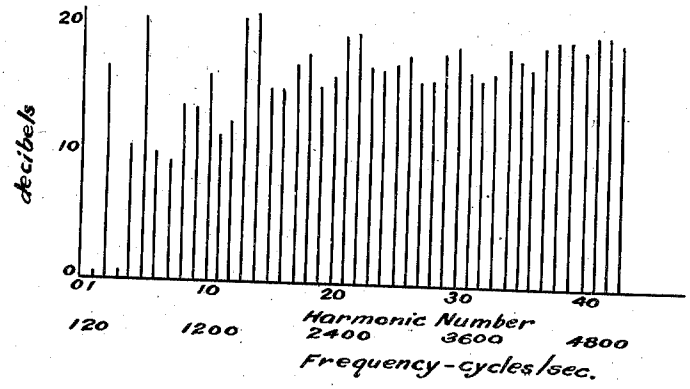
March 18, 1941. E. G. WITTING 2,235,733

AUDITORY MASKING METHOD

Filed June 27, 1936

Fig. 1.



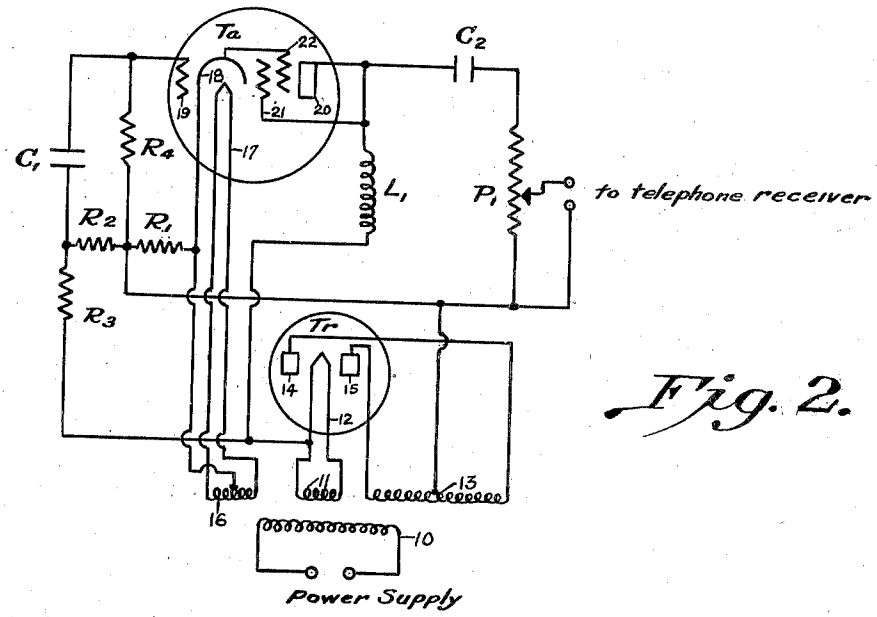


Fig. 2.

Fig. 3.



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AUDITORY MASKING METHOD

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Application June 27, 1936, Serial No. 87,772

3 Claims. (Cl. 128—2.1)

The present invention pertains to a novel method of testing human hearing by means of sounds produced by electrical oscillations.

In measuring and testing the degree of hearing, it is sometimes found that the hearing acuity of one ear of the patient is less than the other.

While several types of mechanical and electrical apparatuses are used in acuity testing and measuring, the conventional medium in use today is a telephone circuit comprising an oscillator, amplifier and receiver, together with various types of measuring instruments to determine the intensity of sound, hereinafter referred to as the "testing sound" to distinguish it from other sounds used, impressed on the ear of the patient, and to arrive at some basis of comparison between normal and defective hearing.

However, otologists have been handicapped in measuring and testing the degree of hearing of the patient because the usual similarity of the acuity curves for the deaf ear and that of the good ear, resulting in what is known to those killed in the art as a "shadow curve". This "shadow curve" is observed when a "testing" tone or sound is applied to the deaf ear and is made sufficiently loud to be heard in the good ear, by reason of its transmission around the head and its conduction by the head, or both.

The present invention eliminates this cross-hearing of the "testing sound" or tone intended to be impressed only on the one ear by impressing a "masking sound" or noise produced by electrical oscillations of nearly constant amplitude having a given frequency on the other ear. Such a "masking" noise or auxiliary sound must be loud enough to neutralize or drown the "testing sound" or tone transmitted from the deaf ear across the head to the good ear, but not loud enough to be conducted across the head and interfere with the "testing" tone or sound. Naturally, if the poorer or deafer ear hears the testing sound equally as well when the "masking sound" is applied to the better ear, the test proves the ability of the poorer ear to hear. On the other hand, if the "testing sound" is actually heard by sound transmission through the head into the better ear, a test using the masking noise or sound on the better ear will show the lack of ability to hear in the poorer ear.

Therefore, it is the purpose of this invention to improve prior methods of testing hearing by generating and applying a novel sound to one ear with an intensity sufficient to "mask" that ear, while applying a separate "testing" sound to the other ear.

A test of this type may be used also to determine the ability of a patient to hear with one ear by means of bone conductivity only. This is done by shielding the good ear with the special masking sound of this invention and then vibrating the bone structure in the immediate vicinity of the other ear with some well-known means.

