Oct. 23, 1956 R. E. ALLISON 2,768,236

HEARING TEST SYSTEM

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FIG. 1

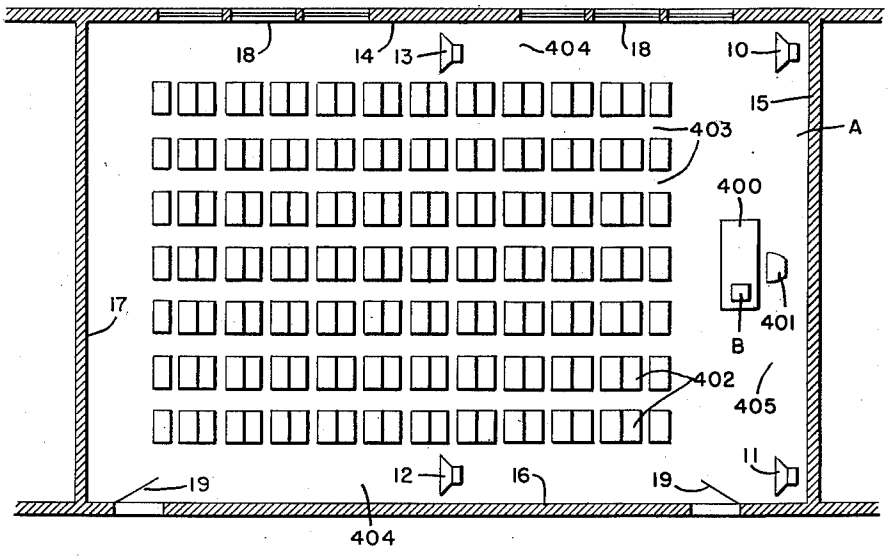
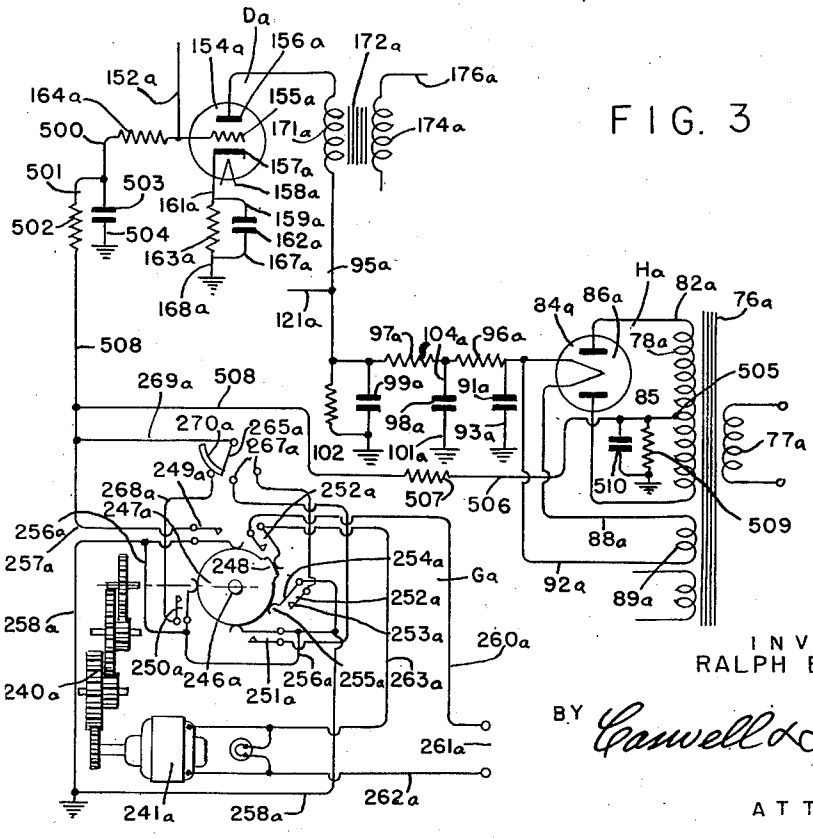


