

# Phonetics in 1924

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“Phonetics, a necessary prerequisite  
for all exact work in linguistics...”

-- Sapir (1929), “The Status of  
Linguistics as a Science”, *Language*

# Four areas of phonetics important in 1920s

Traditional descriptive phonetics

Experimental phonetics

Acoustic phonetics

Speech communication

# Traditional general and practical phonetics

Impressionistic transcription and description of the  
speech sounds of languages,  
within a general framework

“A universal terminology is coming into existence; a universal phonetic alphabet is well on its way; the principles of phonetics and of phonetic transcription are developing rapidly.”

-- Harold E. Palmer (1921),

*The Principles of Language-Study*

# The IPA in the 1920s

- The **International Phonetic Association** was founded in 1886, newly revived in 1923 after a hiatus for WWI
- Its most recent **phonetic alphabet** was from 1912, given as a chart (next slide) plus “other sounds” and diacritics
- The chart not only displays the symbols, but gives a classification framework

# 1912 IPA chart

	<i>Lips</i>	<i>Lip-teeth</i>	<i>Point and Blade</i>	<i>Front</i>	<i>Back</i>	<i>Uvula</i>	<i>Throat</i>	
<b>CONSONANTS</b>	<i>Plosive</i>	p b		t d	c ɟ	k ɡ	q ɢ	ʔ
	<i>Nasal</i>	m		n	ɲ	ŋ	ɴ	
	<i>Lateral</i>			l ɭ	ʎ	(ɮ)		
	<i>Rolled</i>			r ɽ			ʀ	
	<i>Fricative</i>	f ɸ ɱ w ɥ σ ρ	f v	θ ð s z σ ρ ʃ ʒ ɹ	ç j (ç)	(ɱ w) x ɣ	χ ʁ	h ɦ
<b>VOWELS</b>	<i>Close</i>	(u ü y) (ʊ ʏ)		<i>Front</i> i y ɪ ʏ	<i>Mixed</i> ɨ ʉ	<i>Back</i> ɯ u ʊ		
	<i>Half-close</i>	(o ɔ ø)		e ø	ë ö	ɤ ɒ		
	<i>Half-open</i>	(ɔ ɔ̃ œ)		ɛ œ	ɛ̃ ɔ̃	ʌ ɔ		
	<i>Open</i>			æ ɶ a	ɶ ɑ			

(Sounds appearing twice on the chart have a double articulation, the secondary articulation being shown by the symbol in brackets.)

# The IPA in the 1920s

- Use of the IPA alphabet was well-established for teaching pronunciation, clinical work, documenting English allophones and dialects
- The IPA journal *Le Maître Phonétique* (itself printed in IPA) was publishing sample transcriptions (“specimens”) for many languages -- in 1924, Burmese, Russian, Scottish Gaelic, Somali, Korean (next slide)

# Beginning of Korean “specimen”

*Maître Phonétique* June 1924

## spesimen

korien

prəhənsieɪʃn əv K. MINN əv *Seoul*. trənsleɪʃn bəɪ mɪstə MINN  
trənskɪpʃn bəɪ mɪstə MINN ɪn kələbərəɪʃn wɪð D. JONES

ʌnəspɪreɪtɪd p, slɑɪtli əspɪreɪtɪd p', ənd strɔŋli əspɪreɪtɪd  
ph ə kliəli dɪstɪŋgwɪʃt. ðə dɪfrənsɪz ə sɪgnɪfɪkənt. ɪgzɑ'mplɪ:  
pe (boʊn), p'e (raɪs ɪn ðə hɑːsk), phɛ (wɔːdn leɪbl). sɪmɪləli wɪð  
t, t', th, k, k', kh, ts, ts', tsh.

