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A. G. STEPHENS

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CONE-HORN COMBINATION

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Fig. 1.

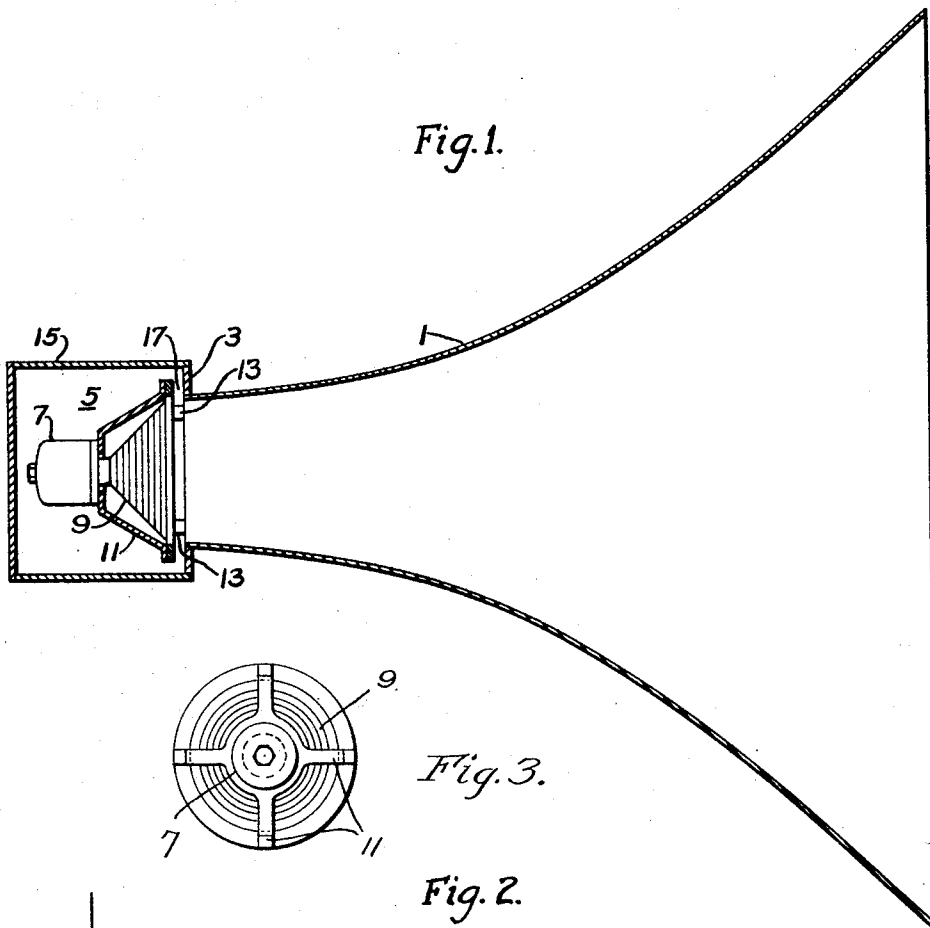
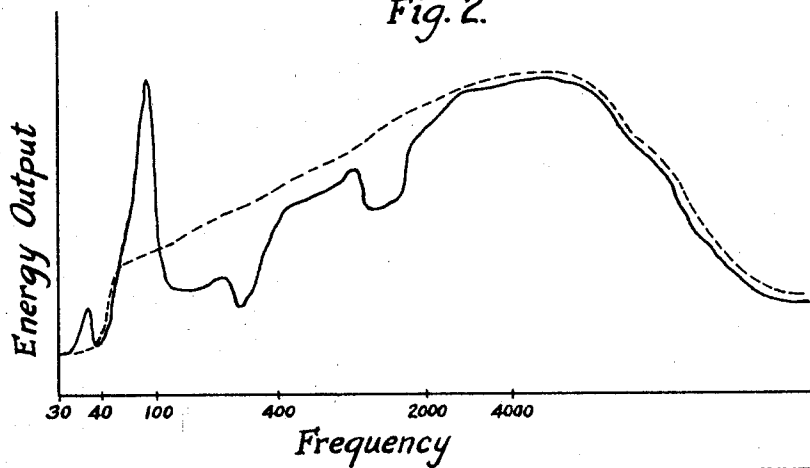


Fig. 2.



WITNESSES:

Leon J. Taza
CSROKER

INVENTOR

Allan G. Stephens

BY

F. M. Hyle
ATTORNEY

UNITED STATES PATENT OFFICE

ALLAN G. STEPHENS, OF EAST SPRINGFIELD, MASSACHUSETTS, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

CONE-HORN COMBINATION

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My invention relates to energy-translating devices, such as loud speakers or the like, wherein electric energy may be converted into sound or sound converted into electric energy. More particularly, my invention relates to improvements in apparatus of the above type whereby improved operating characteristics may be obtained.

