No. 789,915. PATENTED MAY 16, 1905.

M. R. HUTCHISON.

METHOD OF DETERMINING DEGREE OF DEAFNESS.

APPLICATION FILED OCT. 19, 1903.

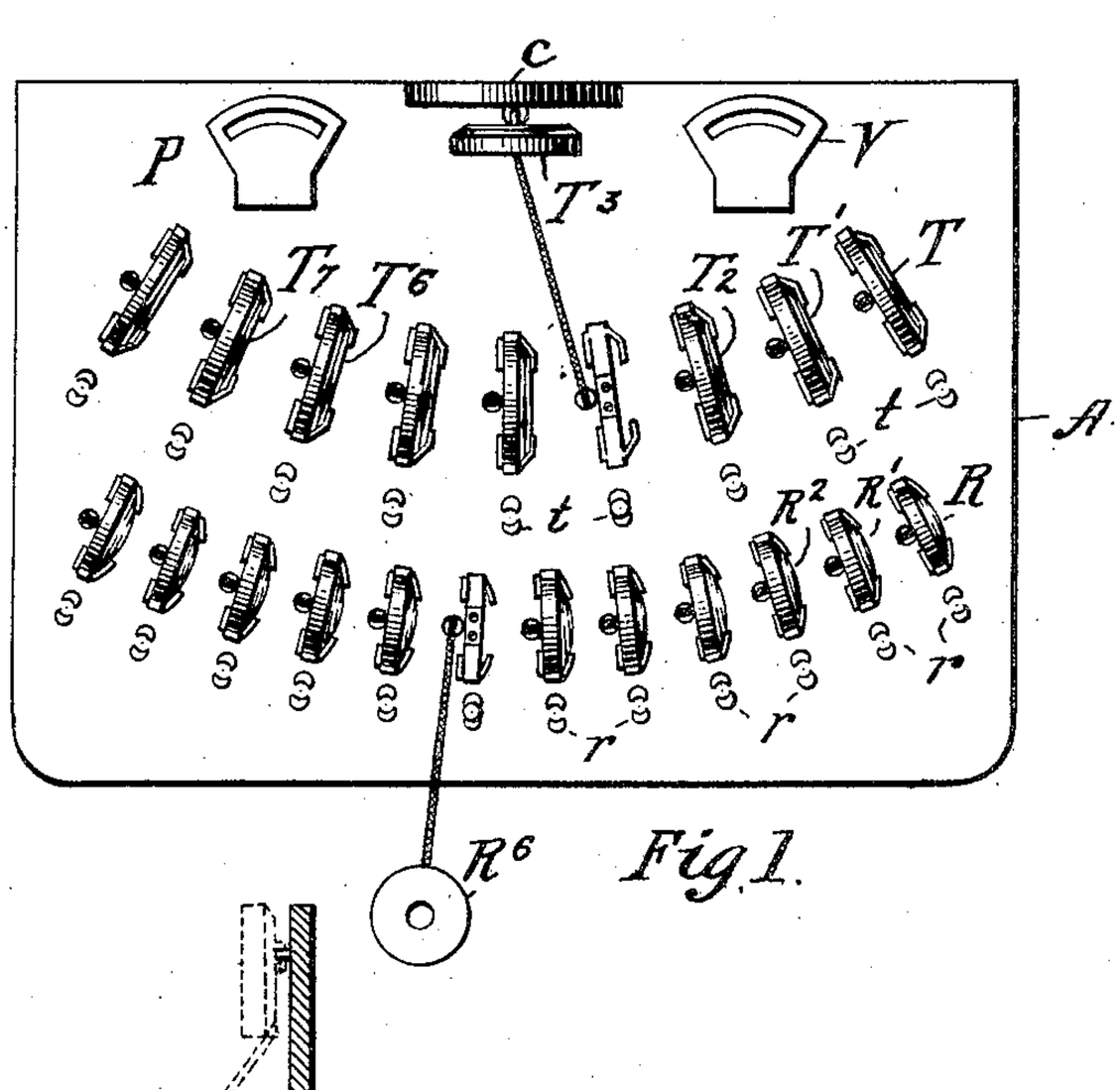

Fig. 1.