b, d, g, dz ə sʌbsɪdʒəri mɛmbəz əv ðə foʊnɪ:mz p', t', k', t'  
(nɒt əv ðɪ ʌnəspɪreɪtɪd sʌndz, əz maɪt bɪ ɪkspektɪd). soʊn  
sɪ:mz ðæt ɪn sɪmplɪfaɪd əθɒgrəfi ðeɪ ʃʊd bɪ rɪtn p', t', k', ts'. ðə  
vɔɪst fɔ:mz ɑr ə'lweɪz ju:zd wɛn ə neɪzl kɒnsənənt prɪ'sɪ:dz. ðə  
t'əndzi məndzə kænɒt bɪ sed wɪð ts' ɪvɪn ɪn slɔv spɪ'tʃ. ðə vɔɪst  
fɔ:mz ɑr ə'lsoʊ ju:zd ɪn ræpɪd spɪ'tʃ bɪtwɪ'n ʌðə vɔɪst sʌndz ɪn  
ðə mɪdl əv grʊ:ps; bʌt ɪt əpɪəz ðæt p', t', k', ts' wʊd bɪ sʌbstɪtju:tɪd  
ɪn slɔv spɪ'tʃ. ðəs ndʊgu, t'ədʌndʌnʃi wʊd bɪ ɪn slɔv spɪ'tʃ ndʊku.  
t'ət'ʌndʌnʃi.

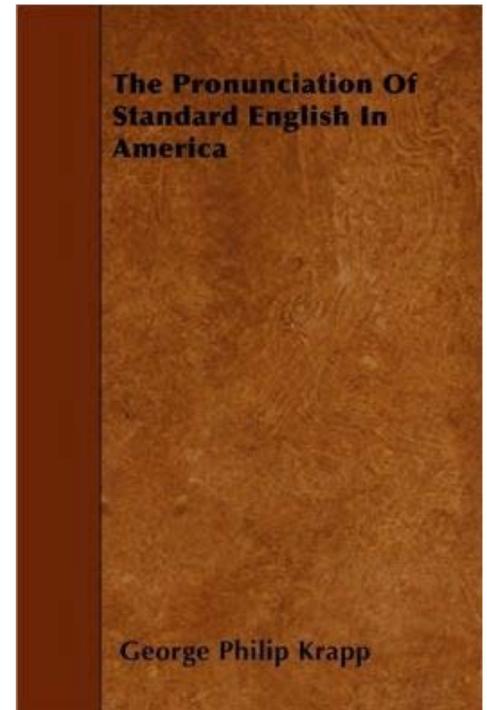
# The IPA in the U.S. in the 1920s

- 65 1924 U.S. members, including Bloomfield
- IPA was generally used for phonetic and phonemic transcription of American English
  - L. Bloomfield and G.M. Bolling (1927), “What Symbols Shall We Use?” (*Language* 3(2))
  - J. S. Kenyon (1929), “The International Phonetic Alphabet”, (*American Speech* 4(4)) reports that the Practical Phonetics Group of the Modern Language Association and the National Association of Teachers of Speech both adopted the IPA in 1927

# Phonetic descriptions of American English

- **Daniel Jones**'s British work provided a model
  - 1909/1924: *The Pronunciation of English*
  - 1917: *An English Pronouncing Dictionary*
  - 1918: *An Outline of English Phonetics*
- **George Philip Krapp** (1919):  
*The Pronunciation of Standard English in America*

“When people become conscious of so familiar an activity as speech, it means that changes are taking place in it....All cultivated speakers do not speak alike in America.”

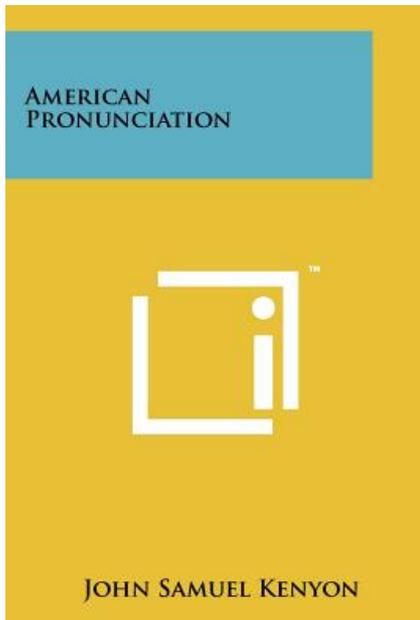




# John Samuel Kenyon (1924)

## *American Pronunciation*

“Phonetics has exceptional qualities as a branch of science adapted to educational ends. Its large field of basic facts – its raw material – lies all about us and is immediately available to every student – the facts of pronunciation always within reach of our personal observation. Moreover, they are facts of constantly vital and social interest. They are elemental facts of mental behavior in one aspect of experience; and the observation of these facts constitutes as real an approach, so far as it goes, to the understanding of mental phenomena as the study of psychology.”