FIG. 3



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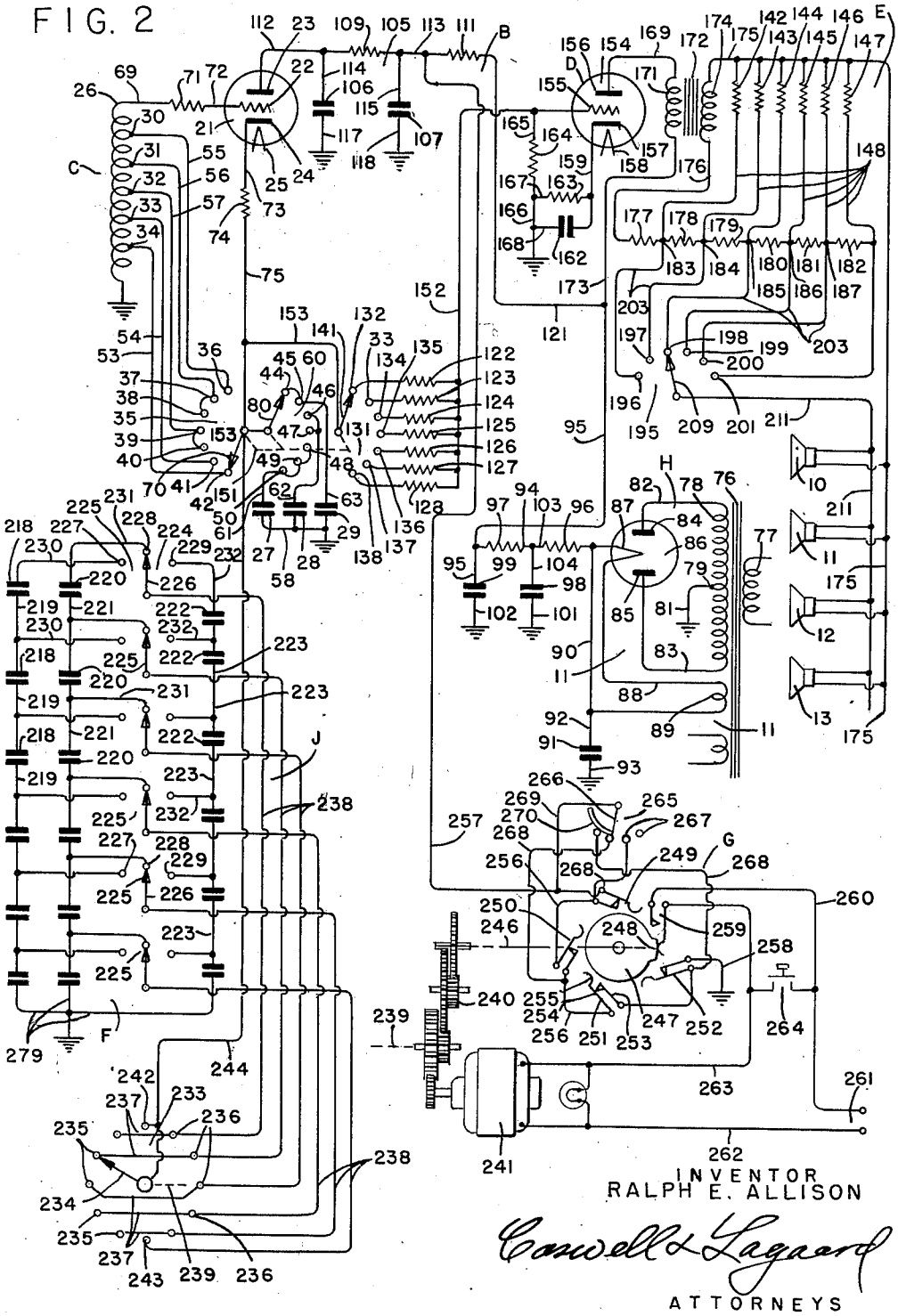
ATTORNEYS

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HEARING TEST SYSTEM

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FIG. 2



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ATTORNEYS

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2,768,236

HEARING TEST SYSTEM

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15 Claims. (Cl. 179—1)

The herein disclosed invention relates to hearing test systems and methods of testing hearing acuity and has for an object to provide a system and method by means of which groups of persons may be simultaneously tested without the use of individual ear phones or similar receivers.

Another object of the invention resides in providing a system using one or more loud speakers and in which the intensity of tone produced by the speakers is substantially the same at all localities where the persons to be tested are stationed.

Another object of the invention resides in conducting the test in a room having walls adapted to reflect sounds and in which the loud speakers are arranged in the room to direct the sound toward one of the walls of the room.

An object of the invention resides in utilizing in large rooms a plurality of loud speakers and in arranging some of said speakers adjacent one of the walls of the room and emanating sound waves directed toward the opposite wall and in arranging other of said speakers intermediate said walls and emanating sound waves directed toward the same wall.

A still further object of the invention resides in using an audiometer for actuating the loud speakers and in providing the audiometer with a generator for producing a tone having a warble whereby the frequency of the reflected sound waves continuously vary within limits so that when the wave from a reflected train of waves reaches the waves directly emanating from the loud speakers the sounds produced by the combination of the direct and reflected waves is not appreciably varied in intensity and thus standing waves are prevented with the result that the intensity of the sound is approximately the same throughout the room in which the test is being conducted.

Another object of the invention resides in constructing the generator with an oscillator producing alternating currents of various frequencies and with a frequency modulating device for modulating the currents to produce in the loud speakers tones having a warble.

A still further object of the invention resides in providing a current interrupting device by means of which the currents are formed into current pulses producing tone pulses arranged according to predetermined sound patterns.