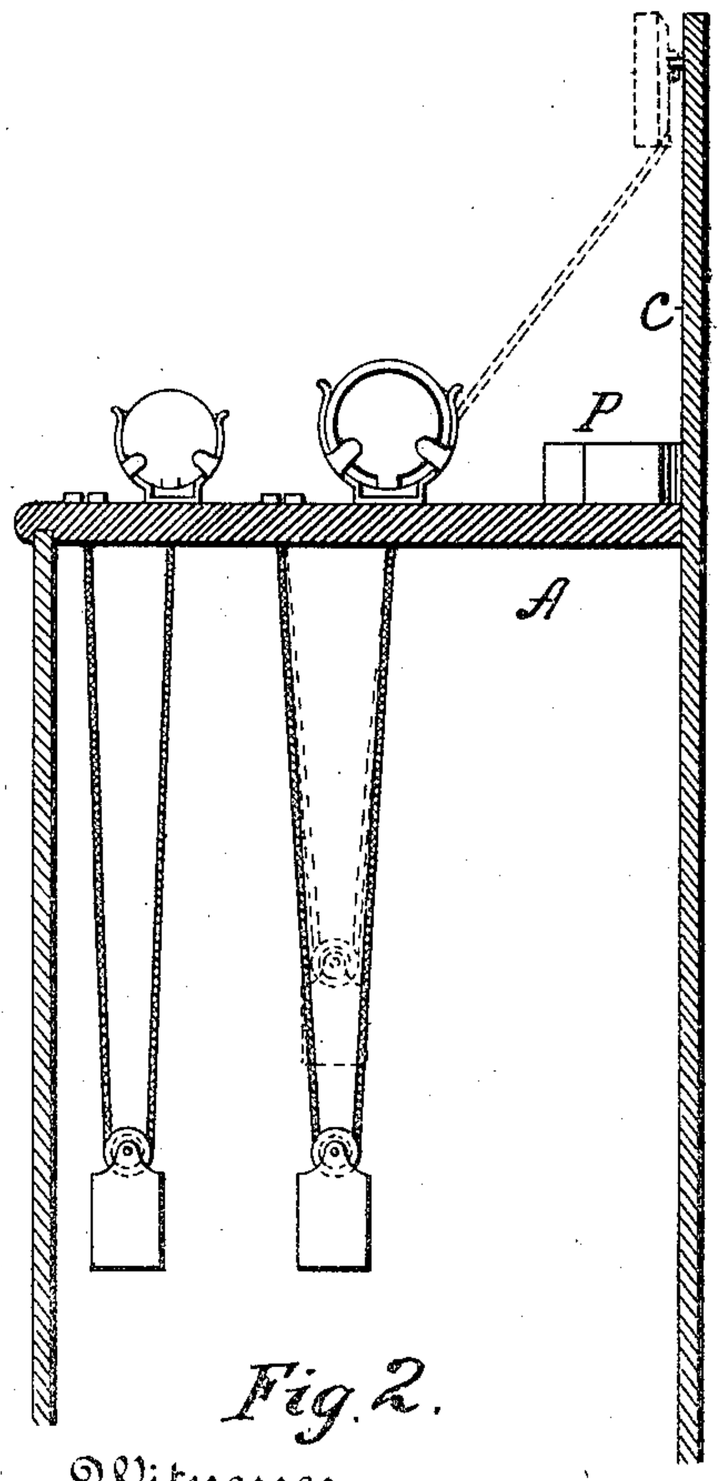

Fig. 2.

