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APPARATUS FOR USE IN THE TREATMENT OF DEAFNESS.

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1,057,279. Patented Mar. 25, 1913.

Fig. 2.

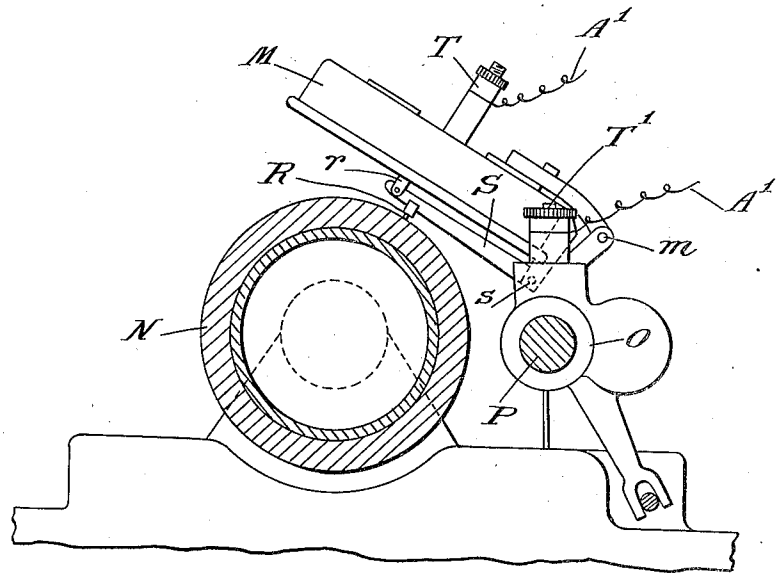


Fig. 3.

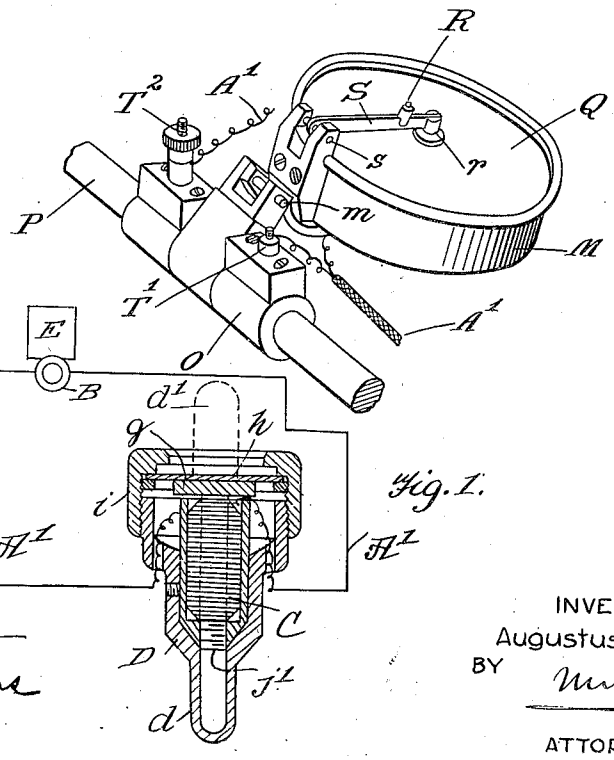


Fig. 1.

WITNESSES

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APPARATUS FOR USE IN THE TREATMENT OF DEAFNESS.

1,057,279. Specification of Letters Patent. Patented Mar. 25, 1913.

Application filed July 30, 1909. Serial No. 510,463.

To all whom it may concern:

Be it known that I, AUGUSTUS ROSENBERG, a subject of the King of Great Britain, and resident of 259 High Holborn, London, W. C., England, engineer, have invented Apparatus for Use in the Treatment of Deafness, of which the following is a specification.

My invention has for its object a device for the treatment of deafness and other disorders of the auditory organs by agitating the sound-conducting and sound-perceiving portions of the ear by means of mechanical vibrations having a continuous undulatory character corresponding to that of the sounds (speech, music and the like) to which it is required to train the ear to respond.

