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.

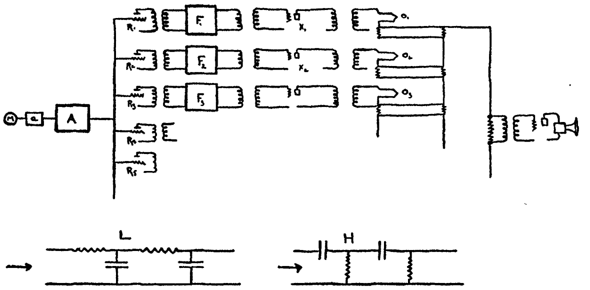
When the orifice and volume of the physiological resonator, the mouth, are varied during the progressive opening of the lips in saying the word "pope," the characteristic resonance frequencies must change rapidly while approximating the steady-state distribution. A similar change will occur at the close 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.



"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

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

[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.

for circulating gases, only minor changes are necessary to render the apparatus described by them efficient for circulating liquids, as was pointed out by Funnel and Hoover. A single valve, probably less efficient, electromagnetic all-glass pump for circulating liquids was described by Smith and Wood in 1923.[5]

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SPECIAL ARTICLES

ON THE CRITICAL TEMPERATURE OF SERUM: DEPOLARIZATION FACTOR AND HYDRATION OF SERUM MOLECULES

IN a series of papers published recently[1] we have shown, successively, first, that the curve representing the viscosity of serum as a function of temperature presented an absolute minimum around 56° C.; second, that the curve expressing the rotatory power of serum, unaffected by heat up to 54°, suddenly showed an increase around that temperature, and that the subsequent increases were nearly proportional to the temperature; third, that the amount of light scattered at right angles by the serum also began to increase after 55° had been reached.

By application of Lord Rayleigh's formula connecting the amount of scattered light to the volume of the scattering particles, this last value was computed and was shown to increase almost linearly with the temperature, above 57° C. The purpose of this paper is to summarize the results obtained by measuring the depolarization factor of the scattered light. It is known that this light is almost completely polarized vertically in colloidal solutions and that the amount of depolarized light depends on the size, the shape and the anisotropy of the molecules or particles. It is difficult to estimate the part played by the shape, when dealing with particles which are not opaque; Cabannes has shown that, in the case of open chain hydrocarbides, the depolarization factor was independent of the length of the chain.[2] It is therefore probable that the main factors are the size and the optical anisotropy.

It was found that the depolarization factor ϱ begins to increase, just as do the physical properties quoted above, after a certain temperature is reached, namely, 57° C. Its increase is slow at first, then very rapid, and its value may reach 0,50 for pure serum heated for ten minutes at 68°. The increase is continuous, and shows no jump when the sol becomes a gel. After the gel state is attained, the increase goes on, regularly, just as the increase in volume of the molecules, computed from Lord Rayleigh's formula. Table I gives the figures for a normal horse serum, heated ten minutes in sealed tubes.

TABLE I

Temperature	Norm.	55°	58°	60°	62°	64°	66°	68°
ϱ	0,0175	0,0170	0,0191	0,0282	0,0490	0,0725	0,0832	0,467
							coagulated	

When the serum is diluted with saline solution (0,9 per cent. NaCl) the depolarization factor may reach, for ten minutes heating at 76°, the extremely high value $\varrho = 0{,}810$. In this case the amount of polarized light amounts to less than 20 per cent. of the scattered light.

If an attempt is made to explain the behavior of serum proteins in the aforesaid experiments (viscosity, polarized light, scattered light) it becomes soon obvious that hydration is the main factor. But in order to account for the quantitative side of the phenomena, it is necessary to resort to a new hypothesis concerning the mechanism of hydration. We have shown previously that, after a certain temperature was reached, the rotatory power and the volume of the molecules increased very nearly proportionally to the temperature, and that below a certain temperature nothing happened. We find now that the optical anisotropy of the molecules, expressed by ϱ, increases very rapidly also. If the water molecules were adsorbed at the surface of the protein molecules, these facts would not be comprehensible. If on the contrary we assume that the water molecules can penetrate inside the huge molecular structure of the protein, and in doing so, change the relative position of the groups, the optical phenomena become quite clear. This hypothesis has the further advantage of

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[1] P. L. du Noüy, *Ann. Inst. Pasteur*, 42: 742, 1928; 43: 749, 1929; 44: 109, 1930; *J. Gen. Phys.*, 12: 363, 1929.

[2] J. Cabannes, "La diffusion moléculaire de la lumière," p. 135, Paris, 1929.

[5] Smith and Wood, *Journ. Am. Chem. Soc.*, 45: 2632, 1923.