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VARIABLE FREQUENCY OSCILLATOR

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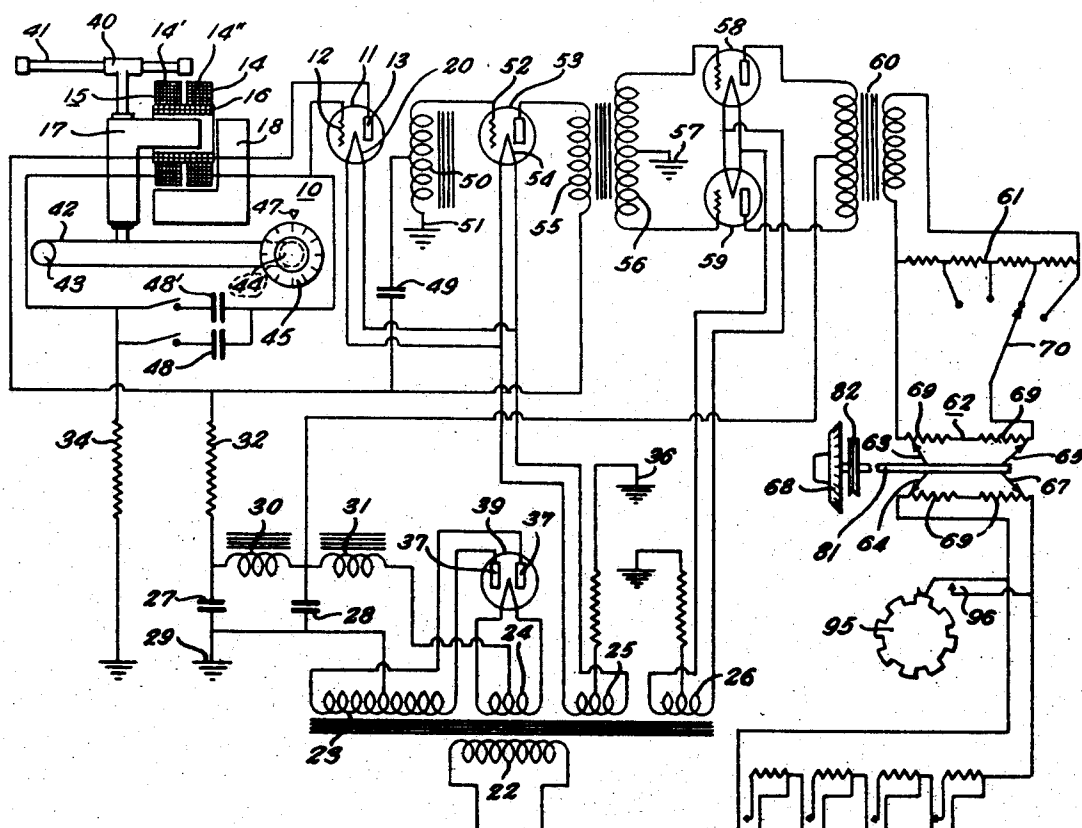


Fig. 1.

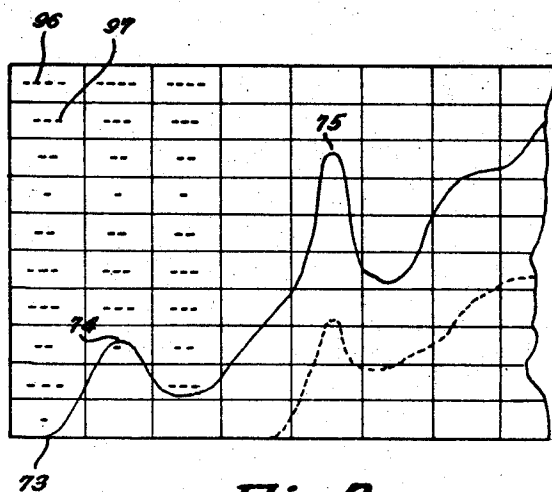


Fig. 3.