In apparatus involving the use of vibrating air columns to produce sound from electric currents or to convert sound into corresponding electric currents, it has been found that the apparatus amplifies to an undesirable and disagreeable extent those notes or tones having a frequency which substantially coincides with or bears a harmonic relationship to, the resonant frequency of the air column. The result is that the frequency response of the apparatus becomes quite irregular, the response at resonant frequencies giving rise to peak effects which, in turn, produce undesirable volume changes and distortion in the reproduced program, and overloading of the apparatus.

In loud speakers or apparatus of a similar nature wherein a horn is employed for amplifying sound waves, the difficulties outlined above are met, inasmuch as the horn defines a vibrating column of air. Theoretically, it would be possible to so design the horn as to bring its resonant frequency outside of the frequency limits within which it is desired to receive, but newer and greater disadvantages would arise as a result of attempting to follow such procedure.

If the horn be constructed large enough to bring its resonant frequency down below the lowest frequency to be received, the high-frequency response of the horn will be impaired. Similarly, if the horn be made so small as to bring its resonant frequency above the highest frequency limit of reception, the low-frequency response of the horn will suffer. Consequently, it becomes more or less a necessary evil that the resonant frequency of the horn should lie somewhere within the range of frequencies to which the speaker is designed to respond. The remedy, therefore, will be not in so constructing the horn as to bring its resonant frequency outside of the

frequency range of reception but in reducing the effect produced by reason of a resonant condition existing within the frequency range.

It is, accordingly, one object of my invention to provide means for reducing resonant peaks in the frequency response of an energy-translating device.

It is another object of my invention to provide an energy-translating device having smooth frequency-response characteristics.

Another object of my invention is to provide means whereby the frequency-response characteristics of a horn loud speaker may be substantially smoothed out.

Other objects of my invention will be disclosed in the following description of the same, taken in conjunction with the accompanying drawing wherein

Figure 1 is a schematic view, in cross-section, of an energy-translating device constructed according to my invention.

Fig. 2 is a curve illustrating the comparative results obtained through the use of my invention.

Fig. 3 is a rear view of the driver and cone structure.

In practicing my invention, I provide a driving motor and its associated cone diaphragm in spaced relationship to the baffle board to which it is customarily affixed and enclose the driving mechanism within a substantially closed chamber. The space between the driving means and the baffle provides an air-passage connection between the chamber and the air column defined by the horn.

Referring more particularly to Fig. 1 of the drawing, my invention comprises a horn 1 affixed to a baffle board 3. Mounted directly behind the baffle, in spaced relationship thereto, and in axial alignment with the horn, I provide a driving mechanism 5 comprising a driver 7 and its associated cone diaphragm 9 being maintained or supported against transverse movement by means of a support 11 mounted on the driver. Spacing members 13 are employed for supporting the driving mechanism in its spaced position relative to the baffle. The driving mechanism is enclosed

by a box 15 or other similar structure mounted on the baffle board, thereby defining a chamber which has connection with the horn by means of the air passage 17 formed by maintaining the driving mechanism in spaced relationship to the baffle board. The horn, by reason of its physical dimensions, as necessitated by practical requirements, has, by reason of its length, a certain fundamental resonance which, as explained heretofore, will, to some extent, impair speech reproduction and produce overloading of the apparatus at the frequency of resonance. By spacing the driving mechanism from the horn, a leakage path is established between the chamber behind the cone and the air column defined by the horn, which has been found quite effective, at lower frequencies, in reducing the amount of energy supplied to the air column of the horn. Also, by reason of this leakage characteristic, the efficiency of the horn, as a resonator at its fundamental frequency, is greatly reduced.

The effect, therefore, of the leakage path is to reduce the response or volume of the speaker at the lower frequencies, particularly at those frequencies at which peaks occur, apparently, by reason of the fact that the air connection between the horn and the enclosed chamber serves to bypass some of the energy, at low frequencies, which would otherwise find an exit through the horn.

While it is very beneficial to remove the peak-effect characteristics of energy-transferring devices, it would, at the same time, be very desirable to otherwise increase the response of the device at the low-frequency end of the frequency spectrum. In other words, it is my object to simultaneously decrease the response at the resonant frequencies of the horn and increase the response at the other frequencies toward the lower end of the scale and thereby smooth out the frequency response of the device.

The apparatus, as described by me, is capable of functioning to obtain the above beneficial results. The leakage path provided between the horn and the chamber serves to by-pass energy at the peak frequencies, in particular, to thereby materially reduce the energy output of the device at those frequencies. At the same time, by reason of the fact that the chamber about the driving mechanism is substantially closed, a certain amount of resonance is introduced, the closed chamber defining a confined air column which is normally caused to resonate with the cone mass. This resonance phenomenon is a broad one, that is, it extends throughout a substantial range of frequencies, and, at those frequencies at which the chamber resonates, the normal damping effecting on the energy delivered to the device will be reduced, thereby causing the device to partake of the characteristics of a band-pass filter. This will lead

to an increase in output energy and a corresponding increase in the efficiency of the device at those frequencies.