An object of the invention resides in the method of testing hearing acuity which consists in utilizing sounds adapted to be simultaneously heard at all of the localities where the persons tested are stationed and in applying ear closures to the ears of the persons being tested alternating from one ear of each person to the other.

Other objects of the invention reside in the novel combination and arrangement of parts and in the details of construction hereinafter illustrated and/or described.

In the drawings:

Fig. 1 is a plan view of a room illustrating the arrangement of the equipment used with the system.

Fig. 2 is a wiring diagram of the audiometer used with the system.

Fig. 3 is a wiring diagram of a portion of an audiometer showing a modification of the invention.

In the drawings has been illustrated a room in which tests for hearing acuity may be conducted. This room has a front wall, a rear wall and side walls and these walls, particularly the rear wall are constructed to reflect sound waves. In this room have been shown seats for the patients and four loud speakers for producing the desired tones. These speakers are arranged, two near the front wall and two intermediate the front wall and rear wall and all four emanating sound waves directed toward the rear wall. The audiometer used with the system utilizes a triode oscillator of the variable frequency type including a number of condensers and a tapped coil adapted to be connected to produce the desired frequencies by means of a selector switch. This oscillator is connected to a bank of equalizer resistors which are adapted to be selectively connected in the circuit by means of a multiple contact switch simultaneously operable with the selector switch. The output of the oscillator is fed to an amplifier which in turn is connected to an attenuator. This attenuator controls the output of the amplifier which energizes the loud speakers arranged in the room in which the test is being conducted. A frequency modulating device for modulating the alternating current produced by the oscillator is employed. This device consists of a number of condensers of differing capacities adapted to be connected to the resonating circuit of the oscillator by means of a rotary multiple contact switch rotated from an electric motor through a speed reducing transmission. An interrupter is also employed which is similarly driven and which converts the modulated alternating current into current pulses, producing in the loud speakers warbled tone pulses conforming to any of a number of desired sound patterns.

The herein disclosed invention overcomes certain objections to a similar system for testing hearing acuity and disclosed in the application for patent of Scott N. Reger, Serial No. 697,822, filed September 18, 1948, for Audiometers. The Reger invention utilizes a number of ear phones, one for each person being tested. This requires a great amount of wiring with numerous flexible cords and a great many receivers. In addition the time required to set up such apparatus, in a schoolroom for example, is great and the general commotion and confusion occurring, particularly when school children are to be tested, makes the conducting of the tests an arduous task. The use of loud speakers in place of ear phones occurred to applicant but several problems arose. In the first place it became impossible to procure the same sound intensity at all locations in a room where the persons to be tested were to be stationed. This was due to the fact that the sound waves reflected from certain of the walls would meet the oncoming waves and either increase or reduce the sound intensity so that standing sound waves were produced with the result that the sound level varied at different localities in the room. This was overcome by using a warbled sound and by the arrangement of the speakers which eliminated standing waves and gave a sound level practically uniform throughout the room.

In the operation of my invention, a generator is employed which is adapted to produce continuous audible sounds of different frequencies and intensities. These sounds are interrupted in a manner to give individual sounds of definite duration and separated by dwell periods of predetermined length. These individual sounds have been referred to in the specification and claims as sound pulses to distinguish from the resultant sound which has merely been designated as a sound and which may consist of one or more pulses.

The invention utilizes a room A in which a number of loud speakers are placed and an audiometer B which

energizes said speakers. The audiometer B comprises an oscillator C which produces an alternating current of any of a number of desired frequencies. This current passes through an amplifier D and through an attenuator E from which the same is directed to a number of loud speakers 10, 11, 12 and 13 arranged in a certain manner in the room A. The alternating current produced by the oscillator is controlled by an interrupting device G which interrupts the current to produce groups of current pulses which differ in certain ways to enable the person being tested to distinguish the sounds produced in the different groups by means other than by the frequency or intensity of the sound. The interrupting device G gives to each group of current pulses a different characteristic by means of which it may be recognized and which has been referred to as a sound pattern. The current pulses are further modified by frequency modulation procured by a frequency modulating device F. A power supply unit H furnishes suitable current for operating the audiometer. The oscillator C, amplifier D, frequency modulating device F and interrupting device G form a generator of modulated alternating current pulses which will be referred to by the reference character J. These parts will now be described in detail.

The room A shown in Fig. 1 is representative of an ordinary school room having four walls 14, 15, 16 and 17 with the usual windows 18 and doors 19. The walls 14, 15, 16 and 17 as is the case with the ordinary school room are hard plastered and provide good surfaces for reflecting sound waves. While it is not necessary that all of the walls be reflecting walls, at least the wall 17 should be so constructed. In the room are arranged a desk 400 and chair 401 for the instructor and the required number of combination seats and desks 402 for the students or the persons to be tested by the apparatus and method. These seats and desks are arranged in the middle of the room with aisles 403 therebetween and with aisles 404 between said seats and the walls 14 and 16. The seats 402 do not extend up to the wall 15 so that a space 405 is formed between said seats and the wall 15 in which the desk 400 and chair 401 are situated.