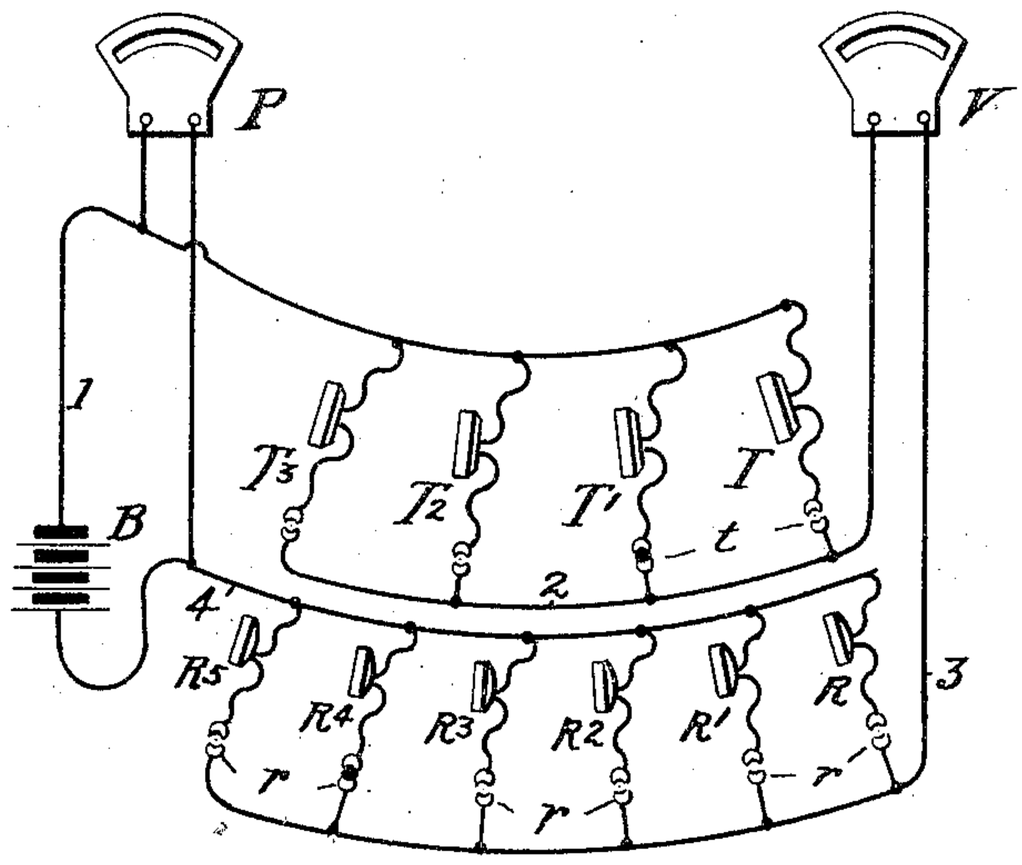

Fig. 3.

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No. 789,915. Patented May 16, 1905.

UNITED STATES PATENT OFFICE.

MILLER REESE HUTCHISON, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO HUTCHISON ACOUSTIC COMPANY, A CORPORATION OF NEW YORK.

METHOD OF DETERMINING DEGREE OF DEAFNESS.

SPECIFICATION forming part of Letters Patent No. 789,915, dated May 16, 1905.

Application filed October 19, 1903. Serial No. 177,533.

To all whom it may concern:

Be it known that I, MILLER REESE HUTCHISON, a citizen of the United States, residing at the city of New York, in the borough of Manhattan and State of New York, have invented certain new and useful Improvements in Methods of Determining Degree of Deafness, of which the following is a full, clear, and exact description.

This invention is a method by which the degree of impairment of hearing of a partially-deaf person can be ascertained in such terms as to be able at once to furnish the person with artificial hearing devices and apparatus best suited to his or her condition.

In selecting an ear-trumpet a partially-deaf person will try various shapes, sizes, and types of the instruments until he finds one with which he can hear best; but in making the selection neither the afflicted person nor the attending physician is guided by any known and definite value or characteristic which the various instruments possess. One may be known as "better" than another, while others may be known as "best adapted" for a certain condition; but to what extent one is better than another or is better adapted than another is never known or, at least, cannot be expressed in terms.

In treating a patient for impaired hearing the physician would be enormously aided if he could ascertain and note accurately the degree of betterment or deterioration of hearing during the progress of the treatment, for then the efficiency of the remedies and apparatus would be definitely known and the treatment regulated accordingly.

My invention not only furnishes a ready and accurate method of "fitting" the ears of deaf persons with hearing apparatus, but also determines how much more deaf such persons are at any instant of test than are persons with normal hearing.

My invention involves the use of certain kinds of hearing apparatus, which by reason of the forces used and the mechanical construction adopted are of certain desired predetermined values or capacities with respect to a standard instrument or combination of instruments. The standard instruments have all the characteristics of value of the normal ear—that is, by their use the hearing of a normal ear is neither improved nor reduced.

The elements used by me in conducting tests are, first, a standard of sound intensity and articulation; second, a standard distance from the source of sound; third, a telephone-transmitter and a telephone-receiver of the said standard or unit values; fourth, a series of telephone-transmitters and a series of telephone-receivers graduated in value from a minimum (say one degree stronger than the standard) to a maximum, (say twenty or more degrees stronger than the standard,) and, fifth, a source of electricity of constant and uniform value.