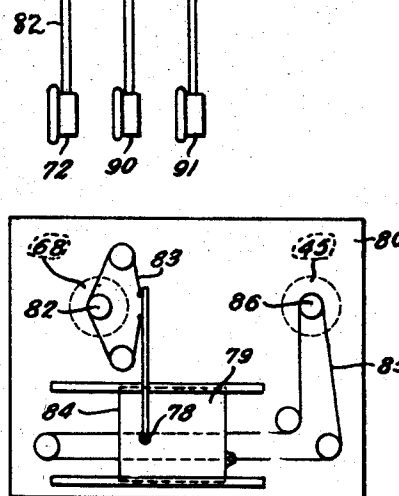


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VARIABLE FREQUENCY OSCILLATOR

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9 Claims. (Cl. 174—177)

This invention relates to audio oscillators and the testing and treating of the ear.

One object of the invention is the provision of an audio oscillator having provision whereby the frequency of the oscillations may be varied without changing the output or sound intensity.

Another object of the invention is the provision of an audio oscillator adapted for use in connection with the ears for testing or treating deafness, arranged to be tuned to any frequency in the normal audible frequency range, and having provision whereby the frequency and the sound intensity may be each independently controlled without affecting the other.

Another object of the invention is the provision of an oscillator having primary and secondary windings of a transformer coupling the grid and plate circuits of a tube at unity coupling, and having a movable magnetic core-part for varying the frequency, this variation being made without affecting the output.

Another object of the invention is the provision of an audio oscillator for the treating or testing of the ear arranged so that the frequency may be varied as desired and so that the output may always be the same at a given setting of the indicator provided in conjunction with the output control.

Another object of the invention is the provision of a novel method of treating deafness to improve the hearing characteristic of the ear.

Still another object is the provision of a novel method of testing the ear for deafness to determine the precise percentage of hearing at any given frequency of sound.

Still further objects and advantages of the invention will be apparent from the following description, the appended claims and the accompanying drawing, in which—

Fig. 1 is a diagrammatic view of the electrical connections of the audio oscillator, embodying the present invention.

Fig. 2 is a view of the audio oscillator showing the recording control mechanism; and

Fig. 3 is a detail of one of the charts obtained in accordance with the present invention.

Referring more particularly to the drawing by reference numerals, like numerals designating similar parts in the various views, 10 designates generally an oscillating circuit included in which is an oscillating tube 11 having grid and plate elements 12 and 13 respectively arranged in grid and plate circuits. In the grid circuit is a secondary winding 14 of the transformer designated generally 15, the secondary winding being coupled

at unity coupling to the primary winding 16 of the transformer, which is provided in the plate circuit. Within the windings is a magnetic core preferably comprising a movable core piece 17 and a fixed core piece 18 which form a practically closed flux circuit when the movable core piece 17 is in its innermost position. The grid and plate circuits of the tube 11 are thus coupled together, the plate being connected to a suitable power supply through the primary winding and the grid being connected to ground through the secondary winding. The tube 11 may be a type 226 tube having three elements including the heater element 20. The primary winding of the transformer may be 2700 turns of No. 36 wire while the secondary of the transformer may be 18,000 turns of No. 40 wire arranged in two windings 14' and 14'' as shown, these windings being provided on core piece 17 having a cross-section of about $\frac{5}{8}$ " x $\frac{7}{8}$ " and a length of about $2\frac{5}{8}$ ". Of course, there are many variations possible in the design of the transformer and the figures mentioned are merely for setting forth one of many forms of construction.

The power supply may come from the primary 22 of 110 volt transformer having secondary coils 23, 24, 25 and 26. The secondary coil 23 has an intermediate connection to condensers 27 and 28 and a connection to ground as indicated at 29. Condensers 27 and 28 may have values of 4 and 2 micro-farads respectively.

