to the spectrum of total speech power for that speaker, than would be obtained by assuming a constant relation between pressure and total power at all frequencies.

If the pressure measurements are made at a different point, the data of Table I may be applied to get the corresponding curve. This has been done for the point [30, 0, −45], and the result is shown in the lower curve of Fig. 13. The shape is considerably different, as would be expected. It may be of particular interest to observe that between 100 and 2800 cycles this curve remains within 1 db of a constant value.

The spectrum of total speech power is interesting, not alone for its own sake, but also as applicable to certain practical conditions. One of these is speech in a live room, where the energy radiated in every direction contributes to that which may be observed at a point distant from the speaker. Another application is to the case of speech produced very close to a transmitter mouthpiece, or in an acoustic device such as the megaphone. This is not to say that other effects could be neglected, such as selective absorption in the case of the room, or the change in the impedance offered the mouth in the second case.

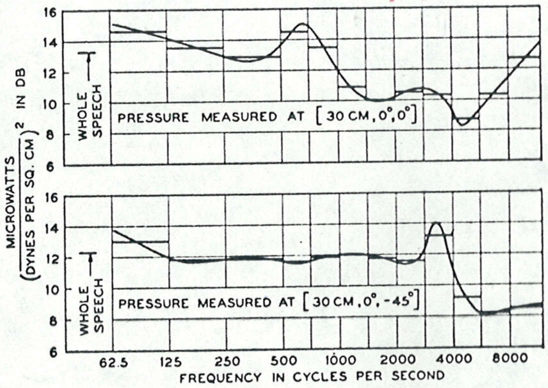

FIG. 13. Ratio of average speech power in the total field to mean-square pressure at a single point, expressed in db.

Reference to Other Observers

In conclusion, we shall refer briefly to two other experimental investigations along similar lines. Trendelenburg[5] measured the pressure due to a sustained speech sound, as a function of direction in the horizontal plane only, at a distance of 100 cm from the mouth. Frequency discrimination was achieved through the use of different sounds, having energy maxima in different frequency regions. Our results in bands 10 and 12 are in good agreement with his curves for 3300 and 6000 cycles. A comparison at low frequencies is difficult, because of irregularities in his curves which he attributed to reflections from external surfaces.

Braunmühl and Weber[6] investigated the dependence of speech pressure on distance from the lips, for distances of 1 cm to 40 cm. Presumably the direction was forward. They used sustained sounds, and separated the different frequency regions through the use of octave filters. They concluded that pressure is inversely proportional to distance, except that frequencies above 3200 cycles show smaller pressures near the lips than would be predicted by this law, from measurements at greater distances. They also found a difference between speakers, in the magnitude of the departure at high frequencies,—a phenomenon which they attributed to differences in the shape of the mouth. In the present investigation, a noticeable departure was found only above 5600 cycles, but it should be noted that the 5600–8000-cycle band includes a part of their 3200–6400-band. Since, in addition, we used but one speaker, it can only be concluded that the results are in agreement.

[5] F. Trendelenburg, "Beitrag zur Frage der Stimmrichtwirkung," Zeits. f. tech. Physik 10, 558 (1929).

[6] H. J. v. Braunmühl and W. Weber, "Beitrag zur Frage der Sprachübertragung aus geräuscherfüllten Räumen," E.N.T. 13, 414 (1936).