

Jan. 20, 1959

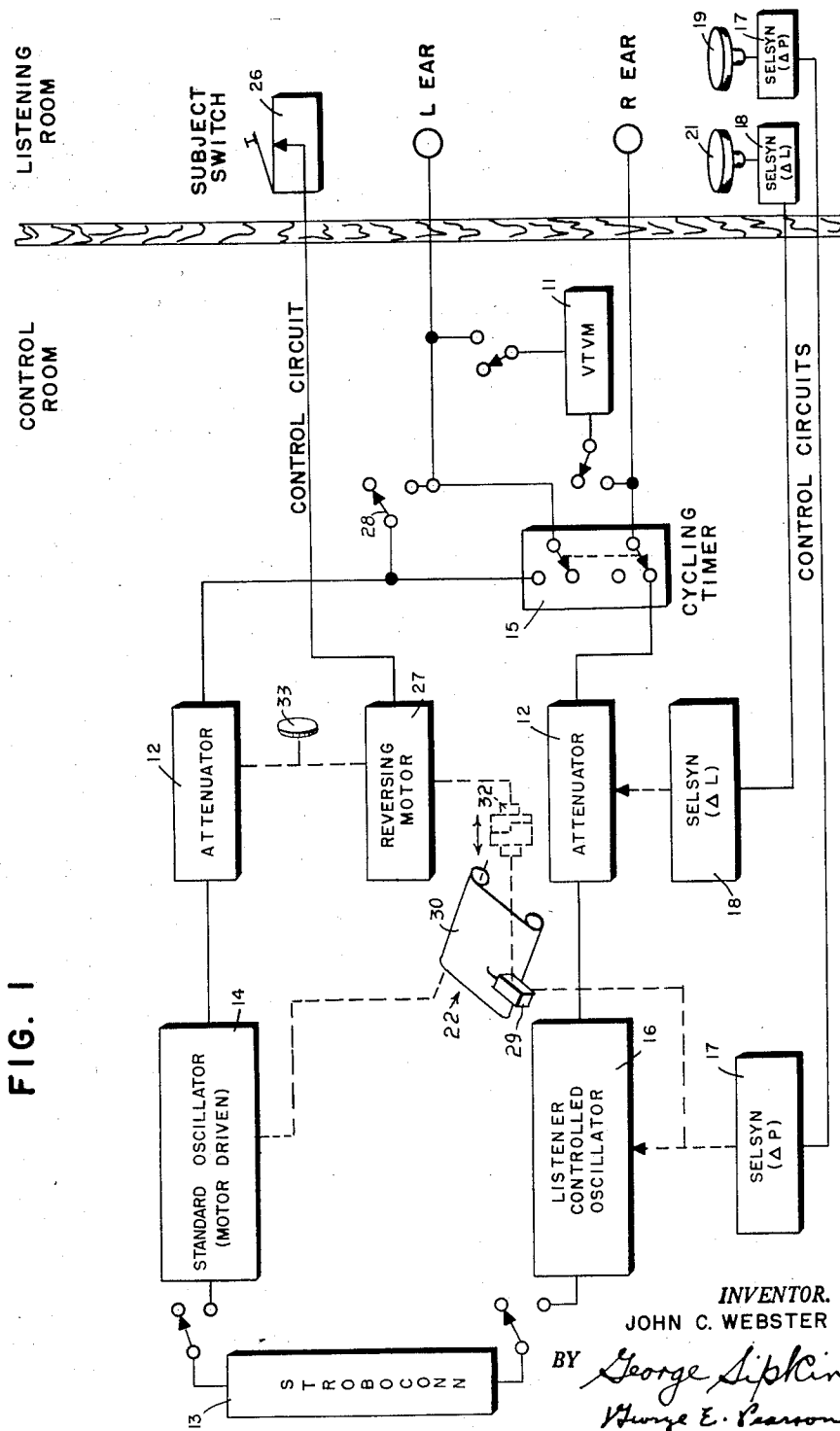
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AUTOMATICALLY RECORDING PITCH MATCHING EQUIPMENT