Condensers 27 and 28 are connected as shown to the choke coils 30 and 31 each of which may have a value of 20 henries, choke coil 30 being connected as shown to a resistance 32 of about 10,000 ohms which connects in the primary or plate circuit as shown. The grid or secondary circuit of the transformer is connected through suitable resistance 34 to ground. The filament 20 of the tube 11 is connected across the secondary 25 of the power supply transformer, the neutral or intermediate turn of which is connected to ground, as indicated at 36. The secondary 23 of the power supply transformer has its ends connected to the plates 37 of a 280 type tube 39, the heating element of which is connected across the secondary winding 24.

By reason of these connections energy is supplied to the tube 11 which oscillates at a frequency determined by the setting of the core of the transformer 15. This core may be moved into and out of the transformer windings being supported by bracket 40 slidably mounted on a suitable supporting rod 41. The core part 17 is also connected to a belt 42 which operates around an idler

pulley 43 and a control pulley 44 adapted to be manipulated by a hand knob 45. The hand knob 45 is provided with suitable graduations, preferably expressed in terms of frequency and cooperating with a fixed index mark 47. It will be apparent that if the control knob 45 is turned the core part 17 will be moved in the direction of the axis of the transformer to vary the frequency of the oscillations generated in circuit 10. The unity coupling of the primary and secondary of the transformer 15 is maintained regardless of the position of the core part 17, and with a transformer of suitable design such as above indicated the variations of frequency will have no effect on the output, that is on the intensity of the generated sound. Moreover with the transformer having a large number of turns and the other characteristics as previously referred to, the impedance of the transformer effective on the input and output circuits of the tube 11 will be very high as compared to the internal impedance of the tube itself. In the example of transformer arrangement referred to the impedance of the transformer is of the order of ten thousand times the impedance of the tube. This is advantageous, as any changes of tube impedance do not substantially affect the frequency generated. The tube 11 may become old and its impedance change or may be replaced by a new tube with a different internal impedance all without shifting the frequency with respect to the indications on the control knob 45.

In the grid circuit of tube 11 are two condensers 48 and 48' which may have values of .03 and .015 micro-farads respectively and which are selectively coupled across the secondary winding of the transformer 15, to provide for a complete range of frequency throughout the normal audible range.

The plate circuit including the primary of the transformer is connected preferably through a suitable condenser 49 to an audio transformer 50 grounded at one end as indicated at 51 and connected at its other end to the grid 52 of a 226 type tube 53. The heating element 54 of tube 52 is connected in parallel with heating element 20 of tube 11. The plate of tube 53 is connected as shown to the primary 55 of an audio transformer, the secondary 56 of which is connected to ground as indicated at 57 and to two tubes 58 and 59 connected in push-pull relationship to an output transformer 60. The secondary of this transformer 60 is connected through a voltage divider 61 and an output control 62 to a suitable ear piece or ear pieces. The output control 62 has four movable arms, as shown at 63, 64, 65 and 67, all moved simultaneously by a control dial 68. At maximum output value all the arms are in position as shown, while at minimum output value the arms are all at the center of the two resistance elements. These resistance elements, designated 69 may have a total value of 40,000 ohms each. The voltage divider 61 is preferably arranged in four steps which may have values of 150, 1200, 10,000 and 10,000 ohms respectively, suitably controlled by the switch 70 for the variation of the voltage through four steps between minimum and maximum values. The control dial 68 forms a means for manually governing the exact value of the output, this dial being suitably graduated so that its graduations may be readily observable and for indicating definite amounts of output. The graduations on dial 68 are correlated to the several steps of the voltage divider 61. By reason of the construction of

the output or volume control which is described variations in output being made through the voltage divider referred to, are without effect on the frequency of oscillations of the device.

The audio oscillator is adapted to generate oscillations, productive of sounds in the ear piece 72 of any frequency within the normal audible range, say from 20 cycles to 5000 cycles per second, by control of the transformer 15, and the condensers 48 and 48'. The volume or output may be controlled by the dial 68 in conjunction with the switch 70 so that at the lowest volume setting the sounds heard in the ear piece 72 would be very faint and of such character that they may just be detected by the keenest hearing. At the maximum output the volume is very great, so great in fact as to be extremely uncomfortable and vibrate the inner ear.