## Hans Kurath: surveying American English

- Planning for the *Linguistic Atlas of New England* (1939) began in 1924; Krapp and Kenyon were involved, along with many others



- Bernard Bloch wrote the phonetics chapter in the accompanying *Handbook of the Linguistic Geography of New England*, describing use of IPA

# Summary, practical phonetics

- Descriptive phonetics was at a very high standard
- The IPA was in broad use at this time
- **Otto Jespersen's** Copenhagen Conference in April 1925 pushed the IPA to add new symbols, aiming at a truly universal alphabet

# Experimental phonetics

Laboratory studies  
of speech production

“But, linguistics demands the recording of speech-movements or of the resultant sound-waves. For this purpose a kind of simplified physiology of speech has hitherto been used; as it is in many ways unsatisfactory, methods of mechanical observation, both physiologic and acoustic, are being developed.”

-- Bloomfield (1925), “Why a linguistic society?”, *Language* 1(1)

# Before 1924

About when the IPA was establishing itself, two early “fathers of **experimental phonetics**”:

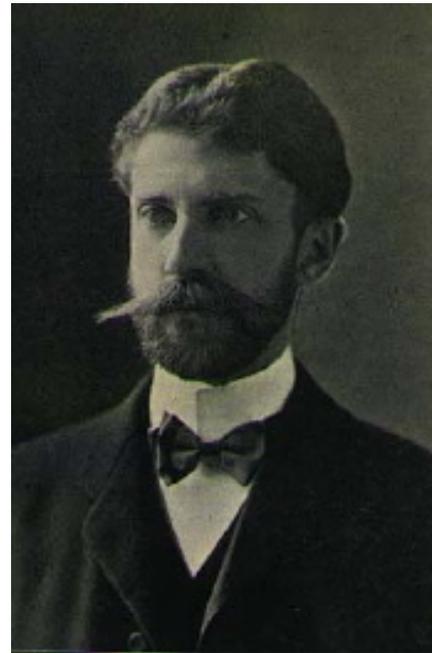
**Abbé Rousselot**

(1846-1934)



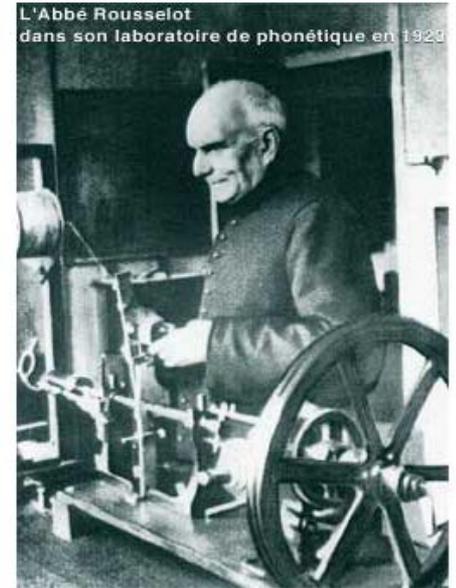
**Edward W. Scripture**

(1864-1945)

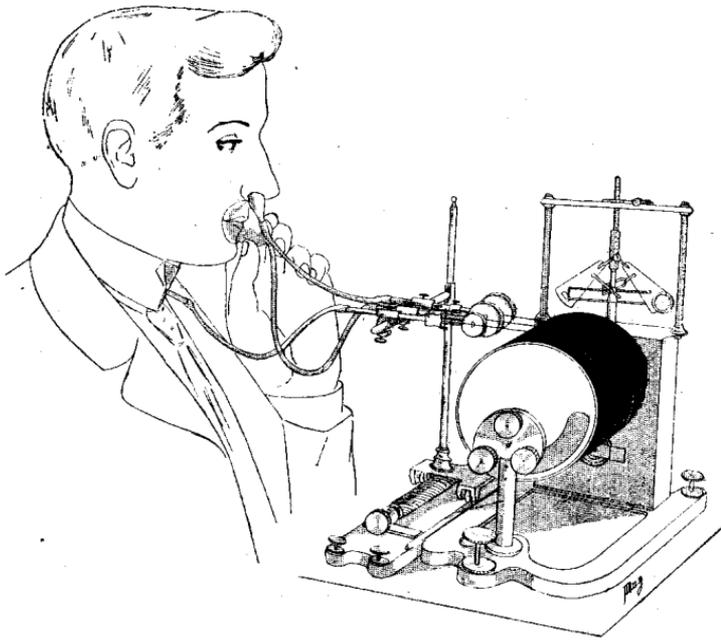


# Abbé Rousselot

- Early work was in dialectology
- 1889, 1897: phonetics labs in Paris
- 1902: *Précis de prononciation française*
- 1923: Chair in **Experimental Phonetics** at the Collège de France
- Applied phonetics to language teaching, deaf speech training, singing, poetry