Impaired hearing is usually due either to a defect in the auditory nerve or to the ankylosis of the ossicles of the ear. The latter is the more general cause of deafness. These bones are articulated in a manner to form an extremely flexible chain, and a decrease of this flexibility or a stiffness of the joints dulls the hearing, both the articulation of spoken words and the general sound being decreased.

The articulation of a word does not exercise the same mechanical force upon the tympanum of the ear as the general sound. It is therefore evident that to enable the impaired ear to understand speech with approximately the same distinctness as the normal ear it is necessary that the mechanical forces corresponding to the general sound and those corresponding to the articulation be presented to the nerves of the impaired ear in the same ratio as they are presented to the nerves of the normal ear.

Artificial apparatus to enable deaf persons to understand articulate speech must be capable of accentuating the articulation over the general sound. In other words, there must be a stepping up of articulation, but of the general sound not so much.

Motion is imparted to the ossicles of the ear by sound-waves and the moment of inertia of the ossicles of the normal ear is known. Hence the amount of work done by a sound of a known or standard intensity upon the nor-

mal ear can be determined. Therefore the third element above mentioned is a pair of instruments on which the amount of work done by the standard sound is equal to that done on the naked normal ear. Hence the standard instruments are equal to the normal ear. The work done by the instruments in transmitting articulate speech is as regards the general sound ascertained by the variation of electromotive force created by the transmitter and as regards articulation by the amplitude and character of vibration of the diaphragm of the receiver. The difference between these data of the standard instruments and the corresponding data of instruments that "fit" the impaired ear under the same conditions determines the degree of ankylosis of the impaired ear or the extent of the deafness.

A set of apparatus by means of which my method can be carried out is illustrated in the accompanying drawings, in which—

Figure 1 is a plan of a table containing a portion of the testing outfit. Fig. 2 is a vertical section of the same, and Fig. 3 is a diagram of the circuits.

A is the top of an ordinary table or desk, upon which are arranged in suitable clamps or holders *a* and *b* a series of telephonic transmitters T T′ T², &c., there being nine in the series shown, and a series of telephonic receivers R R′ R², &c., there being twelve in the series shown. At the back of the table an elevated support *c* is arranged, upon which a transmitter is hung when in use. Adjacent to each clamp is a socket *t* or *r*, by plugging into which a corresponding instrument is thrown into circuit. The instruments are removable from the clamps, and to keep them in circuit while removed a flexible conducting-cord *d* is attached to each and leads through the table-top and thence over a suspended pulley-weight *w*, under the table, and finally connected to the corresponding socket *t* or *r*. This is a common arrangement for keeping slack out of the cords. A voltmeter V and an ampere-meter P are conveniently placed on the table, and a battery B is located at a suitable place.

The action of the transmitters in accomplishing variations of electromotive force of the circuit in the type of transmitter used by me depends upon the diameter, thickness, and material composing the diaphragm; the way it is retained in the case; the nature, size, and amount of the granules used as a resistance element between the electrodes; the distance of the back electrode from the diaphragm, the material of which the stocking containing the granules is made, (and hence the dampening effect upon the diaphragm,) and the resonant spaces in front and behind the diaphragm.

The action of the receiver in determining the character and amplitude of the sound-waves delivered by it in the type of instrument used by me depends upon the quality of the iron in the cores of the magnets, the size of the wire in the coils, the distance of the pole-pieces from the diaphragm, the diameter, thickness, and material of the diaphragm, the way it is held in the case, and the resonant spaces adjacent the diaphragm.

The nine (or other number) transmitters on the table vary from each other in the character of one or more of their described elements of construction and in such a manner that each instrument is capable of modifying the electromotive force of the circuit to a predetermined degree relative to the degree of the standard transmitter, and they are given numbers or other marks indicative of their relation to the standard instrument. In like manner the twelve receivers are graded and marked, so that their values with respect to the standard receiver are known. It should also be mentioned that any transmitter may be duplicated a number of times on the table in order that in case the intensity of the sound is not loud enough more transmitters can be added to the circuit to increase the sound intensity without altering the character of wave forms or articulation.