The apparatus heretofore described may be used for testing the ear to determine the percentage of hearing, or deafness, for treating the ear for restoring the hearing, or at least in part. When used for testing hearing, the ear piece 72 is placed against the ear, and with the frequency control set to any given value, adjustments are made to govern the output or volume until the sound is very faintly heard by the subject. The settings of the volume dial 68 and the frequency dial 45 are noted or recorded, and tests made in a similar manner at various other frequencies so as to determine the exact hearing characteristic of the subject at a number of points along the range of audible frequencies. These values may then be plotted using volume as indicated on the dial 68 for the abscissa readings and the frequency readings for the ordinates. Such a curve as shown in Fig. 3 might be thus obtained, point by point, the values of the frequency increasing toward the right, while increase of the abscissa readings show increase in volume. Thus the subject shows normal hearing at very low frequencies as indicated by the low level of the full line curve at point 73. Point 74 shows a rather deaf spot in the ear. Point 75 on the curve shows a very deaf spot, the general curve indicating that the hearing is much worse at higher frequencies than at very low frequencies. The dotted line curve shows what results might be accomplished after several treatments of the ear in a manner that will be explained later, showing that the hearing has been brought back practically to normal in the range from very low frequencies to an intermediate frequency, while at high frequencies within the normal audible range the hearing shows a marked improvement but is still much below par.

The points on the chart may be plotted by hand from the readings obtained on the dials 45 and 68. Fig. 2 of the drawing, however, shows an arrangement for controlling the movements of a pencil or other suitable recording device 78, cooperating with a chart 79 movably supported on the casing 80 of the instrument. The casing 80 contains the various parts shown diagrammatically in Fig. 1 with the exception of the ear piece or pieces 72 which are connected through the cable 82. The dial 68 is shown in dotted lines in Fig. 2. On the shaft 81 of this dial is a pulley 82 which governs a cable 83 which in turn controls a pencil support on which is mounted the pencil 78. Suitable guide means is provided for holding the chart frame 84 so it may be guided for movements to the right or left. A second cable 85 is attached to the frame 84, and is operated by a pulley 86 on the dial 45 for control-

ling the lateral movements of the chart. Dial 45 as previously mentioned, controls the frequency and also controls the horizontal movements of the chart, while the movements of the pencil 78 are controlled vertically by the dial 68. The subject may control the dial 68 to determine the point at any given frequency at which he starts to hear the sound generated, while the attendant or person making the test may control the variations in frequency as desired, the pencil being constantly against the paper, or being pressed on the paper when the volume is the proper amount and thus give the various points of the curve directly on the chart.

For testing the hearing of a number of subjects at the same time a number of ear pieces 72, 90, 91 etc., may be used in conjunction with the several jacks provided, as shown in Fig. 1. Each subject may have one of these ear pieces against the ear being tested, and the person making the test may control the frequency of the oscillations, simultaneously heard by all of the subjects. At any given frequency the volume is regulated in some predetermined manner so that the subjects can each record the data for his own chart. A mechanical interrupter may be provided in the output circuit, such an interrupter being shown at 95 for periodically shortcircuiting the output circuit through the shortcircuiting switch 96. This interrupter may be operated in some predetermined manner to give a definite number of breaks in the circuit at any given frequency or volume setting. For example the volume may be set at some rather high value and the output of circuit broken four times at this value. Each subject should hear the four breaks in the circuit and can, therefore, mark four dots as indicated at 96 in Fig. 3 in the space corresponding to lowest frequency of the test and maximum volume. The volume may then be reduced to a slightly lower value and the circuit then broken three times, recorded by the subject by marking three dots as indicated at 97. Thus each subject marks the dots on the paper in accordance with the number of breaks caused by the interrupter until he ceases to hear any more, or until he hears only one or two of a complete signal of three or four breaks in the circuit. Thus the peak of the curve indicated at 74 in Fig. 3 might be determined by the subject marking a single dot instead of two dots which should have been heard, showing that he hears at least in part at this frequency and volume setting. A great number of persons can, therefore, be tested at the same time, each recording the data necessary to show his percentage of hearing at any given frequency.

