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REPRODUCTION OF SOUND

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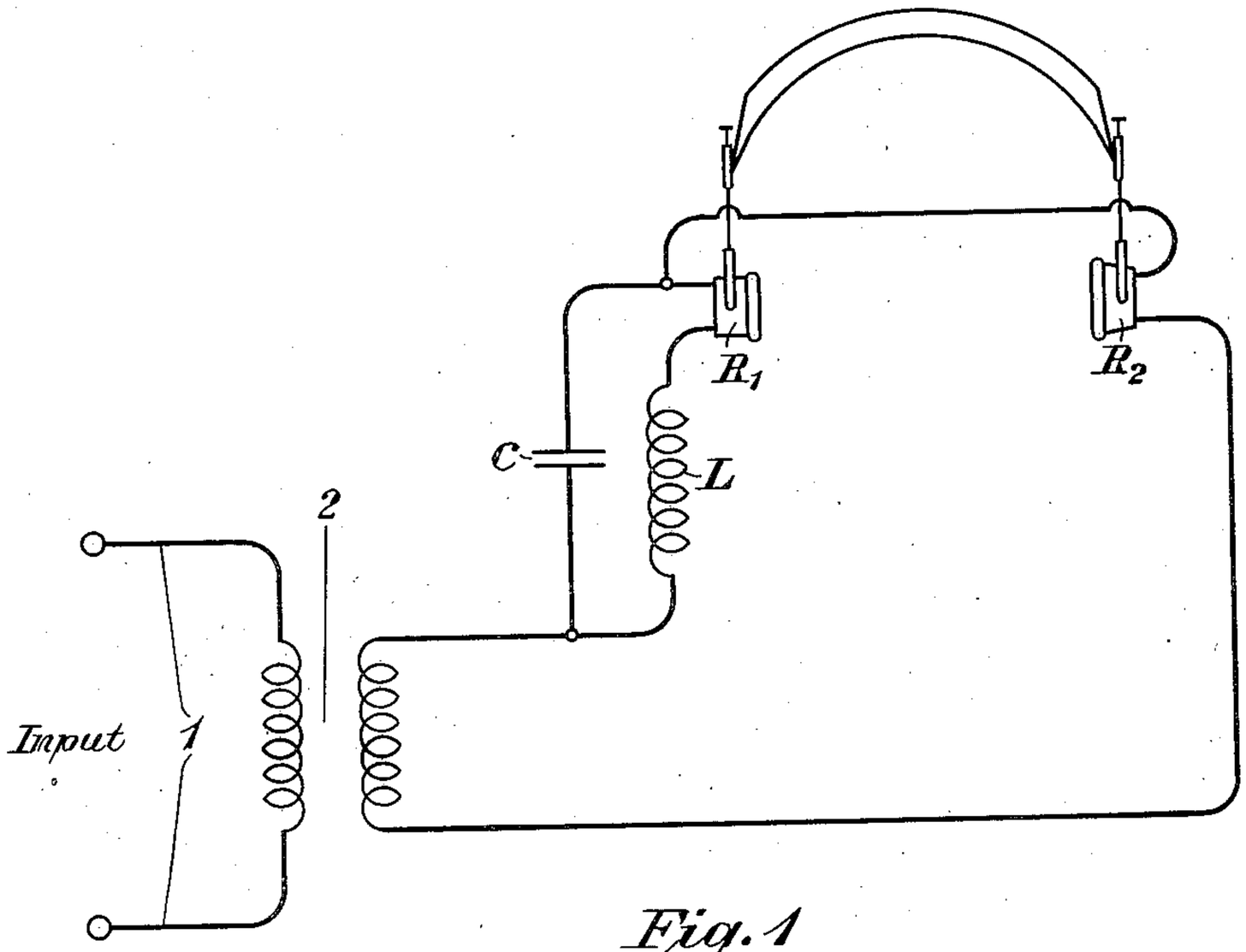