The oscillator C consists of a thermionic tube 21 having a grid 22, a plate 23, a cathode 24 and a heater 25 for said cathode. The tube 21 is coupled with a portion of an inductance 26 and any of a number of condensers 27, 28, 29, which are connected in series to form a resonant circuit. This construction provides an oscillator which produces an alternating or pulsating current whose frequency depends upon the relation between the inductance and condenser connected in the circuit. For connecting a certain portion of the inductance 26 and any one of the various condensers in the circuit, two multiple contact switches 35 and 60 are employed. The switch 35 has a number of fixed contacts 36, 37, 38, 39, 40, 41 and 42 and a movable switch arm 70. The switch 60 has a number of fixed contacts 44, 45, 46, 47, 48, 49 and 50 and a movable switch arm 80. Both of the switch arms 70 and 80 are mounted on the same shaft, which is diagrammatically indicated at 151 in the drawing, and travel in unison so that certain of the sections of the inductance 26 are always connected to certain of the condensers 27 to 29 inclusive. The inductance 26 is provided with five taps 30, 31, 32, 33 and 34. A conductor 55 is connected to the tap 30 and also to the contact 36. Another conductor 56 is connected to the tap 31 and to both of the contacts 37 and 38. Another conductor 57 is connected to the tap 32 and to both of the contacts 39 and 40. A conductor 54 is connected to the tap 33 and to the contact 41 while still another conductor 53 is connected to the tap 34 and contact 42. One side of each of the condensers 27 to 29 inclusive is connected to a conductor 58 which is grounded. The other side of the condenser 27 is connected by means of a conductor 61 with contacts 48, 49 and 50. The other side of condenser 28 is connected by means of a conductor 62 with contacts 46 and 47 while the other side of condenser 29 is connected by means of a conductor 63 with contacts 44 and 45. The inductance 26 is connected by means of a conductor 69 with a resistor 71 which, in turn, is connected by means of a conductor 72 with the grid 22 of tube 21. The cathode 24 of this tube is connected by means of a conductor 73 with a resistor 74 which, in turn, is connected by means of a conductor 75 with both of the switch arms 70 and 80. It will thus be seen that one of the condensers 27 to 29 inclusive and a portion of the inductance 26 are connected in series in the grid circuit of the tube 21.

For the purpose of providing current for operating the invention, the power supply H is employed. This power supply includes a transformer 76 having a primary 77 adapted to be connected to a suitable source of alternating current. This transformer also has a secondary 78 which is provided with a center tap 79 and which is connected to ground by means of a conductor 81. The ends of this secondary are connected by means of conductors 82 and 83 to the plates 84 and 85 of a rectifier tube 86. The filament 87 of this tube is connected by means of a conductor 88 to a secondary winding 89 on the transformer 76. This winding is connected to a condenser 91 by means of a conductor 92. Condenser 91 is grounded through a conductor 93. Another conductor 90 connects the other side of the filament 87 to conductor 92. The output of the tube 86 is directed through a filter system 94 and from which direct current is furnished to the audiometer by means of a conductor 95. The filter system 94 includes two resistances 96 and 97 and in addition to the condenser 91, two other condensers 98 and 99. Both the condensers 98 and 99 are grounded through conductors 101 and 102. The resistance 96 is connected to the conductor 92 and by means of conductor 103, to the resistance 97. This resistance is, in turn, connected to the conductor 95. Condenser 98 is connected by means of a conductor 104 with the conductor 103 while condenser 99 is directly connected to the conductor 95.

The plate 23 of tube 21 is connected to a filter system 105 which consists of two condensers 106 and 107 and two resistors 109 and 111. The plate 23 is connected by means of a conductor 112 to the resistor 109 which is connected by means of a conductor 113 to the resistor 111. A conductor 114 connects the conductor 112 with condenser 106 and another conductor 115 connects the conductor 113 with condenser 107. Both condensers 106 and 107 are grounded through conductors 117 and 118. Plate voltage is procured for the tube 21 from the conductor 95. A branch conductor 121 is connected to the conductor 95 and to the resistance 111 which in turn is connected to conductor 113.

Due to the fact that certain frequencies are more audible to the human ear than other frequencies, it becomes necessary to equalize the output of the oscillator C in accordance with the frequencies of the currents produced thereby. For this purpose, a series of equalizing resistors 122, 123, 124, 125, 126, 127 and 128 are employed. Also, an additional multiple contact switch 131 is used. This switch has a number of contacts 132 to 138 inclusive which are connected to the various resistors 122 to 128. Switch 131 also includes a switch arm 141 which is adapted to make contact with any of said contacts. The three switches 35, 60 and 131 are all ganged and the switch arms 70, 80 and 141 of the same are all connected to the common shaft 151, previously referred to. All of the resistors 122 to 129 inclusive are connected to a common conductor 152 which will be subsequently referred to. The switch arm 141 is connected by means of a conductor 153 to the conductor 75 which is associated with switches 35 and 60.

