ANALYSIS OF THE MECHANISM OF SPEECH.

THE impetus which recent events have given to the study of spoken languages has brought with it a renewed interest in the scientific analysis of the mechanism of speech. He who wishes to learn how to speak a foreign language must necessarily devote much of his time to the acquisition of the pronunciation, and he will most easily learn to become proficient at this difficult art if he can ascertain precisely what he has to do with his speech-organs in order to speak correctly. The need for accurate information about speech movements has led to the development of that branch

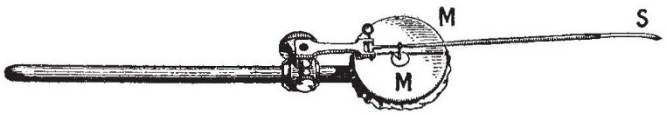

FIG. 1.—A Marey tambour. MM, the membrane; S, the style.

of science known as experimental phonetics—the branch of science which has for its object the accurate analysis of speech by mechanical means.

Among the numerous instruments which have been devised for speech analysis there is one of particular importance, known as the phonetic kymograph, and it is the object of this article to give a brief description of the nature and use of this apparatus.

The phonetic kymograph is essentially an application of the Marey tambour to linguistic purposes. The principle of this tambour is well known, and it is not necessary to describe it in detail. It will be sufficient to recall that it is a

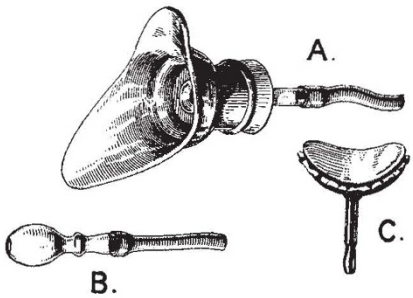

FIG. 2.—A, mouthpiece; B, nasal olive; C, larynx capsule.

mechanism by which vibrating air is communicated to an elastic membrane, and the vibrations of this membrane are in turn communicated to a very light needle or style (Fig. 1). The vibrations of the style are generally recorded on a revolving drum covered with smoked paper or some similar contrivance. Tambours may be of various sizes and materials. A very useful type is one in which the membrane is made of perished rubber, and measures 3 cm. in diameter.

Air vibrations set up by speech may be communicated to the tambour in three principal ways: (1) from the mouth, (2) from the nose, (3) from the outside of the larynx. A rubber tube is attached to the tambour, and at the end of this tube is fitted (A) a mouthpiece (into which the observer speaks), or (B) a nasal olive (which fits into one nostril), or (C) a "larynx capsule" (which is pressed firmly against the outside of the larynx). These appliances are shown in Fig. 2.

The complete apparatus is shown in Fig. 3, which is an illustration of a small portable kymograph. The diagrams in this article were made on the large kymograph in the laboratory of ex-

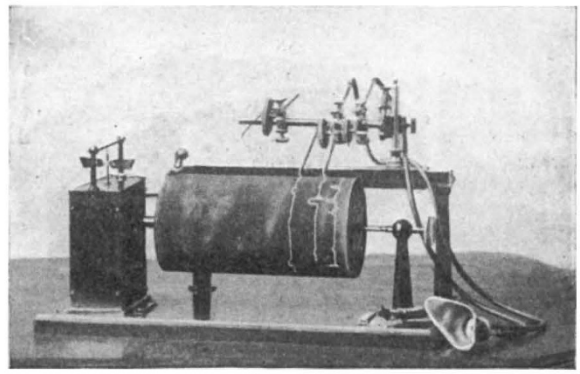

FIG. 3.—A small portable kymograph.

perimental phonetics at University College, London; the cylinder of this machine has a circumference of one metre and a maximum surface speed of 70 cm. per second.

The most useful single tracings that can be made on the phonetic kymograph are those which result from speaking into the mouthpiece. More detailed information may, however, often be obtained by taking nose and mouth tracings, or mouth and larynx tracings simultaneously, or by taking tracings of all three kinds at the same time.

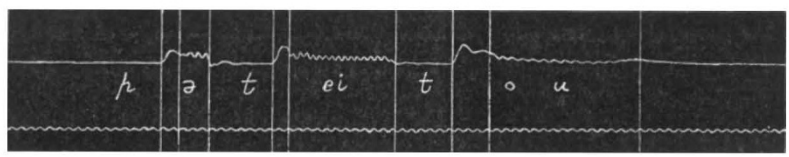

FIG. 4.—Mouth-tracing of *potato*.

The accompanying illustrations show the nature of kymographic tracings and the deductions which can be made from them. Fig. 4 shows a mouth-tracing of the English word *potato*.[1] The horizontal parts of the line show the places where no air issues from the mouth, *i.e.* the "stops" of the consonants *p*, *t*, and *t*. The three steep rises in the line mark the plosions of these consonants. The small waves are caused by the air set in vibration by the vocal chords when "voice" is produced; in this diagram they represent the vowels. The regular wavy line figuring in this and other illustrations is a time-measurer showing hundredths of a second.