# Many signals captured (by *tambours*): oral and nasal flow, glottal vibration, jaw opening, lip opening, tongue height, palate contact

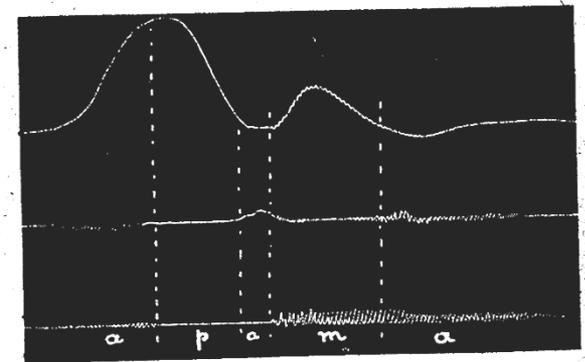


Czech [apma]:

Lips

Oral

Nasal



30

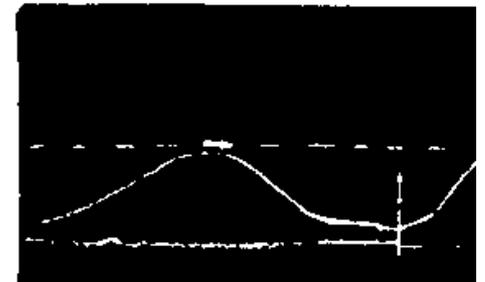
VOYELLES



Fig. 14.  
Position des lèvres pour les voyelles a en parisien.

a moyen : voyelle neutre.  
a ouvert : 1<sup>re</sup> voyelle de la série antérieure.  
d fermé : 1<sup>re</sup> voyelle de la série postérieure.

French vowel [a]:  
mouth, palate



tongue height



Fig. 15.

Traces comparatives laissées sur le palais artificiel par la langue

# Edward Wheeler Scripture

- Early experimental psychologist at Yale (“experimental psychology of speech”); later studied medicine
- 1902: *Elements of Experimental Phonetics*
- 1923-1935: Vienna, phonetics lab modeled directly on Rousselot’s – “a laboratory of **linguistic phonetics**”
- Applied phonetics to telecommunications, neurological disorders, pronunciation teaching, poetry