Filed June 9, 1954

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

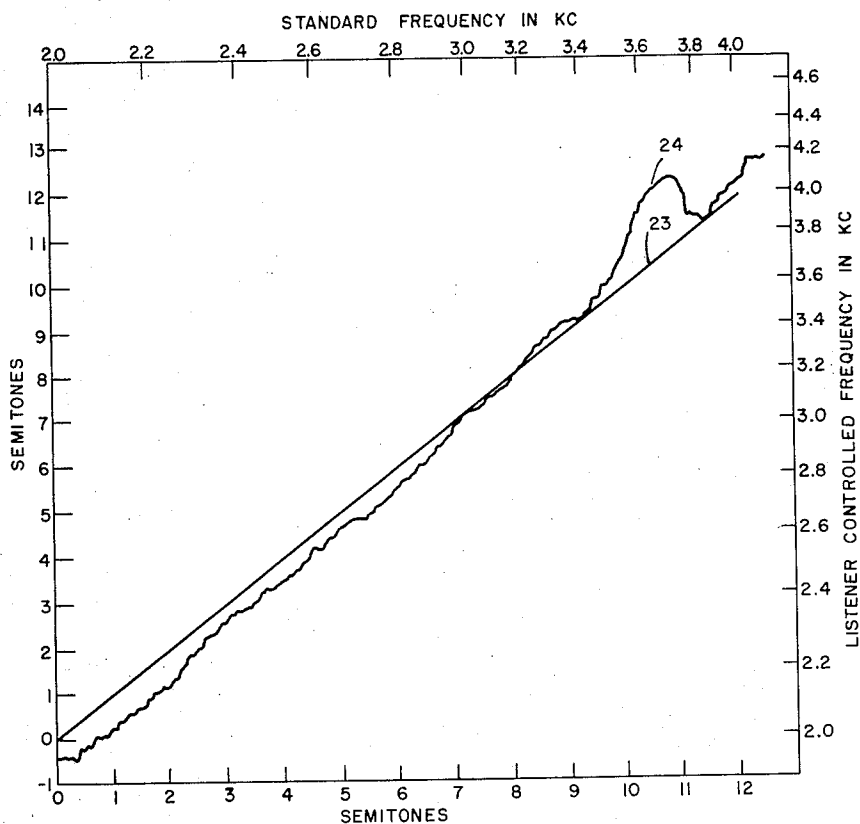


FIG. 2

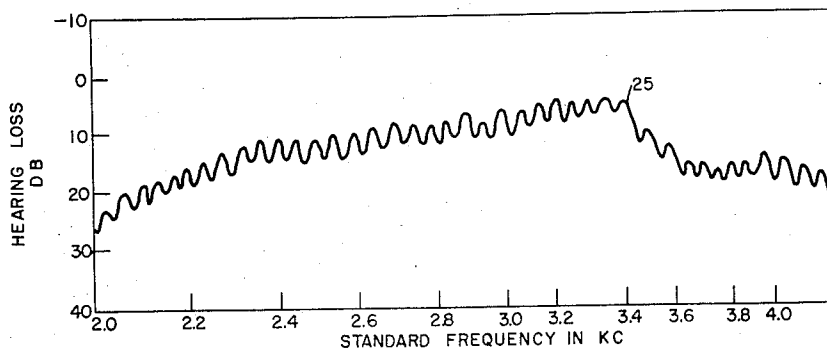


FIG. 3

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AUTOMATICALLY RECORDING PITCH MATCHING EQUIPMENT

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4 Claims. (Cl. 181—5)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to automatically recording pitch matching equipment and more particularly to a method and apparatus for determining the pitch differences between the two ears of a listener in which the listener alternately hears a standard pitch of changing frequency in one ear and a tone in the other ear whose frequency the listener attempts to match in pitch with the first tone and providing a written record of the differences in pitch detected by the two ears.