I have found it possible to "tune" the chamber, so to speak, to bring about a resonant condition within a predetermined band of frequencies. According to my invention, this band of frequencies will be selected to substantially coincide with a band of frequencies within which the response of the device happens to be poor and inefficient. This "tuning" effect may be accomplished by altering the characteristics of the enclosed chamber, either by changing the size of the same or by providing means whereby the stiffness of the air column may be altered. One way of accomplishing this would be to provide the sound chamber with a resilient or permeable wall. Rubber or felt is suggested as a material suitable for the purpose.

It is characteristic of horn loud speakers, in general, that the response at the lower-frequency end of the spectrum, except at the resonant frequency of the horn, is poor. Consequently, the sound chamber will be "tuned" to produce a resonance condition at those frequencies. While, by reason of the leakage path connecting the chamber with the horn, a certain amount of the energy emitted at the lower frequencies will be diverted away from the horn, the resonance condition which occurs at these poor-response frequencies will more than compensate for the lost energy. The ultimate result arising out of the use of my invention, therefore, is to reduce the peak responses and build up the response at the frequencies where the response is normally poor.

By reason of the fact that loud speakers of the present day vary in characteristics, it is impossible to set forth definite figures which will apply equally well for all of them. The constants best suited for any particular loud speaker are easily found by varying the physical dimensions of the sound chamber and the spacing between the diaphragm and the baffle. For a speaker the horn of which is resonant at a frequency of approximately 100 cycles, I have found that a space of approximately $\frac{1}{4}$ " is sufficient to obtain the desired results.

In Fig. 2, I have illustrated the important results obtained in the practice of my invention as applied to a speaker having a resonant condition at approximately 100 cycles. The solid line represents the energy output, as plotted against the frequency for a speaker which does not embody my invention. The dotted or broken line represents the energy output of the same speaker, as constructed according to my invention. It will be noted that the horn frequency peaks at 35 cycles and at the 100 cycles have been materially reduced by reason of the leakage

path existing between the enclosing chamber and the horn. It will also be noted that, by reason of the broad resonant condition existing within the enclosed chamber, the frequency response of the speaker has been appreciably improved between the 150~ and 400~ frequency limit, and also between the 800~ and 2000~ frequency limit. The ultimate result is that the frequency response of the speaker has been materially smoothed out, as clearly shown by the broken line.

The speaker, described above, the output curve of which is illustrated in Fig. 2, embodies an exponential horn, as I have found that my improvement works remarkably well with a horn of that type. It is apparent, however, that advantageous results may be obtained, regardless of the design of the horn structure.

Various modifications may be made within the scope of my invention and, while I have described my improvement in the art in great detail, I do not desire to be limited to such details, except insofar as may be required by the prior art and by the appended claims.

I claim as my invention:

1. An energy-translating device comprising a horn, driving means associated therewith, said horn and driving means being deficient in frequency response over a range of frequencies, and means for increasing the output of said device at substantially those frequencies at which it is normally deficient.

2. An energy-translating device comprising a horn, driving means associated therewith and means for smoothing out the frequency response of said device, said means comprising a chamber connected to said horn by an air path.

3. An energy-translating device comprising a horn, driving means associated therewith and means for smoothing out the frequency response of said device, said means comprising a chamber substantially enclosing said driving means and providing a leakage path to said horn.

4. An energy-translating device comprising a horn, driving means associated therewith and means for smoothing out the frequency response of said device, said means comprising a chamber substantially enclosing said driving means, said driving means being spaced from said chamber to provide a leakage path from said horn to said chamber.

5. An energy-translating device comprising means less responsive to certain frequencies than to others and means associated therewith for improving the response of said first means at substantially those frequencies.

6. An energy-translating device comprising means less responsive to certain frequencies than to others, and means associated therewith for improving the response of said

first means, said means being resonant at those frequencies.

7. An energy-translating device comprising means having a frequency response which is over-emphasized at certain frequencies and under-emphasized at other frequencies and means associated therewith for reducing the response at the over-emphasized frequencies and increasing the response at the under-emphasized frequencies.

8. An energy-translating device comprising means having a frequency response which is over-emphasized at certain frequencies and under-emphasized at other frequencies and means associated therewith for simultaneously reducing the response at the over-emphasized frequencies and increasing the response at the under-emphasized frequencies.

In testimony whereof, I have hereunto subscribed my name this 23rd day of May 1931.

ALLAN G. STEPHENS.