Audio oscillators, of the type herein described may be used in treating the ear to improve the hearing. The hearing of a person who is hard of hearing but who still retains the sense of hearing to some extent, that is the hearing of a person whose auditory nerve is still alive, will be improved by treating the ear generally in the following manner. Having determined a range of frequencies to which the ear of the subject is not fully responsive, or in other words having determined a deaf spot of the ear, the volume is set to a value above the limit of hearing of the defective ear in the deaf spot. In some cases the volume may be set at such a high value that for frequencies in the deaf spot of the defective ear the vibrations are quite loud or even vibrate the inner ear as evidenced by a strong vibration felt within the head of the subject. The volume

is then preferably kept at this value and the frequency varied by suitable manipulation of the control dial 45 so as to provide for gradually increasing and gradually decreasing frequencies through a range of frequencies from one that can be heard to and through the frequencies that are not audible to the subject. This method is carried out for several minutes, and seems to have the effect of setting up a counter-irritant causing increased circulation of the blood to and from the ear. It has been found in many actual tests and treatments that in very many instances the hearing has been markedly improved in a very short time. The treatment may be given several times a week, each treatment continuing for a few minutes, although obviously the treatment may be shortened and given at more frequent intervals and otherwise varied to suit particular conditions.

An important use of the device is for diagnosing ear troubles, as the shape of the curve gives a fair indication of the particular trouble. Thus ossification, soft spots, lime deposits, attachments, etc., can be detected by the curve shape, since the volume required to make the ear respond is a determined factor for any given frequency. After determination of the trouble, the proper ear treatment may then be determined upon.

It will now be apparent that the construction heretofore described provides a device that gives a volume of known intensity for any given setting of the volume dial, and one in which the frequency may be varied without altering the volume or output. The simple controls may be readily operated either by the subject or by the attendant. The oscillator may be used for the treating or the testing of deafness although it is apparent that the apparatus is not necessarily limited in scope to either or both of these particular uses mentioned.

While the method herein described, and the form of apparatus for carrying this method into effect, constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to the precise method and form of apparatus, and that changes may be made in either without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A device of the class described comprising an audio oscillator including an audio oscillating tube for producing electrical vibrations, a converter for changing the electrical vibrations to sound vibrations, means for varying the intensity of the sound vibrations, and manually adjustable means for gradually varying the frequency through a continuous range of values and adapted to be set to selected positions for determining the frequency of the vibrations, said two means being practically independent of one another and each effecting its control without modification of the factor governed by the other.
2. An electrical oscillator for testing the hearing of a subject to determine the volume of sounds within the limit of hearing at various selected frequencies throughout the range of normal audibility and adapted to produce sounds of great intensity at any frequency in the range of normal audibility for the treatment of the ear of the subject at particular frequencies, comprising an audio oscillating electronic tube having elements in an oscillatory circuit, adjustable means adapted to be adjusted to selected

