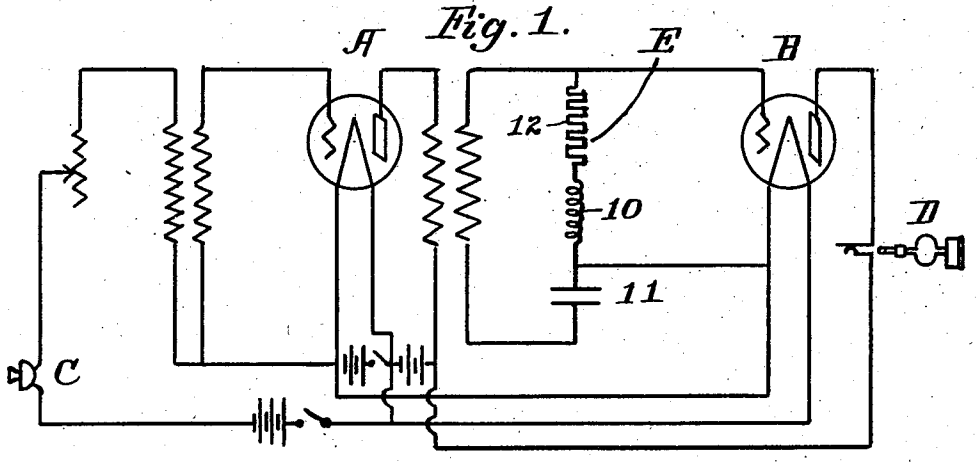
Dec. 14, 1926. 1,611,130

V. O. KNUDSEN ET AL

ARTIFICIAL AID FOR IMPROVING HEARING

Filed Oct. 22, 1924

Fig. 1.



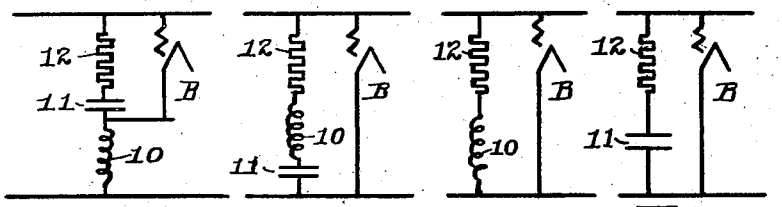
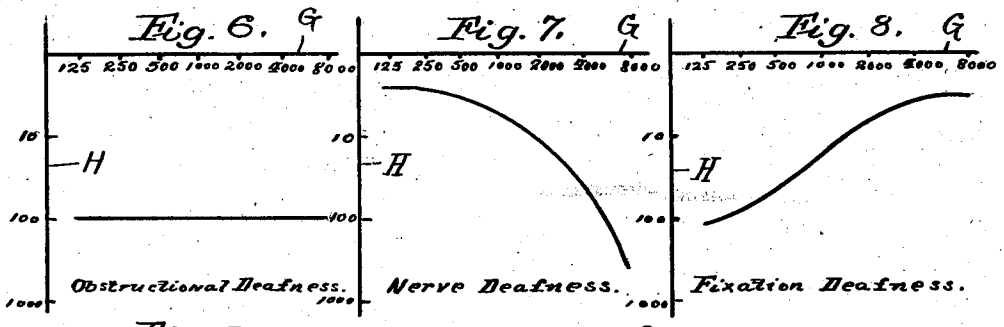
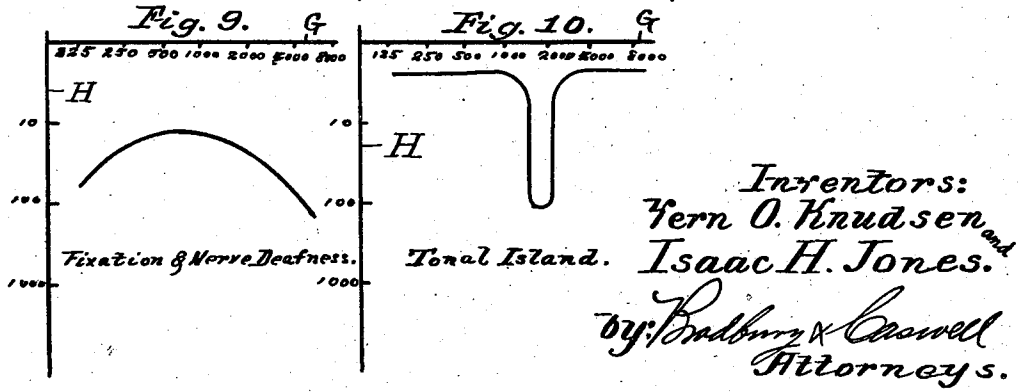


Fig. 2. Fig. 3. Fig. 4. Fig. 5.





Inventors:
Vern O. Knudsen and
Isaac H. Jones.
by: Bradbury & Boswell
Attorneys.

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UNITED STATES PATENT OFFICE.

VERN O. KNUDSEN AND ISAAC H. JONES, OF LOS ANGELES, CALIFORNIA.

ARTIFICIAL AID FOR IMPROVING HEARING.

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Our invention relates to a new artificial aid for improving the hearing of those who are partially deaf. This instrument which we have chosen to term a magnaphone, employs a vacuum tube amplifier similar to those used in telephone and radio practice. It differs from all other artificial aids to hearing in a novel and an important manner; namely each amplifier is designed to amplify selectively tones of different pitch according to a prescription which is determined by precise audiometric tests on the person for whom the instrument is designed. This selective amplification is effected by introducing an electrical correction circuit between the two stages of the amplifier, and is of such design as will give the type of amplification needed to correct the hearing defects in each individual case of deafness.