By my invention, mechanical vibrations, having the continuous undulatory character required, are generated initially by means of apparatus (of the general type represented by the phonograph) capable of producing such vibrations for any length of time as may be necessary for the purposes of the treatment. The vibrations thus generated are converted into, and transmitted electrically without make-and-break as, corresponding continuous undulatory pulsations in the current flowing in an electric circuit; the current-pulsations being due to corresponding continuous undulatory variations of resistance produced in the electrical conductor under the control of what may be termed a sound-controlled current-regulator (such for example as a microphone) which is interposed in the circuit and agitated by direct mechanical contact with the phonograph or equivalent instrument whereby the initial vibrations are mechanically generated. The continuous undulatory pulsations thus set up in the electric current are reproduced as mechanical vibrations by means of an improved form of electrical apparatus (analogous to the telephonic receiver) which is also interposed in the circuit and is further adapted to transmit said vibrations to the inner ear or the osseous structure of the head; the arrangement being such that the reproduced vibrations exhibit not only a character and periodicity identical with those of the original vibrations, but also an amplitude so much greater as is necessary in order that transmission to the sound-perceiving portions of the ear may be insured.

The apparatus whereby the continuous undulatory mechanical vibrations are initially generated, and the current-regulator whereby said vibrations are converted into corresponding continuous undulatory pulsations in the electric current, are so combined as to constitute together a single instrument of special construction (hereinafter for convenience called the "transmitter"), wherein the movements of a stylus (or equivalent mechanical contact-member) under the influence of a phonographic or like record are communicated directly to the structure of the microphone or equivalent device.

Hence the device of the present invention consists in the combination of a "transmitter" such as that just described; a source of electrical energy in whose circuit the microphonic element constituting the current regulator of said transmitter is interposed; an electro-magnet or other electrical device (hereinafter for convenience called the "undulator") also interposed in the circuit and adapted to transform into undulatory mechanical vibrations, the undulatory pulsations set up in the electric current by the action of the current-regulator; and a casing or support for the undulator (hereinafter for convenience called the "vibrator"), adapted to be inserted in the external auditory canal or otherwise applied to the person of the patient in such manner that the mechanical vibrations communicated by the undulator to the vibrator shall be transmitted to the osseous structure of the head.

In the accompanying drawings, Figure 1 is a diagrammatic view of the entire device, the undulator and vibrator being shown in section. Fig. 2 is an end elevation, partly in section, of a transmitter as above described; and Fig. 3 is a perspective view of the microphonic portion of said transmitter, the microphone itself being thrown back into the inoperative position.

A (Fig. 1) represents a source of electric energy which is interposed in a circuit A^1, a switch F being also interposed in the circuit for the purpose of opening or closing the same when desired. The sound-controlled current-regulator B, which is agitated by direct mechanical contact with the phonograph or equivalent instrument E, is also interposed in the circuit, and the undulator, contained in the vibrator D, is connected therewith in the manner to be described. The undulator comprises a permanent mag-

net j' wound in the neighborhood of its pole or poles with a coil C of insulating wire, which is connected at its ends with the terminals of the circuit; the magnet-armature being preferably constituted by a freely-vibrating piece of magnetizable metal g mounted on a spring h which bridges, and is attached at both ends to the vibrator D or casing of the undulator. The magnet j' itself is preferably of the tubular or iron-clad type, wherein a central core is surrounded at a distance by a concentric tube in magnetic connection with the core, the winding being placed in the annular space between the core and tube, as indicated.

The vibrator D, which is adapted to respond to the vibrations set up in the undulator and to transmit these vibrations directly to the person of the user, is in the form of a casing inclosing the undulator from whence it receives pulsations, this casing being preferably circular in cross section, and of approximately mushroom-shape as indicated. Any portion of the vibrator may be applied to the person, but it is generally preferable to employ for this purpose that end of the casing which is opposite the magnetic armature g; the said end being prolonged as at d to form a cylindrical plug having a length and diameter adapted for insertion into the external auditory canal in such manner as to insure the communication of the vibrations to the inner and middle ear (or other parts involved in the disorder) as directly as is practicable.

The plug d should have a smooth surface, and a rounded end as indicated so as to avoid injury to the surface with which it is brought into contact.

The amplitude of the vibrations caused by the magnet-armature or equivalent part is regulated by adjusting the distance between the armature and the pole of the magnet. For this purpose the armature g may be attached by the spring h not directly to the casing forming the vibrator D, but to the interior of a cap i which preferably screws over the end of the casing opposite to the plug d, the armature being made to approach or recede from the pole of the electro-magnet by turning the cap until the vibrations set up on the passage of current through the winding of the magnet exhibit the amplitude or intensity desired.