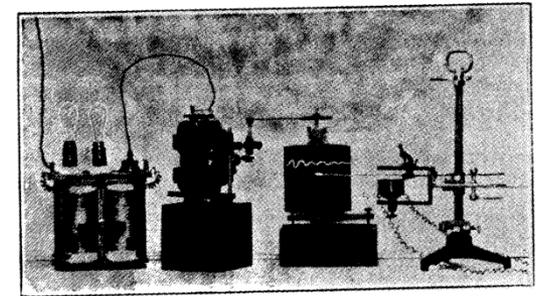
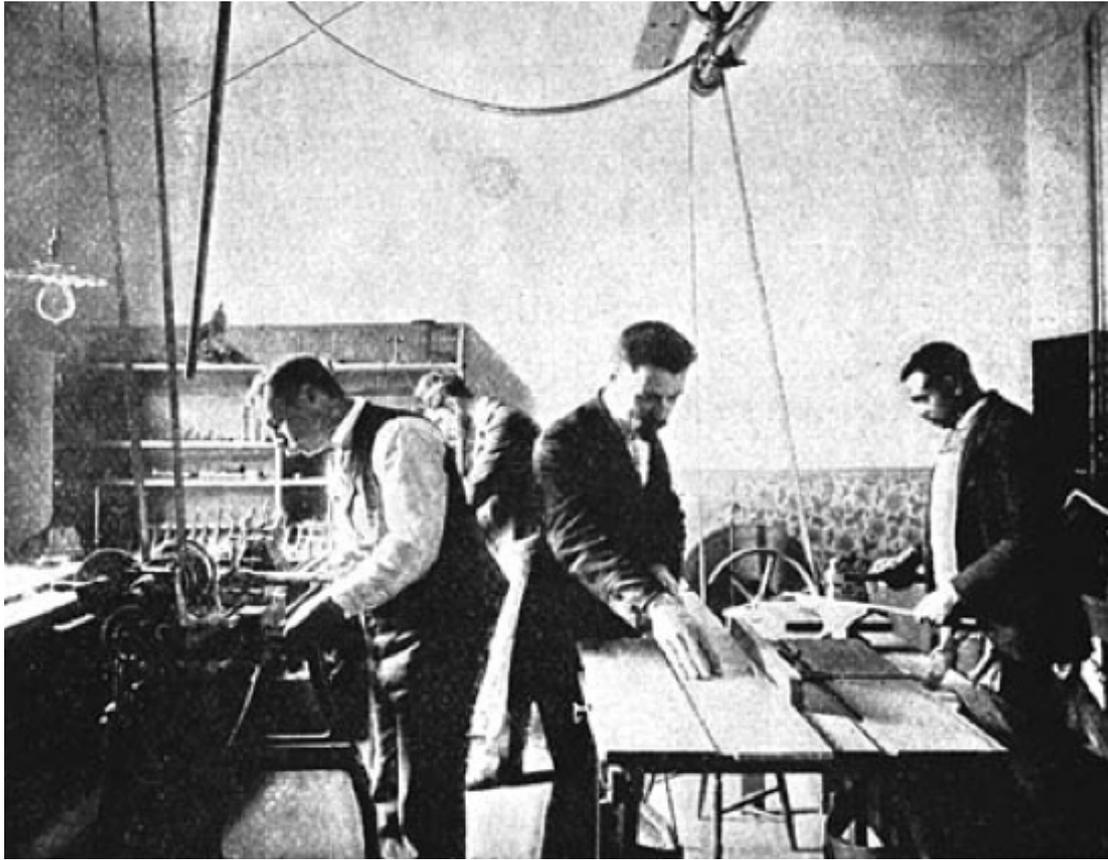


FIG. 6.

Several of these drums may be smoked and kept ready for use. Long strips of paper may be used over two drums. The continuous-paper drum shown in Fig. 7 is suitable for very long records. Two plates *DE* are held together by cross-  
 rods. At any points on the edges of these plates metal shafts may be clamped, and two drums *A, B* with hollow axles placed on them. A band of paper *CC* is fastened evenly around the drums and tightened after the paste is dry by ad-

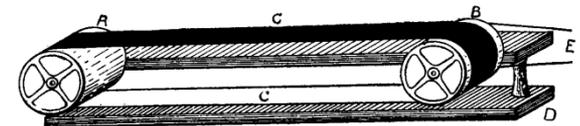
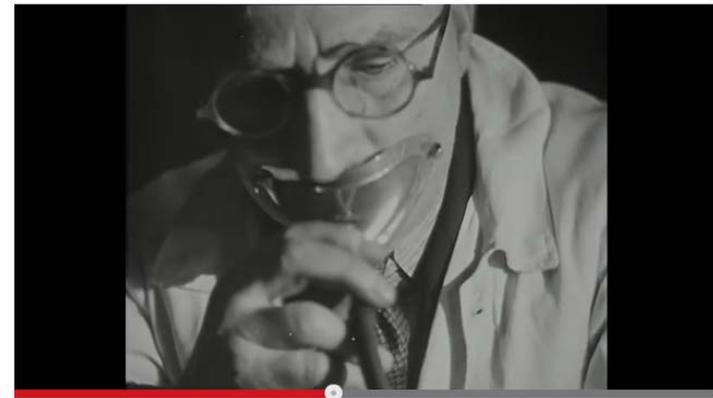


FIG. 7.