In conducting a test or diagnosis a sound of standard intensity is used and when desirable of standard articulation also. A sound of standard intensity can be obtained with a whistle or siren rotated at a given speed and having orifices of given dimensions through which fluid at a given pressure is blown. A standard of both intensity and articulation can be obtained with a "talking-machine," such as a graphophone or telegraphone constructed with predetermined characteristics. Where these are not convenient, the operator may by practice be able to modulate his voice and speech sufficiently to serve as a standard of sound intensity and articulation. The next requirement of the test is a determinate distance between the standard of sound and the point where the various transmitters are to be successively located—for instance, the distance between the support *c* and the source of sound. This distance should preferably be equal to that used in determining the value of the standard instruments; but its ratio thereto will serve for a calculation of results. The next requirement is to see that the battery is of the standard electromotive force, which is determined by any of the usual methods. The patient is now handed what might be termed a "mean" receiver, which applies roughly to a general condition. This he places to his ear, and it is connected in circuit by plugging in the corresponding socket. Next a transmitter is hung upon the support *c* and a plug inserted in its corresponding socket. The sound is now delivered and the patient required to report if he hears it and how well. The various transmitters or combinations of transmitters are

successively tried until the patient selects the one with which he can hear best. Then with the selected transmitter or transmitters the various receivers are tried in succession until the best receiver is found.

When any pair of instruments—say, for instance, transmitter T′ and receiver R^4—are in use, the circuits are as follows: from battery B by wire 1, transmitter T′, switch *t*, wire 2, voltmeter V, wire 3, switch *r*, and receiver R^4, and wire 4 to battery. The transmitter and receiver are therefore in series with the battery, and any alteration of the voltage on the circuit by the transmitter is responded to directly by the receiver. It is obvious that other arrangements of circuits involving induction-coils in which the primary wire includes the transmitter and the secondary wire the receiver may be used. The condition of the battery can be observed when any pair of instruments are cut into circuit by ascertaining if the variation of the meters V and P corresponds with the variation that should be caused by the particular pair of instruments in circuit.

If it is merely intended to ascertain what instruments are best adapted for the patient, the prescription can at once be written out for Receiver No. .. and Transmitter No. .. (or combinations thereof;) but if the physician wishes to know the degree of deafness or the degree of ankylosis of the ossicles of the ear he will compare the ratings of said Receiver No. .. and said Transmitter No. .. with the ratings of the standard instruments and learn the result.

In treating the patient the physician will have occasion to make these tests from time to time, as he can thereby ascertain with certainty the improvement or deterioration of the hearing and regulate the treatment accordingly.

It is obvious that my invention is not confined to the use of instruments such as are herein referred to, for evidently telephonic transmitters and receivers having a different construction, and therefore requiring different adjustment to alter their value with respect to the standard set, can be used. Likewise it is obvious that any other character of apparatus to enable the deaf to hear which is susceptible of being adjusted or calibrated may be used to carry out my methods.

Having described my invention, I claim—

1. The method of determining the value and characteristics of apparatus to improve the hearing, which consists in providing a series of transmitters having graduated predetermined values and characteristics and a series of receivers also having graduated predetermined values and characteristics, then successively testing each transmitter with each receiver until a combination of two instruments is found which affords greatest improvement in hearing.

2. The method of determining the value and characteristics of apparatus to improve the hearing, which consists in providing a series of transmitters having graduated predetermined values and characteristics and a series of receivers also having graduated predetermined values and characteristics, then successively testing each transmitter in conjunction with a "mean" receiver until the best transmitter is obtained, then successively testing each receiver in conjunction with said best transmitter until a combination of the two kinds of instruments is found which affords the most satisfactory improvement in hearing.

3. The method of determining the degree of ankylosis of an impaired ear, which consists in comparing the value and characteristics of a transmitter and receiver of sound, which when used together will not alter the hearing of a normal ear, with the value and characteristics of a transmitter and receiver of sound which, when used together, will most satisfactorily improve the hearing of the impaired ear.

4. The method of "fitting" an impaired ear with artificial hearing apparatus which consists in successively testing the ear with a series of telephone-transmitters and telephone-receivers used in combination and having a predetermined graduated rating or value.

5. The method of "fitting" an impaired ear wherein ankylosis of the ossicles exist, with artificial apparatus for improving the hearing, which consists in transmitting sounds to the ear by a series of transmitters and a series of receivers used successively in combination, the said series of transmitters and receivers being each graduated in value and having definite ratings, said transmitters being rated with respect to intensity of the general sound and said receivers being rated with respect to articulation, substantially as described.

In witness whereof I subscribe my signature in presence of two witnesses.

MILLER REESE HUTCHISON.

Witnesses:

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