Various features of pronunciation may be

[1] The lettering appearing in this and other diagrams is a phonetic transcription of the pronunciation (International Phonetic system).

studied from such a tracing as this. Such are: (1) the extent of "aspiration" of the plosive consonants (shown by the distances between the vertical lines 1 and 2, 4 and 5, 7 and 8); (2) the lengths of the vowels (shown by the distances between the vertical lines 2 and 3, 5 and 6, 8 and 9). The variations in the pitch of the voice may also be calculated to any degree of accuracy by measuring the voice vibrations in successive small intervals.

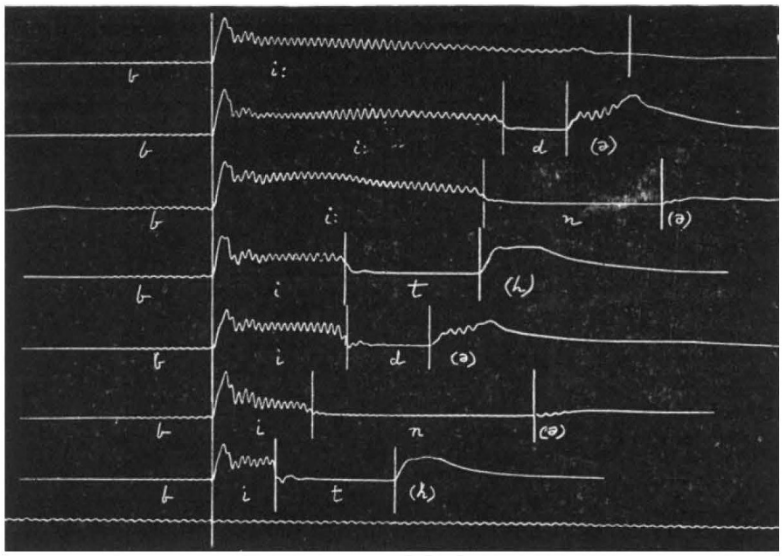

FIG. 5.—Mouth-tracings of *bee, bead, bean, beat, bid, bin, bit*, showing lengths of vowels and final consonants.

Fig. 5 illustrates the variations in length which English vowels undergo under certain conditions. The first four tracings show variations in the length of the English sound of *ee* as exhibited in the words *bee, bead, bean, beat,* and the remaining three tracings show similar variations in the length of the so-called "short *i*" in the words *bid, bin, bit.* It will be seen that the vowels in *bean* and *beat* differ from that in *bead* in somewhat the same manner as the vowels in *bin* and *bit* differ from that in *bid.* It will also be observed that the so-called "short" vowel in *bid* is just about the same length as the so-called "long" vowel in *beat.* (Ignorance of the fact that the vowels in words like *beat, late,* are much shorter than those in *bead, laid,* is the cause of noticeable mispronunciation on the part of many foreigners.)

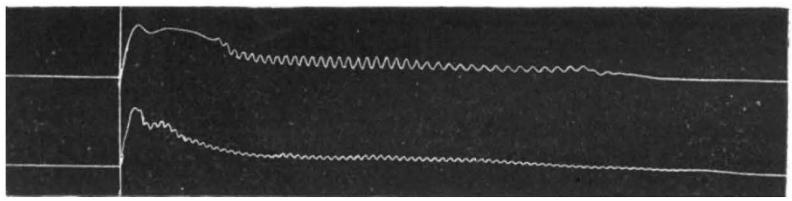

FIG. 6.—A, mouth-tracing of *play* as said by the writer; B, mouth-tracing of the same word mispronounced by a Flemish-speaking Belgian.

Fig. 6 shows (A) a mouth-tracing of the word *play* said by the writer, (B) a mouth-tracing of the same word said by a Flemish-speaking Belgian with a bad accent. It will be noticed that the Belgian mispronounced the *l* by making it completely voiced; in normal English this *l* is partially devocalised, *i.e.* the vibration of the vocal chords does not begin until an appreciable time after the explosion of the *p*.

Fig. 7 is a record of *good morning* (as said on parting), in which tracings of the nose, mouth, larynx, and a time-measurer have been taken simultaneously. The points at which the various sounds begin and end are clearly seen from the nose and mouth tracings. (This is where kymographic tracings have an advantage over enlargements of talking-machine records.) The distances between the vertical lines show the lengths of the various sounds. From the nose-tracings we may gather information as to the extent to which nasal consonants exert a nasalising influence on neighbouring vowels. The larynx-tracing shows vibration-waves throughout, since every sound is voiced; this would be the most convenient curve to use for the purpose of calculating pitch.

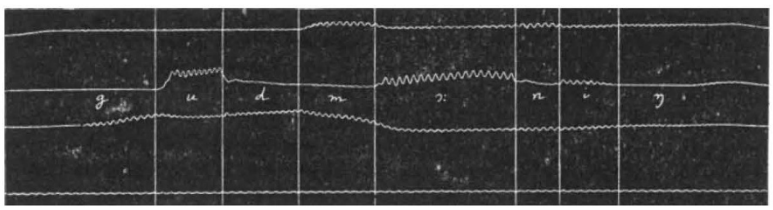

FIG. 7.—Simultaneous nose, mouth, and larynx tracings of *good morning* (as said on parting).