# In Britain: Stephen Jones (1872-1942)



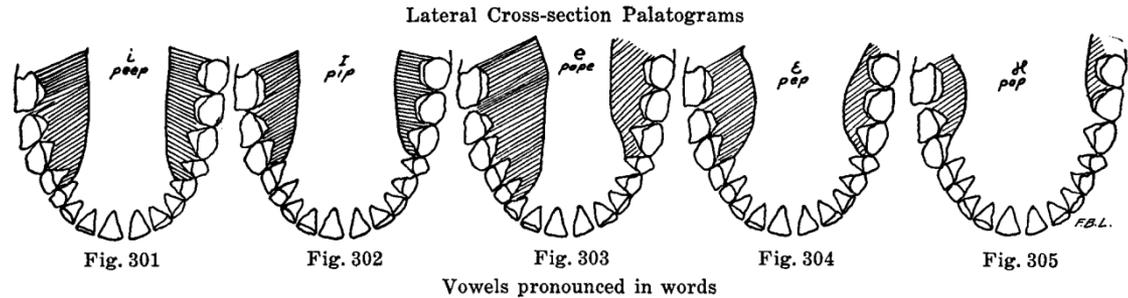
- At University College London 1912-1937
- Developed an improved kymograph by 1928
- His film about the UCL lab was posted on YouTube by Michael Ashby
- Taught phonetics in Iowa in summer 1929, probably invited by **Scripture's** student **Carl Seashore**

# G. Oscar Russell

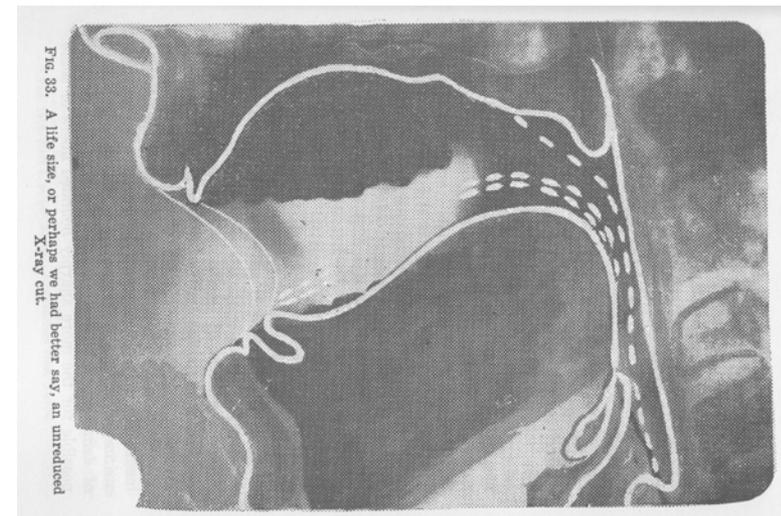
(1890-1962)

- Iowa 1919-1923; Ohio State 1925-41

- False palate for recording tongue contact and movement



- 1928: *The Vowel: Its Physiological Mechanism as Shown by X-Ray*



# Russell's views on vowels

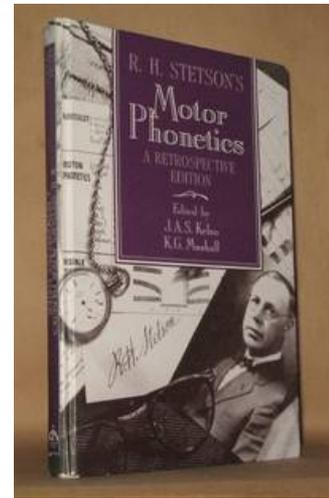
- X-ray evidence clearly shows that the IPA's tongue-height classification – or *any physiological classification* – is wrong
- There's no current good “scheme” for vowels
- Most likely should be *acoustic*, but cavity-size accounts haven't been fully successful yet, and *damping effects* (tension) *of vocal tract walls* are probably crucial in differentiating vowels



# Raymond H. Stetson

(1872-1950)

## *Motor Phonetics, 1928*



- Motor phonetics: “the study of the skilled movements involved in the process of handling articulatory signals”
- The **syllable** (and the contrast between syllabic and non-syllabic within it) is the basic unit of speech, the minimal unit with meaning
- Each syllable is a “**chest pulse**”: expiratory muscles produce the pulse, inspiratory muscles arrest it
- Much of the book shows how articulations can be re-organized with changes in rate, stress

ledge concerning the acoustic aspects of speech, especially as related to telephonic communication, has given further impetus to research in experimental phonetics. Advances in technology, especially in the application of electronics to the problems, have motivated research in this field.