- positions for varying the frequency of oscillation throughout a wide range of audible frequencies with a constant volume, indicating means connected with said adjustable means to indicate the different selected settings of said adjustable means, means for converting the oscillations at audible frequency to air oscillations for application to the ear of the subject, and means for widely varying the intensity of the air oscillations while the frequency remains constant for any particular setting of the adjustable means.
3. An electrical oscillator for testing the hearing of a subject to determine the volume of sounds within the limit of hearing at various selected frequencies throughout the range of normal audibility and adapted to produce sounds of great intensity at any frequency in the range of normal audibility for the treatment of the ear of the subject at particular frequencies, comprising an oscillatory electronic tube having input and output elements in oscillatory circuits, adjustable means adapted to be adjustably set for proportionately varying the impedance of the circuits containing the input and output elements of the tube and producing variations of frequencies throughout a wide range of audible frequencies with a constant volume, indicating means connected with said adjustable means to indicate the different selected settings of said adjustable means, means for converting the oscillations at audible frequency to air oscillations for application to the ear of the subject, and means for widely varying the intensity of the air oscillations while the frequency remains constant for any particular setting of the adjustable means.
4. An electrical oscillator for testing hearing comprising an audio oscillating circuit, an amplifier circuit therefor, a transformer having a primary winding connected in the amplifier circuit and a secondary winding inductively related to said primary winding, an ear piece, and a connection from said ear piece to the secondary of said transformer, said connection having substantially constant impedance to both the amplifier circuit and the ear piece and including a voltage dividing resistance having provision for changing the output while maintaining the frequency constant and variable means independent of said connection for varying the frequency of the oscillating circuit while the output remains constant.
5. A device of the class described comprising an oscillating electronic tube having input and output elements in input and output circuits, variable frequency controlling means adjustable to proportionately vary the impedance of the input and output circuits for changing the audio frequency in the audible range with constant power in said output circuit, means for gradually changing and adjustably setting said frequency controlling means for determining the frequency to a desired point in the audible range, a converter for changing electrical vibrations to mechanical vibrations of audible frequency, a converter circuit, an amplifier circuit including an amplifier electric tube between the converter circuit and the output circuit of said first tube, adjustable means in said converter circuit for changing the amplitude of vibrations of said converter while maintaining substantially constant impedance effect on the amplifier circuit, indicating means for the frequency, and indicating means for the converter vibration amplitude.
6. A device of the class described comprising an audio oscillator including an oscillating tube having input and output circuits connected with unity coupling for producing electrical vibrations of audible frequency, a converter for changing the electrical vibrations to sound vibrations, means for varying the intensity of the sound vibrations without affecting the frequency, and adjustable means adapted to be manually operated for gradually proportionately varying the impedance of the input and output circuits of said tube and adapted to be set to selected positions for determining the frequency without affecting the intensity.
7. An electrical oscillator of the character described for producing mechanical vibrations in the audible frequency range comprising an audio oscillating tube, an inductance inductively coupling the input and output elements of said tube together, said inductance having an impedance value so much higher than the impedance value of the said tube as to make changes of tube impedance of negligible effect on the generated frequencies, a magnetic core piece for the inductance, means for adjustably setting said core piece with respect to the windings of the inductance to select a desired frequency while the output is maintained constant, and a converter associated with said tube for changing the electrical vibrations of the oscillating tube to mechanical vibrations.
8. A device of the class described comprising an oscillating tube and an oscillating circuit therefor productive of electrical vibrations in the audible range of frequencies, a converter for changing the electrical vibrations to mechanical vibrations, means for varying the intensity of the vibrations without affecting the frequency, a transformer having inductively related primary and secondary windings with unity coupling connected to output and input elements of said tube and having a relatively movable iron core, adjustment means adapted to be set to selected positions and to move said core with respect to said windings to gradually vary the frequency of oscillations through a continuous range of values at substantially constant intensity, and means for indicating the position of said adjustment means.
9. A device of the class described comprising an oscillating tube and an oscillating circuit therefor productive of electrical vibrations in the audible range of frequencies, a converter for changing the electrical vibrations to mechanical vibrations, means for varying the intensity of the vibrations without affecting the frequency, a transformer having inductively related primary and secondary windings with unity coupling connected to output and input elements of said tube and having a movable iron core piece adjustable from a position within said windings to a position outside of said windings, a fixed iron core part outside of said windings and cooperating with said core piece to form a closed flux path when the core piece is within the windings, adjustment means adapted to be set to selected positions and to move said core piece to gradually vary the frequency of oscillations through a continuous range of values at substantially constant intensity, and means for indicating the frequency of oscillations.

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