frequencies and damping constants of the principal resonators typically involved in the production of sustained vocal tones. The method has been used in further research; and the present report deals with data secured on the vowels "O" and "AH." Generalized values are presented. In addition, some of the effects on vowel structure of variations in pitch and loudness level are shown. It is evident, for example, that the magnitude of high frequency components, relative to the magnitude of low frequency components, varies with loudness level. The effects of pitch variation are, on the whole, neither clear-cut nor consistent.

[1] J. Acous. Soc. Am. **8**, 91–99 (1936).

20. High Speed Motion Pictures of the Vocal Cords. (A motion picture presentation.) W. HERRIOTT AND D. W. FARNSWORTH, *Bell Telephone Laboratories.*—Bell Telephone Laboratories has for several years made use of high speed motion picture photography as a visual aid in the study of problems associated with the design, manufacture and performance of telephone apparatus. This presentation is concerned with its application to problems relating to the functioning of the vocal cords in speech production. Vocal cord pictures taken at several different camera speeds up to 4000 frames per second are shown. These pictures, projected at a rate of sixteen or twenty-four frames per second, permit detailed observation of the motion of the cords vibrating at voice frequencies. Adequate illumination was secured by directly imaging a tungsten light source on the vocal cords. Harmful heat and ultraviolet radiation were absorbed by a liquid filter.

21. Limits of Audition for Bone Conduction. NORMAN A. WATSON, *University of California at Los Angeles.*—The laboratory facilities and apparatus described in an earlier paper[1] were used to study the normal intensity and frequency limits of audition for bone conduction. The condition of the observer's head to give greatest acuity for pure tones, and the optimal total force of application and area of the vibrator button were found to be essentially the same as for speech sounds.[1] Acuity was found to vary with the position of application of the vibrator; for example, the maximum variation with position of the 1000-cycle threshold was 18 db. A threshold for open canals was determined for the frequency range 80–2000 cycles, without interference from stray air radiation (18 normal observers). Above 2000 cycles air radiation interfered with open canal tests to such an extent that a special technique was devised to obviate its effects. The occluded threshold curve, for a single normal individual, lay below his open canal curve over the range 80–2000 cycles, and also at 10,000 cycles. The usable intensity range for open canals was tentatively determined; it is a maximum of 80–90 db at 1000–2000 cycles. The total audible frequency range for open canals was found to be at least 25–17,000 cycles.

[1] N. A. Watson, J. Acous. Soc. Am. **9**, 99–106 (1937).

22. On the Phase and Magnitude of Subjective Tones. DON LEWIS, *State University of Iowa.*—It has been shown by Lewis and Larsen[1] that the phase and the magnitude of a subjective tone heard monaurally may differ significantly for two different observers with normal hearing. This paper deals with a study of the two ears of the same observer. Differences as well as similarities in both phase and magnitude are indicated, differences in magnitude being more common than differences in phase. Further investigation seems necessary before a satisfactory explanation of the findings can be offered.

[1] Proc. Nat. Acad. Sci. **23**, 415–421 (1937).

23. Preliminary Report on a High Fidelity Reproducer for Lateral Cut Disk Records. F. V. HUNT AND J. A. PIERCE, *Harvard University.*—The moving element of the reproducer is a horizontal, single-turn, elongated loop of phosphor bronze ribbon which is driven by an inverted conical shell whose base is attached to the free end of the loop and whose apex bears a sapphire stylus. In the front half of the loop, which passes through a concentrated magnetic field, the ribbon lies in the vertical plane and is bent into a channel to increase its rigidity. In the remainder of the loop the ribbon is twisted into the horizontal plane and its ends are clamped between insulating blocks. This provides a light structure which is relatively stiff for lateral displacement but quite flexible in torsion, so that a lateral vibration of the stylus is converted into an oscillation of the stiffened portion of the loop about its longitudinal axis. Damping is provided by a membrane of Pyralin connecting the free end of the loop with the adjacent magnetic structure. The mass of the entire moving system is approximately 50 milligrams and the unbalanced weight on the stylus is less than six grams. The electrical output is approximately 50 db below that of a standard transcription reproducer, but the response is proportional to the recorded velocity amplitude within ± 3 db from 30 to 18,000 cycles.

24. Scale Temperament as Applied to Piano Tuning. O. L. RAILSBACK, *Eastern Illinois State Teachers College.*—A number of pianos were tested immediately after tuning to determine whether the actual tuning follows that of the "equal temperament" as defined in physics, within the limits of the ability of the tuner to set the strings, or whether there is a systematic deviation from the equally tempered scale and what the nature of such a systematic deviation is. The method for testing the tuning was by means of the chromatic stroboscope as described in a previous paper.[1] The stroboscope used was an improved model of the type described in the last paper. Tests were made with several tuners and where possible with several pianos of each tuner. This gave an opportunity to determine whether different tuners have individual "styles" of tuning or whether there are marked general trends of a definite character. The results are plotted on graphs showing the deviations of each tone as read from the corresponding tone of the equally tempered scale. Comparisons of charts are made and averages are taken to show trends. In addition to accidental deviations there is a marked trend in the "stretching" of octaves. This stretching tends to be more marked at the upper and lower ends of the piano keyboard. Possible explanations are suggested and further investigation planned.

[1] J. Acous. Soc. Am. **9**, 37 (1937).