In previously used methods the listener adjusted the frequency of an oscillator being fed to one ear until it appeared to match the pitch of the sound fed to the other ear by a second oscillator at a fixed frequency. The difference in frequency between the two oscillators was then determined by the operator. In this method the frequency of the standard oscillator had to be fixed and the time pattern of the listener's adjustment in attempting to match the frequency with the second oscillator could not be determined.

The method and apparatus used by the present invention allows the listener to hear alternately a standard pitch with one ear, which changes in pitch at a predetermined rate, and a tone in the other ear whose frequency is listener controlled, with instructions to keep the two tones matched in pitch. A switch timer is incorporated into the circuit so that the "standard" oscillator is connected to one ear for one second while the "variable" oscillator is disconnected from the second earphone. Then the "standard" oscillator is disconnected while the "variable" oscillator is connected to the second earphone for two seconds. This one second-two second alternation is continued for the duration of the test run. A recording mechanism records both frequencies as they both change, the "standard" at a given rate, and the listener-controlled frequency as the listener responds to the pitch of the standard frequency. In this manner the difference in frequencies between the two oscillators can be continuously measured.

An object of the present invention is the provision of an improved method and apparatus for determining the pitch differences between the two ears of a listener.

Another object of the present invention is the provision of a method and apparatus for continuously recording the pitch differences between the two ears of a listener.

Another object is the provision of a method and apparatus for relating the pitch differences between the two ears to the hearing loss differences between them.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 shows a block diagram of the apparatus used

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for determining hearing losses, and determining the pitch differences between the two ears, taking into account the hearing loss differences while determining the pitch differences;

5 Fig. 2 shows a sample chart recording the listener's response as compared to a reference line indicative of the frequencies in the standard and listener-controlled oscillators; and

10 Fig. 3 shows a sample chart recording of the listener's hearing loss as a function of frequency.

Referring now to Fig. 1 there is shown a vacuum-tube voltmeter 11 calibrated in decibels to measure the voltage across each earphone and plays no part in the claimed invention but merely is a convenient means for determining selectively, at will, the intensity of the sound presented to either ear. Attenuators 12 in each signal line control the intensities of all signals. A Strobocorr 13 is used to measure the frequencies of both the standard and listener controlled oscillators 14 and 16 and is used in the beginning of the test for calibrating the oscillators 14 and 16, and otherwise plays no part in the claimed invention. Cycling timer 15 alternately connects the standard oscillator 14 to the voltage measuring or listening circuit for one second and the listener controlled oscillator 16 thereto for two seconds. The frequency of standard oscillator 14 is continuously increased and appears to the listener to be increased in predetermined increments because of the on and off periods.

Essentially the task of the listener is to match in pitch and loudness the tone he hears in his left ear by adjusting the frequency (P) and intensity (L) of the tone he hears in his right ear. This is done by two pairs of selsyn motors 17 and 18 controlled by knobs 19 and 21 respectively.

A permanent written record can be made of this by connecting the frequency dial of the listener controlled oscillator 16 to the recording mechanism 22. Since the standard oscillator motor drives the recording paper to indicate standard oscillator frequency and the recording pen indicates listener controlled oscillator frequency, a perfect series of pitch matches results in a diagonal line 23 across the paper, as shown in Fig. 2. The oscillators are oriented in such a way that the standard frequency increases from left to right and the listener controlled frequency increases from bottom to top. A sample of the listener's response is shown by jagged line 24.

During the pitch matching the operator keeps the intensities of the standard tones at a fixed amount above the listener's previously determined threshold as shown by line 25 in Fig. 3 by manually controlling the attenuator 12 by control knob 33 to make the pitch matching easier. In this manner the hearing loss differences are taken into account while determining the pitch differences between the two ears. However, the magnitude of the pitch differences are relatively unaffected in making pitch-matches for tones unequal in loudness.