The primary object of this invention is to provide a more effective means for aiding those who are partially deaf and particularly in providing the exact amplification needed in each individual case.

In the accompanying drawing forming part of this specification, Fig. 1 is a diagrammatic view of our invention showing the form of circuit employed, it being understood that other forms of circuits may be used without departing from the spirit of our invention; Figs. 2 to 5 inclusive are diagrams of several correction circuits which may be used for variously amplifying the frequency components of speech according to the nature and degree of hearing defect in each individual case of deafness, and Figs. 6 to 10 inclusive are hearing charts showing types of deafness.

The general arrangement of a typical circuit embodying our invention is shown in Fig. 1. It consists of a two stage vacuum tube amplifier embodying the audion tubes A and B which are connected in the usual manner with telephone transmitter C and telephone receiver D in its input and output, respectively. The receiver and transmitter are preferably of high quality and highly damped design. Between the two stages of the amplifier there is placed a filter E which as shown is in the form of a correction circuit which consists of various combinations of an inductance 10, a capacitance 11 and a resistance 12. These are connected in Fig. 1 in series across the input of the vacuum tube amplifier B.

The necessity for selective amplification may be shown by referring to Figs. 6 to 10, which show the acuity of the hearing function for five types of deafness. The horizontal axis G in each of the hearing charts represents the response of a normal ear to tones of different pitch. The frequencies of these tones are represented by the numbers along this axis. The numbers along the vertical axis H in each chart represent the degrees of deafness on a numerical scale. For example, in chart Fig. 6, at a frequency of 500 double vibrations per second, there is a depression of 100 units which means that the amplitude of a barely audible tone for the ear represented by chart Fig. 6 must be 100 times the amplitude for a barely audible tone of the same pitch for a normal ear. Hence in chart Fig. 6 there is represented a type of deafness in which all tones are equally depressed. In chart Fig. 7 there is represented a typical case of nerve deafness, in which case tones of low pitch are heard almost normally well, but the auditory acuity for the tones of high pitch is very poor. In chart Fig. 8 there is represented a typical case of fixation deafness, where the tones of low pitch are depressed the more and the tones of high pitch are heard almost normally well. Chart Fig. 9 represents a more unusual type of deafness in which tones of low pitch and also tones of high pitch are depressed more than the tones of medium pitch. Chart Fig. 10 represents a type of deafness in which there is a tonal island; that is, a case in which the auditory acuity is relatively insensitive over a narrow band of frequencies.

The charts in Figs. 6 to 10 illustrate strikingly the futility of attempting to use the same artificial aid for correcting different types of deafness. As these charts show, each type of deafness and probably each individual case of deafness requires a prescribed type of amplification. An artificial aid which might be helpful to a person whose hearing function is similar to that represented by chart Fig. 7 might be worse than nothing to a person who had a type of deafness represented by chart Fig. 8. For cases of deafness like those represented in chart Fig. 7, the high frequency components must be given greater amplification than the low frequency components. For cases of deafness similar to those represented

by chart Fig. 8, it is the low frequencies which require relatively more amplification than the high frequencies.

In Fig. 1 the correction circuit shown between the two stages of the instrument is designed to amplify selectively high frequencies more than low frequencies. In Figs. 2 to 5 inclusive, correction circuits are shown with various combinations and arrangements of the inductance 10, capacitance 11 and resistance 12. In Fig. 2 capacitance 11 is placed between the resistance 12 and inductance 10. This arrangement is adapted for selectively amplifying low frequencies and is adapted for use when connected in the circuit in place of the filter shown in Fig. 1 in cases of fixational deafness such as illustrated by the chart Fig. 8. In Fig. 3 another arrangement of the inductance, resistance and capacitance is shown connected across the input of the audion bulb B which will amplify the low and high frequency components of speech such as will benefit the hearing of those afflicted with fixation and nerve deafness as illustrated in chart Fig. 9. Other arrangements and modifications of the correction circuits are also shown in Figs. 4 and 5, it being understood that applicants do not wish to limit themselves to these typical filters which are intended to be adaptable to the magnaphone circuit according to the particular purpose for which they are intended.

The manner in which these artificial aids to hearing may be prescribed and designed is as follows: otologists or others qualified to make audiometric tests would obtain a precise charting of the hearing function for the person who desires an artificial aid. This chart could be sent to a central office or factory where an expert would design the type of amplifier necessary to correct the defects shown by each chart. There is thus afforded a service for prescribing and designing aids to hearing for each individual case of deafness. If binaural hearing is to be restored, each ear will require a separate amplifier. If the person is content with monaural hearing, a single amplifier is all that is needed.

Having described our invention what we claim as new and desire to secure by Letters Patent is:

1. In combination with a two stage vacuum tube amplifier circuit containing audion tubes and a transmitter and a receiver connected with the input and output respectively, and a corrective circuit containing a capacitance, an inductance and a resistance placed in series between the two stages of the amplifier to selectively amplify certain frequencies for use with certain characteristics of deafness.

2. In combination with a two stage vacuum tube amplifier circuit containing audion tubes and a transmitter and a receiver connected with the input and output respectively, and a corrective circuit containing an inductance and a resistance placed in series between the two stages of the amplifier to selectively amplify certain frequencies for applications of use with certain characteristics of deafness.

3. In combination with a two stage vacuum tube amplifier circuit containing audion tubes and a transmitter and a receiver connected with the input and output respectively, and a corrective circuit containing an inductance and a capacitance placed in series between the two stages of the amplifier to selectively amplify certain frequencies for applications of use with certain characteristics of deafness.

VERN O. KNUDSEN.
ISAAC H. JONES.