Fig. 8 shows mouth-tracings of the English *buckle* and the French *boucle.* Two important differences will be noticed in regard to the consonants: (A) the English *l* is voiced, whereas the French *l* is not; (B) in the French word the *k*-sound is held on about twice as long as it is in the English word. The smallness of the voice-waves in the French

word is due to the fact that the record is of a lady's voice.

The above short account of the phonetic kymograph will give some idea of the scope of the apparatus. It will be seen that the instrument is chiefly useful (1) for detecting the presence or absence of voice, (2) for detecting the presence or absence of nasality, (3) for measuring the lengths of sounds, and (4) for calculating the pitch of the voice.

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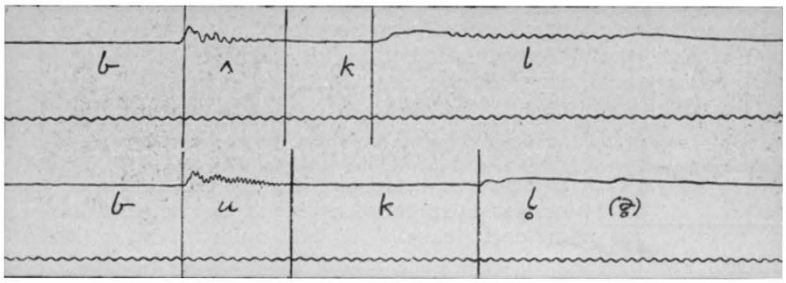

FIG. 8.—A, mouth-tracing of English *buckle* (male voice); B, mouth-tracing of French *boucle* (female voice).

A UNIVERSITY DEGREE IN HORTICULTURE.

THE University of London has, at the suggestion of the council of the Royal Horticultural Society, established a B.Sc. degree in Horticulture. Syllabuses for internal and external students have been drafted, and the University has under consideration the recognition of the Royal Horticultural Society's school and research station at Wisley as a school of the University.

There can be no question that, if university degrees are to be given in technical subjects, the case for a degree in horticulture is a good one; for horticulture connotes not only an industry and an art, but also an applied science.

First of all, however, it is a craft, and, like all crafts, it depends for its successful pursuit on the exercise of practical skill. Therefore, an academic recognition of proficiency which does not carry with it a sure indication of craftsmanship is not only useless, but also pernicious.

The proposed degree in horticulture, if the spirit of the regulations which govern it is observed, makes adequate provision for the requirement of technical expertness. A candidate for the internal degree, besides matriculating and passing the Intermediate Science Examination, must pass the Preliminary Examination for the National Diploma in Horticulture before he proceeds to the Final Examination. This examination, established by the Royal Horticultural Society with the approval of the Board of Agriculture, is an adequate elementary test of practical knowledge and ability. Furthermore, during the final course candidates are required to perfect their knowledge of practical horticulture, and the sciences which are prescribed in the course of study are to be taught with definite reference to horticulture.

If, therefore, a student follows this course at a horticultural college, there is but little danger that general science, botany and chemistry and entomology, will divert unduly the student's interest from horticulture. The Bachelor of Science in Horticulture would thus be possessed of a fair knowledge of science, and would also be a proficient practical horticulturist, able to dig and trench, plant and prune, bud and graft at best as well as the average gardener. If this prove, in fact, to be the case, both science and horticulture will gain. For at present there is a deep gulf fixed between the science and practice of horticulture. The well-trained man of science, say the Part II. Tripos man, has become too specialised in habits of work, too much a victim of the laboratory habit, to be willing to spend a year or so working with his hands on the land.

For these reasons it may be hoped that the establishment of a degree in horticulture will be of no less benefit to potential botanists and agricultural chemists than to professional horticulturists. In the case of botany, at all events, it may reasonably be asserted that much of the botanical ritual observed in our university laboratories is outworn; and although we are not confusing botanists with gardeners, we are confident that, if botanical students were to spend half as many hours working in the garden as they now spend with microscopes and microtomes, they would become better botanists.

From yet another point of view the degree in horticulture is to be welcomed. Tropical horticulture is in many cases more akin to horticulture than to the agriculture practised in this country. The Empire has great need of men to aid in developing its resources. The old class of administrator—the man who could administer anything about which he knew nothing—has been found out. The war has weighed him in the balances and proved him wanting. The new class of administrator must be a new kind of practical man—"a hewer, not a heaver, of things." By providing a course of training in the practice and science of horticulture, the University of London has made a contribution towards meeting the need for this new class of practical men.

This will only be the case, however, if the University insists upon satisfactory practical training for all candidates for degrees in horticulture, and not from internal students only. Unfortunately, the regulations for the external degree in horticulture provide for no *training* in practical horticulture, nor, to be fair, does it