The amplifier D is merely shown diagrammatically and

a single stage has been illustrated. It can, however, be readily comprehended that any type of amplifier may be employed and as many stages as found necessary utilized. The amplifier D includes a thermionic tube **154** having a grid **155**, a plate **156**, a cathode **157** and a heater **158** for the same. The conductor **152** previously referred to, is connected directly to the grid **155** of the tube **154**. A resistor **164** is connected by means of a conductor **165** to the conductor **152**. Said resistor is further connected by means of a conductor **166** to ground. The cathode **157** of this tube is connected by means of a conductor **159** to a condenser **162** and a resistor **163**. This condenser and resistor are in turn connected by means of conductors **167** and **168** to the conductor **166** and thus grounded. The plate **156** of the tube **154** is connected by means of a conductor **169** with one side of the primary **171** of an output transformer **172**. The other side of this primary is connected by means of a conductor **173** with the conductors **121** and **95**. Thus, plate voltage is furnished through the primary of this transformer to the plate **156** of the tube **154**. The secondary **174** of the transformer **172** is connected to conductors **175** and **176** which impresses the amplified voltage upon the attenuator E.

The attenuator E comprises six resistors **177**, **178**, **179**, **180**, **181** and **182** which are connected in series by means of conductors **183**, **184**, **185**, **186** and **187**. The resistor **177** is further connected to the conductor **176**. In addition to the six resistors **177**, **178**, **179**, **180**, **181** and **182**, six other resistors **142**, **143**, **144**, **145**, **146** and **147** are employed. These resistors are all connected at one end to the conductor **175** from the secondary **174** of transformer **172**. The other ends of these resistors are connected by means of conductors **148** to the conductors **183**, **184**, **185**, **186** and **187** previously referred to. The attenuator E also includes a selector switch **195** which comprises a number of contacts **196**, **197**, **198**, **199**, **200** and **201**. These contacts are connected by means of conductors **203** to the various conductors **183**, **184**, **185**, **186** and **187** respectively. Said switch includes a switch arm **209** which is adapted to make contact with any of the said contacts. The loud speakers **10**, **11**, **12** and **13** are connected in parallel and to a conductor **211** connected to switch arm **209** and further to the conductor **175** which is connected to the secondary **174** of transformer **172**.

The frequency modulating device F consists of a number of condensers **218**. These condensers are all connected together in series by means of conductors **219**. In addition to these condensers a number of condensers **220** are employed. These condensers are connected together in series by means of conductors **221**. In addition, other condensers **222** are employed which are connected together in series by means of conductors **223**. All of these condensers are controlled by a multiple switch **224** which has six decks **225**. These decks are all ganged and each has a movable arm **226** and three contacts **227**, **228** and **229**. The condensers **218** are connected by means of conductors **230** to the contacts **227**. In a similar manner the condensers **220** are connected by means of conductors **231** to the contacts **228** and likewise condensers **222** are connected by means of conductors **232** to the contacts **229**. The end condensers **218**, **220** and **222** are grounded by means of conductors **279**.

For operating the frequency modulating device F a rotary switch **233** is employed which has a rotating arm **234** and a number of fixed contacts **235** and **236** arranged in opposition to one another. Each of the contacts **235** is connected to the corresponding contact **236** by means of conductors **237**. The conductors **237** are connected by means of other conductors **238** to the switch arms **226** of the switch **224**. Intermediate the contacts **235** and **236** are contacts **242** and **243**. The contact **242** is connected to a conductor **244** which is connected to the switch arm **234** and to the conductor **75** and to the conductor **153** between the arms **80** and **141** of switches **35** and **131**. The contact **243** is connected to one of the conductors **238**. The arm **234** of switch **233** is mounted on a shaft diagrammatically indicated at **239** which is driven by a transmission **240** operated by an electric motor **241**. The transmission **240** is so designed that the shaft **239** operates approximately 360 R. P. M. The condensers **218** vary in capacity so that when the shaft **239** is uniformly rotated the output of the oscillator C is frequency modulated.

