made listening tests in which two other positions were compared with a position in front of the speaker. One of these was overhead, or rather directly above the lips, at a distance of 60 cm, the forward transmitter being at the same distance. Listeners in another room could switch between the two transmitters. After equalizing the two circuits for loudness (with resistance attenuation only), the listeners could not distinguish between the two transmitters. When, however, one of the transmitters was placed directly behind the speaker, there was a marked loss of the higher frequencies.

Total Voice Power

As another application of the pressure measurements in different directions, the spectrum of total voice power has been calculated, from pressures at the 60 cm distance. The calculations are based on the equation

$$P = Ap^2/415,$$

where p is pressure in dynes per sq. cm, A is the area in sq. cm, and P is power in microwatts. This equation is strictly applicable only to the case of a plane wave, whose direction of propagation is normal to the area A. It is difficult to say in what direction the waves were progressing, in some of our transmitter positions, particularly those at small distances to the rear of the speaker. At 60 cm, however, an assumption of a radial direction at all angles cannot be greatly in error. On the other hand, the data at 60 cm are more complete, and somewhat more accurate, than those at 100 cm.

No interpolation between the measured points was made, each measured pressure being assumed constant over an area extending halfway to the neighboring positions. The error in total power, involved in this assumption, is certainly smaller than the experimental error. On the spherical surface, of 60 cm radius, the areas formed by meridians and parallels halfway between the measured positions were calculated. Absolute pressures were obtained by applying the pressures at [30, 0, 0], from Table II, to the 60-cm data in Table I. The power equation was then applied to each area, and the results added together. It was assumed that pressures to the left of the speaker were equal to those measured in symmetrical positions to his right. In two other positions assumptions were made. The difficulties at [60, 0, −45], have already been discussed, and the estimated pressures in Table I, for this position, have been explained. At $\varphi = -90°$ the pressures were assumed to be as much above those at [60, 0, 0] as the differences at 15 cm for the same two directions. This last assumption is the most doubtful. It is also the most important, since it involves higher pressures than in any other direction, in the bands below 1000 cycles. The area, over which these downward pressures were assumed to apply, was a zone enclosed by the small circle 22.5° from the pole. Since the speaker's body intercepted a considerable portion of the solid angle of this zone, the assumption implies that the energy which struck the body was absorbed, and not reflected to increase the measured pressure at 15 cm downward. However, even if the power taken for this zone is 3 db too high,

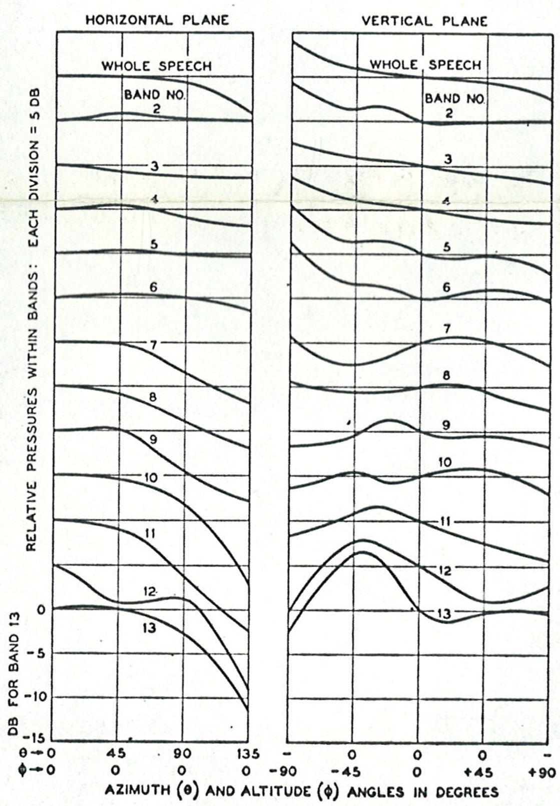

Fig. 12. Similar to Fig. 11, but for a different distance: $r = 15$ cm.

Dunn, H.K., and Farnsworth, D.W., Exploration of Pressure Field Around the Human Head During Speech. 1939 JASA 10, 184–199, Abb. 12 S. 197

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