both medical students and speech students with hearing defects.

As a diagnostic aid, the increased sensitivity which results from amplification may be utilized to detect and identify palpations which may otherwise be overlooked.

It is, therefore, intended that the scope of the present invention be limited, not by the specific embodiments disclosed, but solely by the language of the appended claims when accorded a full range of equivalents.

We claim:

1. A method of teaching speech to students with hearing defects including the steps of:
   a. generating a signal related in amplitude and frequency to the speech responsive displacement of the skin of an instructor;
   b. amplifying the signal;
   c. driving a palpation platform responsively to the amplified signal;
   d. tactually sensing the physical displacement of the palpation platform by the student for comparison with the speech responsive, tactually-sensed, displacement of the student, also sensed by the student.

2. The method of claim 1 wherein the signal is generated responsively to a recording.

3. The method of claim 1 wherein the signal is generated responsively to a transducer in pressural engagement with the throat of an instructor.

4. The method of claim 1 including the further steps of generating a second signal related in amplitude and frequency to the speech of the student;
   driving a second palpation platform responsively to the second signal; and,
   tactually sensing the physical displacement of the second palpation platform by the student for comparison with the physical displacement of the first-mentioned palpation platform by the student.

5. A method of examining the physical displacement of a patient's skin due to subcutaneous cardiovascular displacement comprising the steps of:
   a. providing a sensor adapted for pressural engagement with the skin of a patient;
   b. providing a palpation platform responsive in displacement to the amplitude of an electrical signal;
   c. positioning the sensor on the patient under examination in pressural engagement with the skin thereof;
   d. generating an electrical signal related in amplitude to the physical displacement of the skin sensed by the sensor;
   e. amplifying the generated electrical signal;
   f. applying the amplified electrical signal to the palpation platform; and,
   g. tactually sensing the displacement of the palpation platform.

6. The method of claim 5 wherein the amplification of the generated signal includes the amplification of frequency components in the range between about 0.05 Hz and about 35 Hz.

7. A method of teaching the art of palpation to a student comprising the steps of:
   a. providing a sensor adapted for pressural engagement with the skin of a patient;
   b. providing a plurality of palpation platforms responsive in displacement to the amplitude of an electrical signal;
   c. positioning the sensor on the patient under examination in pressural engagement with the skin thereof;
   d. generating an electrical signal related in amplitude to the physical displacement of the skin as sensed by the sensor;
   e. amplifying the generated electrical signal;
   f. applying the amplified electrical signal to each of the palpation platforms; and
   g. tactually sensing the displacement of one of the palpation platforms while instructing a student in the tactile sensing of the displacement of another of the palpation platforms.

8. The method of claim 7 wherein the amplification of the generated signal includes the amplification of frequency components in the range between about 0.05 Hz and about 35 Hz.

9. The method of claim 7 including the step of simultaneously modifying the degree of amplification of the

generated electrical signal applied to each of the palpation platforms.

10. A method of examining the physical displacement of a patient's skin comprising the steps of:

a. generating a signal related in amplitude to the physical displacement of a patient's skin;

b. amplifying the generated signal;

c. applying the amplified signal to a palpation platform; and,

d. tactually sensing the physical displacement of the palpation platform.

11. The method of claim **10** wherein the amplification of the generated signal includes the amplification of frequency components in the range between about 0.05 Hz and about 35 Hz.

12. The method of claim **10** including the steps of applying the amplified signal to a plurality of additional palpation platforms and tactually sensing the physical displacement of the additional palpation platforms.

13. The method of claim **12** including the step of simultaneously controlling the degree of amplification of the signal applied to all of the additional palpation platforms.

14. A method of examining subcutaneous cardiovascular displacement comprising the steps of:

a. providing a sensor adapted for pressural engagement with the skin of a patient;

b. providing a palpation platform responsive in displacement to an applied signal;

c. positioning the sensor on the patient under examination in pressural engagement with the skin thereof;

d. generating a signal related to subcutaneous cardiovascular displacement as sensed by the sensor;

e. amplifying the generated signal;

f. applying the amplified signal to the palpation platform; and,

g. tactually sensing the displacement of the palpation platform.

15. The method of claim **14** wherein the amplification of the generated signal includes the amplification of frequency components in the range between about 0.05 Hz and about 35 Hz.

16. The method of claim **14** wherein the signal generated is electrical and is related in amplitude to subcutaneous cardiovascular displacement.

* * * * *