The interrupting device G utilizes a shaft diagrammatically indicated at **246** which is connected to and driven by the transmission **240**. This shaft operates at substantially 10 R. P. M. The said shaft carries a drum **247** having on the same a cam **248**. Operating in conjunction with the said drum and cam are switches **249**, **250**, **251** and **252**. Each of these switches has a fixed switch arm **253** and a movable switch arm **254**. On the arm **254** is a cam follower **255**. These various switches are normally closed and when the cam **248** engages the cam followers **255** the said switches are opened for a period of time depending upon the length of the cam **248** and the speed of the shaft **246**. The switches **249**, **250**, **251** and **252** are all connected in series by means of conductors **256** which go from the fixed switch arm of one switch to the movable switch arm of the following switch. The movable switch arm **251** of the switch **249** is connected by means of a conductor **257** to the conductor **113** previously referred to and which is connected to the plate of the oscillator tube **21** through resistors **109** and **111**. The fixed contact **253** of switch **252** is connected by means of conductor **258** to ground. It will readily be comprehended that the switches **249**, **250**, **251** and **252** being normally closed from a by-pass circuit conducting the output of the oscillator to ground and thus rendering the oscillator inoperative as to furnishing operating current for the loud speakers **10**, **11**, **12** and **13**. When, however, the cam **248** reaches the cam follower **255** of switch arm **254** the switch of which said arm forms a part is opened and the output from oscillator C utilized for procuring energy for energizing the said loud speakers. The drum **247** is stopped each time the same completes a single revolution. This is accomplished by means of a switch **259** constructed similarly to the switches **249**, **250**, etc. One side of this switch is connected by means of a conductor **260** to one side of a line **261** connected to a source of alternating current. The other side of this line is connected by means of a conductor **262** to one terminal of the motor **241**. The other terminal of this motor is connected by means of a conductor **263** to the other arm of switch **259**. A push button **264** is connected across the conductors **263** and **260**. This push button serves to momentarily actuate the motor **241** and to start the drum **247** to rotate. As soon as the cam **248** passes the cam follower of switch **259** the push button **264** is released and the drum then continues to rotate until cam **248** subsequently opens switch **259**. The drum **247** normally causes the successive openings of the switches **249**, **250**, **251** and **252** which would produce in the loud speakers **10**, **11**, **12** and **13** four tone pulses of a predetermined duration with certain intervals of quiet therebetween. The sound pattern of the tone so produced can, however, be varied to procure three, two or one such sound pulses instead of four. This is accomplished by means of a selector switch **265** which consists of a movable arm **266** and four contacts **267**. The contacts **267** are connected by means of conductors **268** to the various conductors **256**. The arm **266** is connected by means of a conductor **269** to the conductor **257**. The switch arm **266** has an elongated contact **270** formed on the same and which operates to engage the contacts **267**. As this latter contact moves with the switch, one, two or three of the contacts **267** are closed and the interrupting device G caused to produce four, three, two or one tone pulses in the speakers.

The operation of the invention is as follows: The tube **21** when energized functions as an oscillator with a

grounded plate. Output from the oscillator is fed from the cathode **24** of the tube through the conductors **75** and **152** and to the grid **155** of the amplifier tube **154**. The frequencies of the oscillating current is principally determined by the amount of inductance of the coil **26** included in the circuit by switch **35** and by the amount of capacity introduced into the circuit by the switch **60**. The amplitude of the alternating current so produced is equalized for the various frequencies by the resistors **122**, etc., controlled by switch **131**. In addition to the capacity procured from condensers **27**, **28** and **29**, additional capacity is introduced into the circuit from the condensers **218**, **220** and **222**. This is accomplished by the rotary switch **233**. This switch is driven at a uniform rate of speed and successively and gradually increases and decreases the total capacity so introduced. The capacities **218**, **220** and **222** are selected as to value to cause the frequencies to rise and fall according to a predetermined rate. This has the effect of frequency modulating the alternating current generated by the oscillator C. The interrupting device G includes the switches **249**, **250**, **251** and **252** which are connected in series in a circuit between the plate **23** of the oscillator tube **21** and ground. When all of these switches are closed the plate is grounded rendering the tube **21** inoperative. As the cam **248** successively engages the cam followers **255** the said switches are successively opened causing alternate periods of operation and cessation of operation of the oscillator which produces sound pulses in the loud speakers **10**, **11**, **12** and **13**. There being four switches controlling the energization of oscillator C, four pulses may be produced in succession during a single revolution of the shaft **246**. Paralleling the switches **249** to **252** is the switch **265**. This switch permits of maintaining the plate grounding circuit closed even though the switches **249** to **252** are opened. Thus three, two or one pulse may be procured by properly manipulating switch **265**. Switch **259** deenergizes motor **241** after shaft **246** has made a single revolution, which may only be again energized by actuating push button **264** long enough to cause cam **248** to move off from the cam follower controlling switch **259**. The frequency modulated alternating current is amplified by the amplifier D and passes through the attenuator E, and energizes the loud speakers **10** to **13**. When it was first attempted to use loud speakers for the simultaneous testing of a number of persons it was found that the sound waves were reflected by the walls and met the oncoming sound waves from the speaker. This caused the sounds to be increased in intensity at some locations and decreased in intensity at other locations within the room. In other words standing waves were produced. This effect could not be overcome with any arrangement of the speakers. Comparable tests could hence not be made. This was overcome by frequency modulating the alternating current so a sound of substantially the desired frequency was obtained which had a slight amount of warble to it. This warble, however, was slight enough so that the person being tested would never discern the difference and to all intents and purposes was aware only of hearing a sound of the desired pitch. The reflected sound waves in such case never meet the oncoming sound waves at the same locality and so no standing waves are produced. By directing the sounds toward a reflecting wall the reflected waves are utilized to augment the direct waves in a manner such that almost uniform sound intensity can be procured throughout the entire area in which the seats of a school room are situated. The best results were attained when the loud speaker closest to the reflecting wall was situated a distance therefrom less than the velocity of sound divided by the frequency of modulation of the alternating current.