By applying the masking tone to one ear, it is possible to determine the ability of the other ear to detect or hear speech.

Masking tones generated by an electro-mechanical buzzer, mechanical vibrators and other instrumentalities have been used for this purpose, but to date none of these suggestions has proven entirely practical or satisfactory.

The applicant has determined that a masking sound or noise ideally suited for the purpose is one which contains all frequencies or what is known as a "square wave" sound with very low fundamental frequency. Such a wave sound, however, is purely theoretical and a compromise has been effected which ideally serves the purpose by creating a sound wave consisting of a fundamental of approximately 120 cycles and its accompanying overtones. Analysis of this sound wave up to 5160 cycles shows that the intensity of the overtones or harmonics in this range is constant within four decibels beyond 1680 cycles. From 120 cycles to 1680 cycles, the intensities fall off slowly from the value of the fundamental up to the value of 1680 cycles.

In the drawing:

Figure 1 is a graphic showing of the type of sound used for "masking" the ear which is not being tested.

Figure 2 is a circuit arrangement for producing such a sound;

Figure 3 is a representation of the theoretical wave shape of the voltage output of the rectifier part of the Fig. 2 circuit.

The circuit illustrated may use the conventional 110 volt, 60 cycle home power supply which, when rectified, gives the wave form illustrated in Figure 3. Such a circuit contains a fundamental wave plus a large number of harmonics in addition to the constant component known as "steady state value" or "D. C. component".

In accordance with the typical circuit disclosed in Figure 2, a source of 110 volts, 60 cycle current is connected to a transformer primary 10, whose secondary coil 11 is connected across the heating filament 12 of a full wave rectifier tube Tr. An additional secondary coil 13 of the transformer is connected at its ends with anode plates 14 and 15 of the tube Tr. Still another

secondary coil 16 of the power supply transformer is connected to the heater filament 17, cathode 18 and cathode grid 22 of an oscillator thermionic tube Tα, which is also provided with a control grid 19, anode 20 and space grid 21.

When potential is applied to the control grid circuit of the oscillator or amplifier tube through condenser C_1 having a capacity of approximately .02 micro-farad and resistances R_2 and R_3, having 30,000 ohms and 100,000 ohms values, the fraction

$$\frac{R_2}{R_2+R_3}$$

of the voltage supplied by the rectifier tube Tr is applied to the amplifier tube Tα through condenser C_1, which removes the D. C. component; and thus the fundamental frequency wave, originating in the rectifier, together with all of its harmonics, is applied to the amplifier tube Tα. Resistances R_1 and R_4 have values of 500 ohms and 1 megohm respectively.

It should be pointed out that the source of oscillations which are amplified by the tube Tα is the unfiltered A. C. component of the rectifier. With the type of circuit illustrated, all of these oscillations are received and amplified with substantially equal intensity.

An inductance L_1 of approximately 15 henries value is used as an impedance voltage supply to the anode plate 20. Condenser C_2 of .004 microfarad capacity in the output circuit is for the purpose of by-passing the A. C. output of the tube Tα to the potentiometer P_1 and for controlling the intensity of low frequency oscillations present, while a conventional self-biasing resistance R_1 is connected across the control grid and cathode leads.

The inductance of L_1 and capacitance of C_1 and C_2 are so proportioned that a wave of the form shown in Fig. 1 will be produced at the terminals of the device.

It will be appreciated that the values of the several circuit elements described are merely illustrative of a typical operating circuit and that these values may be varied to suit any particular need.

In order to obtain the desired characteristic, it is essential that no filtering be introduced into the rectifier.

As shown in Figure 2, a telephone receiver is connected across the terminals, and this receiver may be held by the patient against his better ear to convey the masking noise or sound thereto. The intensity of the tone is varied by means of potentiometer P_1 or some other suitable volume control device.

In operation, the pulsating uni-directional current voltage from the rectifier, pulsating at a rate of twice the current supply, may be fed to the input circuit of the amplifier tube in sufficient amplitude to cause an extreme overload. This produces an output wave containing a large harmonic content, that is to say, a wave rich in harmonics of the fundamental frequency.

The fundamental and lower harmonics are prevented from becoming too intense by adjustment of the circuit constants.

What I claim is:

1. A method of testing hearing comprising generating electrical oscillations of nearly constant amplitude having a fundamental frequency of approximately 120 cycles per second and rich in harmonics of said frequency, converting said electrical oscillations into audible sound, masking one ear of a patient by applying said sound thereto with an intensity sufficient to mask that ear, and applying a separate testing sound to the other ear of said patient.

2. A method of testing hearing comprising generating electrical oscillations of nearly constant amplitude having a fundamental frequency of the order of 120 cycles per second and rich in harmonics of said frequency, converting said electrical oscillations into sound which is within the range of human perception, masking one ear of a patient by applying said sound thereto with an intensity sufficient to mask that ear, and at the same time vibrating the bone structure in the vicinity of the other ear to determine its ability to hear by bone conduction.

3. A method of testing hearing comprising generating electrical oscillations of nearly constant amplitude having a very low fundamental frequency and rich in harmonics of said frequency, converting said electrical oscillations into corresponding sound waves which are near the lower limit of audible sound, masking one ear of a person by applying said sound waves directly thereto with an intensity sufficient to mask that ear, and testing the other ear of said person by applying a separate testing sound thereto.

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