It will be obvious that, however powerful may be the current passed through the coil of the electro-magnet, any tendency of the armature to "stick" may be overcome by increasing the distance of the armature from the pole of the magnet. In cases however, where the armature itself, or (for example) a plug d^1 carried thereby as indicated in dotted lines, and similar in form to the plug d already mentioned, is applied to the person or inserted in the external auditory canal, it will be evident that the pressure consequently exerted upon the spring h (or equivalent part) supporting the armature will tend to damp the vibrations of the latter, or even to cause the armature, by contacting with the pole of the magnet, to stick altogether. In such case it is only necessary to increase the distance of the armature from the pole of the magnet until the armature, although subjected to pressure, remains free to vibrate.

It will be obvious that, more especially in cases where a magnet-armature is employed in the form of a magnetizable element constituted or carried by a resilient diaphragm, the mechanical vibrations resulting from the pulsations of the electric current will tend to generate and may actually result in producing so-called sound-waves which will be transmitted through the atmosphere. These sound-waves, which may be distinctly audible to persons of normal hearing powers, and may be partially audible to the patient under treatment in consequence of their impinging upon the membrana tympani of his ear (where this is in a condition to respond to aerial impulses), are nevertheless only incidental or by-products of the action of the vibratory apparatus of the present invention.

Referring now to the transmitter, it is to be observed that the reason why it is necessary that the so-called sound-controlled current regulator should be agitated, through the agency of the phonograph or equivalent device employed for the purpose, not by sound-waves transmitted aerially, but by direct mechanical contact with said device, is that the pulsations in the electric current, and consequently also the mechanical vibrations which are produced in the portion of the apparatus applied to the person of the patient and which are transmitted by osseous conduction to the sound-perceiving portion of the ear, must have, if required by the circumstances of the case under treatment, an amplitude as great as is practically attainable. Hence, for example, the vibratory diaphragm of a microphone constituting the current regulator may be provided with a stylus which rests upon the record-cylinder or equivalent part of a phonograph or like instrument, so that, on the record-cylinder being rotated, the microphone will be agitated to an extent as great as would the ordinary sound-diaphragm of the phonograph. Such an arrangement is illustrated in Figs. 2 and 3 respectively, which show an instrument wherein a microphone M takes (in effect) the place of the sound-box of a phonograph. N is the rotary record-cylinder of the instrument, and O the carrier upon which the microphone M is mounted, and together with which the microphone is caused (by usual means, not shown) to move along

a guide P extending parallel with the axis of the cylinder N, this traversing movement of the carrier O and microphone M being performed in time with the revolutions of the record-cylinder in the same way as in an ordinary phonograph. The microphone M may be hinged to the carrier O as at *m* so as to be capable of being thrown back (as indicated in Fig. 3) in order that access may be had to its underside when necessary. When the microphone is in the normal position shown in Fig. 2, its diaphragm Q is presented toward the record-cylinder N, and rests thereon through the medium of a stylus R carried by a lever S which is hinged at one end to the periphery of the microphone casing as indicated at *s*, the opposite end of this lever, near which end the stylus R is situated, bearing against the diaphragm Q near the center of the latter, as indicated at *r*. The casing of the microphone M is connected with one member of the circuit A^1 through the insulated binding-post T^1 (the nut of which is omitted in Fig. 3) while the terminal T which is mounted on the back of the casing and connected with the usual carbon cup in the interior of the microphone, is connected with the other member of the same circuit through the insulated binding-post T^2. It will be seen that as the record-cylinder N rotates and the carriage O is caused to move lengthwise of said cylinder, the vibrations communicated through the stylus R and lever S to the diaphragm Q will so agitate the microphone as to cause the resistance interposed thereby in the circuit A^1 to be continuously varied in accordance with the nature of the sound whereof the cylinder N bears a record. Consequently, synchronous vibrations will be produced in the undulator C, and these vibrations will be transmitted by the vibrator D to the osseous structure of the head of the patient.