Termination of the sound pulses in the form of the invention shown in Fig. 1 is procured by disabling the oscillator tube **21**. The same results can be procured by controlling the grid bias on the amplifier tube. A circuit utilizing this system is shown in Fig. 3. Due to the similarity of construction the description of the same will not be repeated and the same reference numerals followed by the suffix "*a*" will be used to designate the corresponding parts. In this form of the invention the grid resistor **164***a* is connected by means of a conductor **500** to a filter **501** comprising a resistor **502** and a condenser **503**. The condenser **503** is grounded by means of a conductor **504**. Grid bias is furnished from the power supply H*a*. For this purpose a tap **505** is taken on the secondary **78***a* of transformer **76***a*. A conductor **506** is connected to the tap **505** and to a current limiting resistor **507**. This resistor is in turn connected to a conductor **508** which is connected to resistor **502**. Between the tap **505** and ground a resistor **509** is connected which determines the amount of the bias for the grid **155***a* of tube **154***a*. This resistor is shunted by a by-pass condenser **510**. The bias is of such a value that the tube **154***a* is biased to cut off and normally fails to function. For rendering the tube operable the switches **249***a*, **250***a*, **251***a* and **252***a* are employed. In this form of the invention said switches are normally open and are adapted to be closed when the cam **248***a* engages the proper cam follower **255***a*. These switches are all connected in parallel by means of the conductors **256***a*, which are connected to the switch arms **254***a*. The conductors **268***a* connect the other switch arms **252***a* to the contacts **267***a* of the switch **265***a*. The conductors **257***a* and **269***a* are connected to the conductor **508**.

The method of operation of the form of invention shown in Fig. 3 is as follows: Normally the tube **154***a* is disabled due to the high grid bias on the grid **155***a* of the same. When any of the contacts **267***a* are disconnected from the switch arm **266***a* the circuit through the corresponding switch **249***a*, etc., is open. Upon closing of said switch by the cam **248***a* a path is formed for the grid current which includes conductor **508**, conductor **257***a*, the conductors **256***a* and conductor **258***a* to ground. The opening of the circuits by the switch **265***a* immediately disables the corresponding switch of switches **249***a*, etc., thus controlling the number of pulses produced during each rotation of the shaft **247***a*. The results procured with this form of the invention are exactly the same as with the other form of the invention excepting that the control is procured through the amplifier tube instead of the oscillator tube.

The advantages of the invention are manifest. The conglomeration of wires and circuits used with other forms of test systems for testing the hearing acuity of persons is eliminated with the instant invention. With the invention the sound intensity is substantially constant throughout the entire room in which the test is being conducted so that numerous persons may be conveniently tested. By the use of ear closures the ears of the patients can be selectively tested.

Changes in the specific form of the invention, as herein described, may be made within the scope of what is claimed without departing from the spirit of the invention.

Having described the invention, what is claimed as new and desired to be protected by Letters Patent is:

1. In a group hearing test system for simultaneously and collectively testing a number of persons, an oscillator for generating an alternating current suitable for producing an audible test tone, an interrupting device connected to said oscillator and varying the continuity of the alternating current to produce current pulses of certain duration, a periodically operated frequency modulating device connected to the oscillator and periodically varying the frequency of the alternating current, means for causing the periods of the modulations produced by said modulating device to be shorter than the lengths of said pulses, and a loud speaker energized by said current pulses and converting said current pulses into warbled tone pulses uniformly audible to the persons tested.

2. In a group hearing test system for use in a room having an acoustical reflecting wall and a wall opposite thereto, the combination of a loud speaker in said room adjacent said second named wall and emanating sound waves directed toward said reflecting wall and a generator of frequency modulated alternating current pulses for energizing said loud speaker to produce warbled tone pulses.

3. In a group hearing test system for use in a room having an acoustical reflecting wall and a wall opposite thereto, the combination of a plurality of loud speakers in said room adjacent said second named wall and emanating sound waves directed toward said reflecting wall and a generator of frequency modulated alternating current pulses for energizing said loud speakers to produce warbled tone pulses.

4. In a group hearing test system for use in a room having an acoustical reflecting wall and a wall opposite thereto, the combination of a plurality of loud speakers in said room all emanating sound waves directed toward said reflecting wall, some of said speakers being situated adjacent said second named wall and a generator of frequency modulated alternating current pulses for energizing said loud speakers to produce warbled tone pulses.