One of the objects of this invention is the provision of a method and apparatus to relate the pitch differences between the two ears to the hearing loss differences between them. Hearing loss measurements are desired at all frequencies, not just at octave multiples of 64 C. P. S. as is customary in the usual type of clinical audiometers. To determine a listener's threshold by this method, the operator closes switch 28 which bypasses the timer 15 connecting the standard oscillator 14 to the left ear of the listener who controls the intensity of the tone he hears by means of a hand-held switch 26. If the listener hears a tone, he pushes switch 25 which causes a reversing motor 27 to drive the standard oscillator attenuator 12 and the recording pen 29 of the recording mechanism 22 by mechanical connections. The attenu-

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ator 12 increases the attenuation until the tone is no longer audible and then the listener releases switch 26 which reverses the direction of the motor 27. This decreases the attenuation, reverses the direction of the pen, and allows the tone to become audible again. After the listener's threshold has been determined, the drive motor for the standard oscillator 14 is turned on by the operator and causes the standard oscillator 14 to change slowly in frequency, for example, from 2 kc. to 4 kc. as shown in Fig. 3. As the oscillator 14 covers this frequency range it also drives the recording paper of the recording mechanism 22 to move at right angles to the direction of movement of the recording pen 29.

As a modification, the times of operation of each oscillator is not critical and may be varied as desired.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. The method of producing a continuous and running record of pitch matches between the two ears of a subject under test consisting of the steps of presenting one-second and two-second tones respectively to the ears of the subject alternately, shifting the frequency of the one-second tone continuously upward whereby the frequency appears to the subject to be increased in predetermined increments between successive presentations thereof and independently of the subject, moving recording paper under a pen in response to the one-second tone frequency shift, adjusting the frequency of the two-second tone under control of the subject to maintain the two alternating tones matched in pitch in accordance with the hearing sensitivity of the subject, moving a recording pen in response to the two-second tone frequency shift, thereby producing a record trace of the two frequencies to provide a permanent record of the pitch matches for each of the step variations therein.

2. A method as in claim 1 in which hearing loss is simulated in the ear to which the one-second tone is presented by means of operator controlled tone intensification in accordance with the ear's previously determined frequency threshold to provide a measure of correlation between the slope of the hearing loss and the amount and direction of pitch shift.

3. Apparatus for producing a continuous and running record of pitch matches between the two ears of a subject to be tested comprising, in combination, a recorder having movable recording paper and a pen for inscribing a trace thereon as the paper is moved with respect to the pen, a first adjustable oscillator having means for presenting a one-second tone to one ear of the subject

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at spaced intervals and at predetermined frequencies selectively in accordance with the setting of the oscillator, means for moving said paper in accordance with changes in frequency of said first oscillator, the frequency of said oscillator being adjusted in predetermined increments between successive ones of said one-second tones, and a second adjustable oscillator having means for presenting a two-second tone to the other ear of the subject continuously alternating with said one-second tones and at a frequency obtained by adjustment of the second oscillator by the subject in an amount to match the pitch of the preceding one-second tone in accordance with the tone sensitivity of the subject, means for moving said pen in accordance with changes in frequency of said second oscillator, whereby the recorded trace provides a permanent record of the pitch matching of the alternating tones.

4. Apparatus for producing a continuous and running record of pitch matches between the two ears of a subject to be tested comprising, in combination, a recorder having movable recording paper and a pen for inscribing a trace thereon as the paper is moved with respect to the pen, a first adjustable oscillator having means for presenting a first tone of predetermined duration to one ear of the subject at spaced intervals and at predetermined frequencies selectively in accordance with the setting of the oscillator, means for moving said paper in accordance with changes in frequency of said first oscillator, said oscillator having means for adjusting the frequency thereof continuously whereby the frequency appears to the subject to be changed in increments between successive presentations of said first tone, and a second adjustable oscillator having means for presenting a second tone of different duration to the other ear of the subject continuously alternating with first said tone and at a frequency obtained by adjustment of the second oscillator by the subject in an amount to match the pitch of the first tone on each presentation thereof in accordance with the tone sensitivity of the subject, means for moving said pen in accordance with changes in the frequency of said second oscillator whereby the recorded trace provides a permanent record of the pitch matching of the alternating tone.

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