Fig. 1

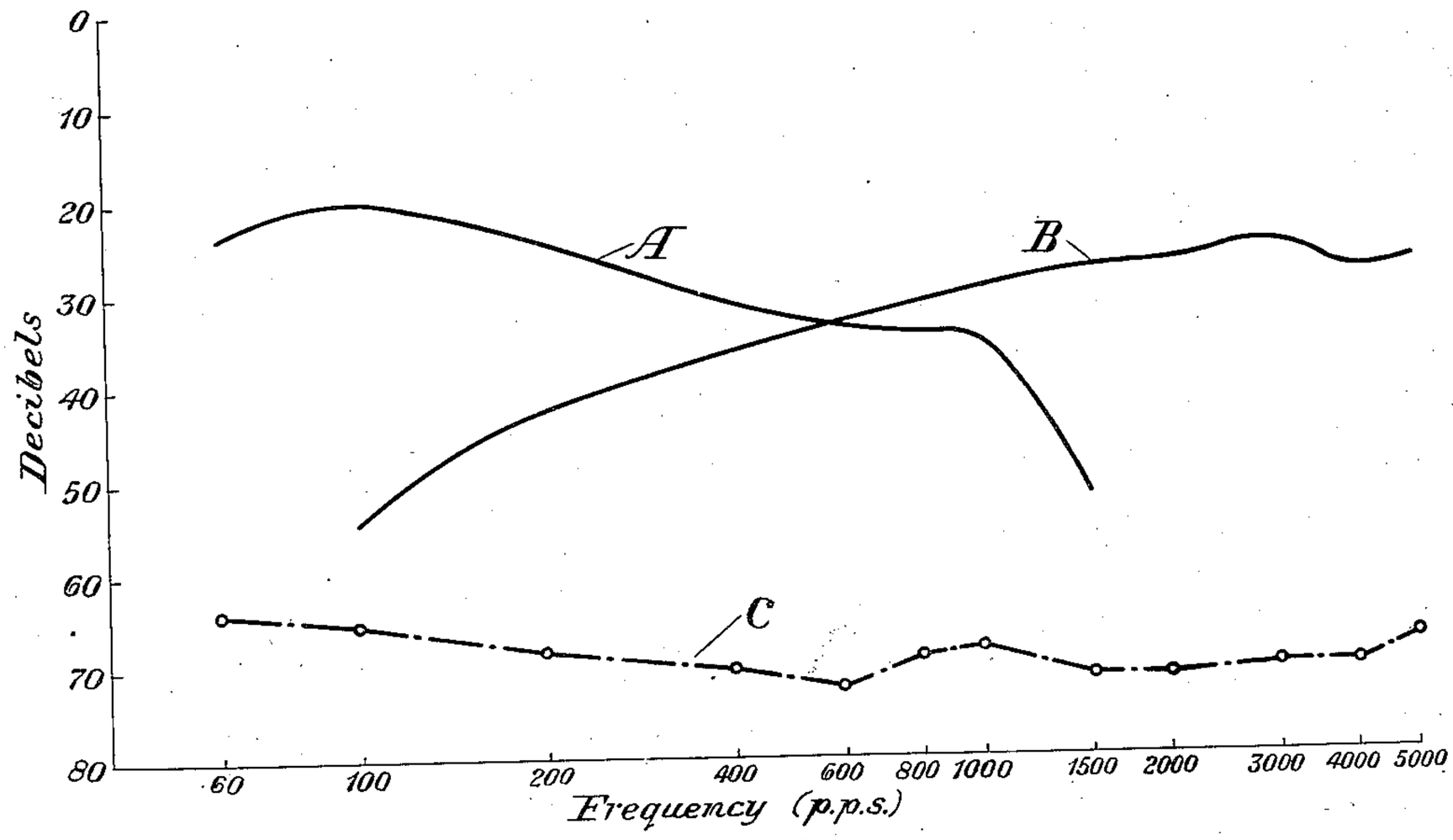

Fig. 2

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REPRODUCTION OF SOUND

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3 Claims. (Cl. 179—1)

This invention relates to an improvement in the reproduction of sound, and particularly to means for reproducing sound embracing a wide range of frequencies. More specifically, the invention pertains to the use of two telephone receivers of different design connected in a circuit which enables each receiver to reproduce that part of a selected frequency range for which it has the greater efficiency.

The common type of magnetic head-receiver depends for its efficiency on the mechanical resonances in the diaphragm which result in a non-uniform frequency response. Uniformity of the response may be approached, to some extent, by damping out these resonances by suitable mechanical means but only at the expense of the receiver efficiency. A more uniform response may also be obtained in an improved type of receiver known as the moving coil type, which uses a light weight diaphragm whose resonance is outside the frequency range to be reproduced. Not only has this type of receiver a more uniform frequency response than the magnetic receiver but it is much more efficient at the higher frequencies in the region of 5,000 cycles per second. The frequency response, however, falls off at the low end and electrical equalization would normally have to be employed to improve the response in the region of 100 cycles per second. Such an improvement, of course, is obtained at the expense of over-all efficiency, making it necessary to use not only greater amplification but also amplifiers of higher load carrying capacity than would be required were it possible to use the full output of this receiver without equalization.

This invention avoids difficult design problems as well as the use of high power amplifiers by using two receivers of conventional design, one of which is efficient at the lower end of the required frequency band and the other over the rest of the frequency band. These receivers are connected in a selective circuit which transmits to each that part of the band for which it is the more efficient. This method of obtaining a uniform response might be termed "compensation" as opposed to the usual method of "equalization".

This invention will be clearly understood from the following description, when read in connection with the attached drawing, of which Figure 1 shows schematically a form of circuit embodying the invention and Fig. 2, which shows frequency response characteristics of the receivers in the circuit of Fig. 1, serves to make clear the nature of this invention.