5. In a group hearing test system for use in a room having an acoustical reflecting wall and a wall opposite thereto, the combination of a loud speaker in said room adjacent said second named wall and emanating sound waves directed toward said reflecting wall and a generator of frequency modulated alternating current pulses for energizing said loud speaker, the distance of said loud speaker from said reflecting wall being less than one-half the ratio of the velocity of sound in air divided by the frequency of modulation of said alternating current.

6. In a group hearing test system for use in a room having an acoustical reflecting wall and a wall opposite thereto, the combination of a plurality of loud speakers in said room all emanating sound waves directed toward said reflecting wall, some of said speakers being situated adjacent said second named wall and others being disposed intermediate said walls, the distance of said last named loud speakers from said reflecting wall being less than one-half the velocity of sound in air divided by the frequency of modulation of said alternating current.

7. In a group hearing test system for use in a room having acoustical reflecting walls for collectively testing a number of persons distributed about said room, the combination of a sound producing device disposed at one locality in said room and emanating sound waves toward certain of said walls, and an electric generator of groups of alternating current pulses comprising components of different frequencies all within a predetermined range, said pulses energizing said sound producing device to produce groups of tone pulses of varying frequency according to predetermined sound patterns.

8. In a group hearing test system for use in a room having an acoustical reflecting wall and a wall opposite thereto, a number of seats in said room arranged different distances from said walls for positioning the patients to be tested in a manner facing the second named wall for testing a number of persons distributed about said room, the combination of a number of loud speakers in said room all emanating sound waves directed toward said reflecting wall and a generator of frequency modulated alternating current pulses connected to and energizing said loud speakers.

9. In a group hearing test system for use in a room having an acoustical reflecting wall and a wall opposite thereto, a number of seats in said room arranged different distances from said walls for positioning the patients to be tested in a manner facing the second named wall for testing a number of persons distributed about said room, the combination of a number of loud speakers in said room all emanating sound waves directed toward said reflecting wall, an audiometer in said room connected to and energizing said speakers and a frequency modulating device connected to said audiometer and varying the frequency of the alternating current generated thereby to cause said loud speakers to provide a warbled tone.

10. In a group hearing test system for use in a room having an acoustical reflecting wall and a wall opposite thereto, a number of seats in said room arranged different distances from said walls for positioning the patients to be tested in a manner facing the second named wall for testing a number of persons distributed about said room, the combination of a number of loud speakers in said room all emanating sound waves directed toward said reflecting wall, an audiometer connected to and energizing said speakers and a frequency modulating device connected to said audiometer and varying the frequency of the alternating current generated thereby to a degree to cause said loud speakers to produce a warbled tone varying in pitch above and below the pitch for which the audiometer is set an amount substantially aurally imperceptible to the patient.

11. In a group hearing test system for use in a room having an acoustical reflecting wall and a wall opposite thereto for testing a number of persons distributed about said room, and combination of a plurality of loud speakers in said room adjacent said second named wall and emanating sound waves directed toward said reflecting wall, an audiometer connected to and energizing said speakers and a frequency modulating device connected to said audiometer and varying the frequency of the alternating current generated thereby to cause said loud speakers to produce a warbled tone.

12. In a group hearing test system for use in a room having an acoustical reflecting wall and a wall opposite thereto for testing a number of persons distributed about said room, and combination of a plurality of loud speakers in said room adjacent said second named wall and emanating sound waves directed toward said reflecting wall, an audiometer within said room connected to and energizing said speakers and a frequency modulating device within said room connected to said audiometer and varying the frequency of the alternating current generated thereby to a degree to cause said loud speakers to produce a warbled tone varying in pitch above and below the pitch for which the audiometer is set an amount substantially aurally imperceptible to the patient.

13. In a group hearing test system for use in a room having an acoustical reflecting wall and a wall opposite thereto for testing a number of persons distributed about said room, and combination of a plurality of loud speakers in said room adjacent said second named wall and emanatsound waves directed toward said reflecting wall, an audiometer within said room connected to and energizing said speakers, said audiometer including an oscillator having an inductance and a condenser connected to resonate at a predetermined frequency and producing an alternating current of such frequency, a bank of condensers of graduated values and time controlled means for successively and periodically connecting said condensers to said first named condenser to frequency modulate said alternating current and cause said loud speakers to produce a warbled tone.

14. An audiometer including an oscillator having an inductance and a condenser connected to resonate at a predetermined frequency and producing an alternating current of such frequency, a loud speaker operated thereby, variable condenser means connected to said condenser and time controlled means connected to and periodically varying the capacity of said variable condenser means connected to said first named condenser to frequency modulate said alternating current and cause said loud speaker to produce a warbled tone.

15. An audiometer including an oscillator having an inductance and a condenser connected to resonate at a predetermined frequency and producing an altrenating current of such frequency, a loud speaker energized there-

by, a bank of condensers of graduated values and time controlled means for successively and periodically connecting said condensers to said first named condenser to frequency modulate said alternating current and cause said loud speaker to produce a warbled tone.

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