It is to be clearly understood that while it is necessary that the electro-magnetic or other device herein called the "undulator", should be capable of translating into undulatory mechanical vibrations undulatory pulsations produced in the electric current by the current-regulator, I do not intend to convey that for the purpose of training the disordered ear I employ exclusively vibrations which are undulatory in the restricted sense of being phonetic (*i. e.* of a character corresponding to the sounds of human speech), since I may and do employ vibrations of any character (musical or other) suited to the particular nature of the disorder and the progressive stages of recovery, and corresponding to any sounds (excepting, of course, mere "noise") to which it may be required to train the ear to respond. Hence the phonograms or records used in connection with the phonograph or similar instrument may advantageously represent not merely human speech (in the form, for example, of recitations or conversations), but also musical performances of all kinds, orchestral and other, as well as songs; in fact the greater the diversity (as regards both character and pitch) of the sounds represented, the better. Obviously, in cases where vibrations corresponding only to musical sounds are for the time being employed, any suitable mechanically or automatically actuated musical instrument (such for example as a musical box, or an automatic piano) may be substituted for the phonograph or similar instrument.

Claims:

1. A device for enabling the communication to the ear of electro-magnetically produced mechanical vibrations, consisting in the combination of a permanent magnet having a central core surrounded at a distance by a concentric tube in magnetic connection with the core, a coil of insulated wire wound about the central core in the space separating said core from the surrounding tube, a spring-supported armature for said magnet, means for adjusting the normal distance of the armature from the pole of the magnet, a casing for the magnet, and a plug integral with said casing and adapted for insertion in the external auditory canal.

2. A device for enabling the communication to the ear of electro-magnetically produced mechanical vibrations, consisting in the combination of a permanent magnet wound with an insulated conductor, a casing of approximately mushroom-shape for the magnet, a cap for said casing, having a screw-connection therewith for adjusting the cap toward and from the pole of the magnet, a spring bridging the cavity of the cap, an armature for the magnet carried by said spring so as to participate in the adjustment of the cap, and a plug integral with said casing and adapted for insertion in the external auditory canal.

3. A device for enabling the communication to the ear of electro-magnetically produced mechanical vibrations, consisting in the combination of a permanent magnet wound with an insulated conductor, a casing of approximately mushroom-shape for the magnet, a cap for said casing, having a screw-connection therewith for adjusting the cap toward and from the pole of the magnet, a spring bridging the cavity of the cap, an armature for the magnet carried by said spring so as to participate in the adjustment of the cap, and a plug mounted on the armature and adapted for insertion in the external auditory canal.

4. Means for treating deafness and other disorders of the auditory organs, consisting in the combination with a source of electrical energy, a current-regulator interposed in

the electric circuit supplied with current from said source, and means for so varying the resistance of said current-regulator as to produce in the electric current a series of undulatory pulsations of different amplitudes, of means for transforming said undulatory pulsations into synchronous mechanical vibrations, said means consisting of a permanent magnet having a central core surrounded at a distance by a concentric tube in magnetic connection with the core, a coil of insulated wire forming part of the electric circuit and wound about the central core in the space separating said core from the surrounding tube, a spring-supported armature for said magnet, means for adjusting the normal distance of the armature from the pole of the magnet, a casing for the magnet, and a plug integral with said casing and adapted for insertion in the external auditory canal.

5. Means for treating deafness and other disorders of the auditory organs, consisting in the combination with a source of electrical energy, a current regulator interposed in the electric circuit supplied with current from said source, and means for so varying the resistance of said current-regulator as to produce in the electric current a series of undulatory pulsations of different amplitudes, of means for transforming said undulatory pulsations into synchronous mechanical vibrations, said means consisting of a permanent magnet wound with an insulated conductor forming part of the electric circuit, a casing of approximately mushroom-shape for the magnet, a cap for said casing, having a screw-connection therewith for adjusting the cap toward and from the pole of the magnet, a spring bridging the cavity of the cap, an armature for the magnet carried by said spring so as to participate in the adjustment of the cap, and a plug integral with said casing and adapted for insertion in the external auditory canal.

6. Means for treating deafness and other disorders of the auditory organs, consisting in the combination with a source of electrical energy, a current-regulator interposed in the electric circuit supplied with current from said source, and means for so varying the resistance of said current-regulator as to produce in the electric current a series of undulatory pulsations of different amplitudes, of means for transforming said undulatory pulsations into synchronous mechanical vibrations, said means consisting of a permanent magnet wound with an insulated conductor forming part of the electric circuit, a casing of approximately mushroom-shape for the magnet, a cap for said casing, having a screw-connection therewith for adjusting the cap toward and from the pole of the magnet, a spring bridging the cavity of the cap, an armature for the magnet carried by said spring so as to participate in the adjustment of the cap, and a plug mounted on the armature and adapted for insertion in the external auditory canal.

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Witnesses:
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