In Fig. 1 the speech input circuit 1 is connected to the receiver circuit by the transformer 2. The receiver circuit includes the head receivers R_1 and R_2 which, as pointed out hereinafter, are of dissimilar types. Connected to the receivers are the inductance coil L and the condenser C which, serve to divide the frequency band between the two receivers. Receiver R_1 is a magnetic type of receiver which has a maximum response at about 1,000 cycles per second. Receiver R_2 is of the moving coil type which is efficient over the frequency band it is desired to reproduce except in the region below 500 cycles per second. This deficiency is common to all ordinary types of head receivers and is due to the difficulty of obtaining a tight seal between the receiver cap and the ear. A comparatively high percentage of the output of the receiver at these lower frequencies escapes to the outer air instead of reaching the eardrum. The receiver must therefore deliver correspondingly more power at these frequencies if the ear is to respond uniformly at all frequencies. Since it is difficult to overcome this deficiency at the lower frequencies in the design of a moving coil type of receiver we propose to utilize the greater low frequency output of receiver R_1 to compensate for the corresponding deficiency in receiver R_2. In other words, the full output of R_2 at all frequencies above 500 cycles per second is used and R_1 is connected in the circuit in such a manner that its output is restricted to the frequencies below 500 cycles per second.

Receiver R_1 is placed in an anti-resonant circuit comprising the inductance coil L and condenser C with the constants of L and C selected to tune the circuit for approximately 75 cycles per second. As shown by curve A of Fig. 2, the output of this receiver is then fairly uniform between 60 and 100 cycles per second where it begins to fall off to compensate for the decrease in the leakage loss with the increase in frequency. As shown by curve B of that figure, the output of receiver R_2 in the region of 100 cycles per second is reduced, due to the high impedance of the anti-resonant circuit in series with it. From curves A and B, it will be seen that as the output of R_1 falls off, that of R_2 rises until at about 600 cycles per second both receivers deliver equal amounts of energy. From 600 to 1,000 cycles receiver R_2 delivers an increasing proportion of the total energy until at 1,000 cycles and beyond, all the sound output comes from this receiver. The frequency response of the receivers in the circuit arrangement of the drawing is shown by curve C, which shows fairly uniform response through the entire range of frequencies.

With the compensation method of obtaining a uniform frequency response the frequency content of the received program is divided between two receivers. The listener wearing the two receivers can detect this division of sound energy, particularly with certain types of programs, but this in no way interferes with his reception or appreciation of the program. When connected to a high quality circuit such as a broadcasting network the quality of the received program compares favorably with that of the best loudspeaker or combination of loudspeakers available. An attendant monitoring on a circuit with these receivers would have no difficulty in detecting trouble due to 60-cycle induction or high-frequency noise.

The invention described herein is not limited to the particular circuit shown on the drawing, which is used merely for the purpose of illustrating the principles involved, but may be embodied in a large variety of circuits using head receivers designed for different frequency ranges.

What is claimed is:

1. In a sound-reproducing system the combination with a sound-reproducing device the frequency response of which is substantially uniform through a portion of a given frequency range and non-uniform through the remainder of the said range, another sound-reproducing device whose frequency response is more nearly uniform than the response of the first mentioned device through the said remainder of the said range, a circuit containing an inductance coil in series with the said other sound-reproducing device, the said coil and receiver being shunted by a condenser, to form thereby an anti-resonant circuit, and the constants of the said elements of the said circuit being so chosen as to improve the frequency response of said other device in the range in which said first device is deficient, the said circuit being connected in series with the said first mentioned device so that the over-all response of both devices is substantially uniform.

2. In a sound-reproducing system, the combination with a pair of head-phones of an input circuit connected thereto, the first of said phones having substantially uniform frequency response throughout a portion of a given frequency range and non-uniform response through the remainder of said range, and the second of said phones having more nearly uniform response through that portion of said range in which the first phone has non-uniform response, characterized by the inclusion of an anti-resonant circuit in series with the first phone, the said circuit comprising an inductance in series with the second phone, and a condenser shunted across said inductance and said second phone, the constants of the inductance and condenser being so chosen as to render more uniform the response of the second phone through the said remainder of the range and to simultaneously reduce the effectiveness of the first phone in the same portion of the range in which an improvement is effected in the response of the said second phone.

3. In a telephone head-set the combination with supporting means of a receiver of the magnetic type connected to one side thereof, a receiver of the moving-coil type connected to the other side thereof, an inductance in series with the receiver of the magnetic type, both shunted by a condenser to form an anti-resonant circuit which is connected in series with the moving coil type of receiver, the constants of the said inductance and condenser being so chosen as to improve the response of said magnetic type receiver through all or a portion of its range and to simultaneously reduce the response of the receiver of the moving-coil type in the same frequency range in which the response of the magnetic receiver has been improved.

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