SCIENTIFIC APPARATUS AND LABORATORY METHODS

ANALYSIS OF VOWELS

THE usual analyses of sustained vowels show characteristic distributions of energy on the frequency scale. It has been impossible to make entirely satisfactory syntheses of vowels by combining such fixed, "characteristic" distributions, either through the use of electric oscillators or by means of models of the vocal organs in position.

Furthermore, it is recognized that analyses of vowels based upon such steady-state conditions are not applicable to every-day speech. At the usual rate of enunciation of from four to eight syllables per second it is obvious that steady-state conditions are rarely approximated.

When the orifice and volume of the physiological resonator, the mouth, are varied during the progressive opening of the lips in saying the word "pope," the characteristic resonance frequencies must change rapidly while approximating the steady-state distribution. A similar change will occur at the close of the vowel. These transients constitute a temporal pattern not related to the cycles of the cord tone but an important part of the vowel.

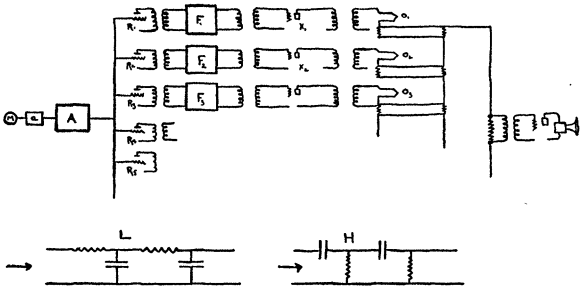
The physiological resonator may not come to a fixed position in the whole course of the spoken or even of the sustained vowel. In the case of the sustained vowel there is always the tremor factor in the fixated muscles of the resonator and in the chest muscles supplying the air-pressure. The pattern of the spoken vowel is certainly one of continuous change.

The vowel in rapid speech must be characterized by a perceptual time pattern of .025 to .200 second duration—a pattern composed of the characteristic transient or transients with their partials in intensity variation. The pattern is to be regarded as an envelop rather than as a group of simultaneous frequencies.

The accompanying diagram indicates a method in process of development for studying the time pattern of the vowels in rapid speech. The disposition of the units is the suggestion of M. S. Mead, of the General Electric Company.

A series of electric filters, perhaps of the resistance-capacitance type,[1] which will be selective for the transient as well as for steady-state pulses, is arranged to pick out bands from the frequency scale. The pulses passing through each of these filter bands are recorded by an individual oscillographic unit.

[1] Shea, "Transmission Networks and Wave Filters," p. 414.



"M" is condenser microphone with associated small amplifier (a) leading to the larger boosting amplifier (A). "R"s are repeater tubes which avoid throwback on the primary circuit—thus making it possible to use one or all filters ("F"s) separately or simultaneously. "X"s are tubes operating oscillographic units ("O"s). The last part of the circuit is an arrangement for synthesizing the analyzed currents. "L" and "H" refer to general type filter circuits (resistance and capacitance).

The parallel tracings of the oscillographs will show the varying intensities of the frequency bands from moment to moment during the course of the vowel. Thus the tracings will give indications from band to band of the time pattern of the transients composing the vowel. Rapid comparison should be possible for a large number of examples of the same vowel or of the different vowels.

The apparatus is so arranged that the pulses passed by the filters can be synthesized and the result of the analysis checked by the actual sound of the vowel which passes through the loud speaker.

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AN ELECTROMAGNETIC PUMP

A DESCRIPTION of an electromagnetic all-glass pump was published recently in this journal[1] by Mr. Henry Rosenberger. It may be worth while to point out that an almost identical piece of apparatus was described in 1926 by Porter, Bardwell and Lind.[2] A double-acting modification of this type of pump was devised by Funnel and Hoover in 1927,[3] and was later improved by Livingston.[4] While the authors of these earlier references were primarily interested in pumps

[1] H. Rosenberger, SCIENCE, 71: 463, 1930.
[2] Porter, Bardwell and Lind, *Journal Ind. Eng. Chem.*, 18: 1086, 1926. See also Francis, *Fuel*, 5: 39, 1926.
[3] Funnel and Hoover, *Jour. Phys. Chem.*, 31: 1099, 1927.
[4] Livingston, *Journ. Phys. Chem.*, 33: 955, 1929.