### 1. The Recording Methods applied to the Processes of Speech

Tracings (recordings) of the movements of the several parts involved are essential to an adequate analysis of the total speech process. Since the timing

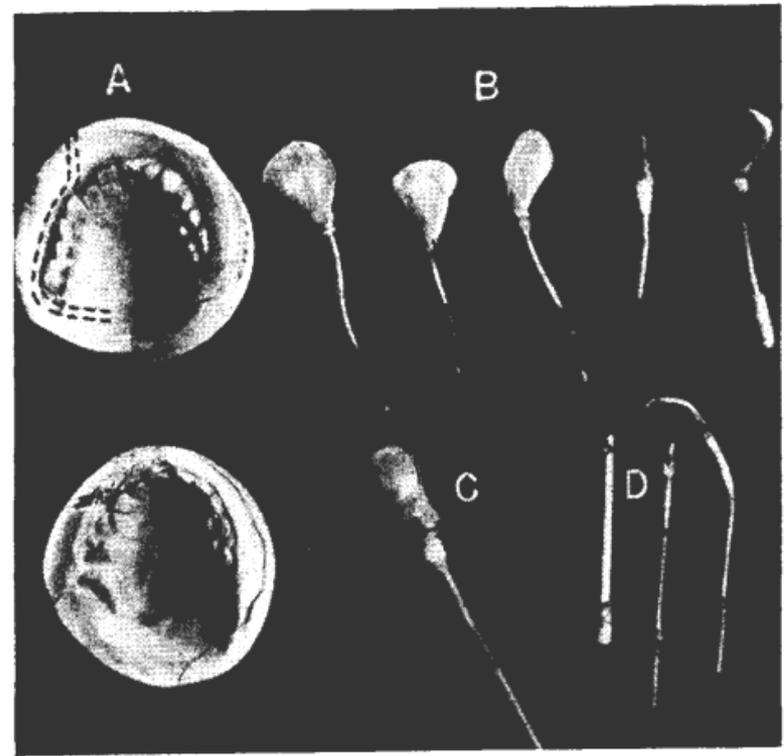
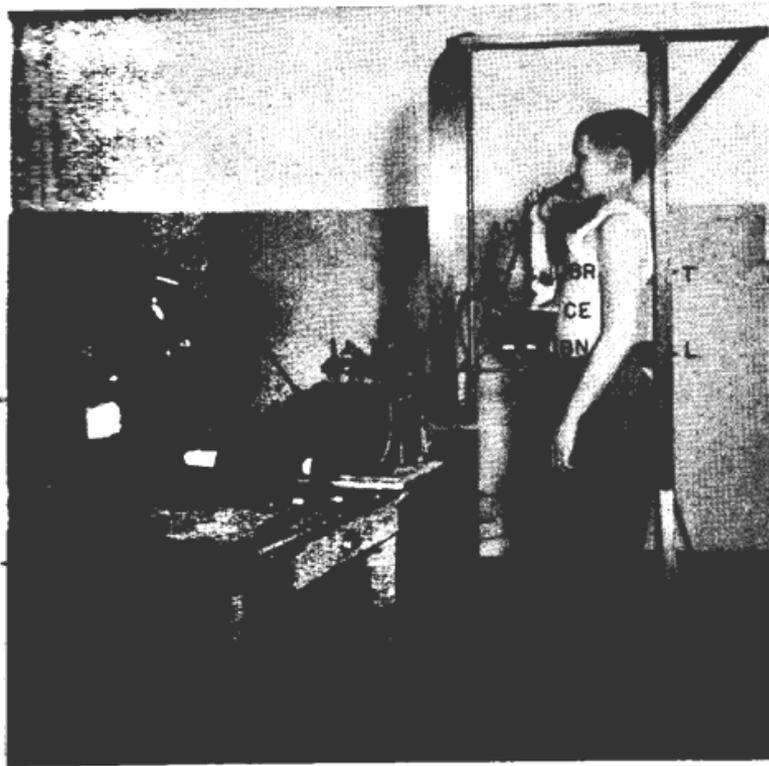


FIG. 2. — Tongue and Lip Markers

- A — Casts of the palate of subject for fitting tongue markers. The dotted lines indicate the position of an air tube (D, curved form) outside jaw.
- B — Various types of tongue markers with steel wire frames which support distended rubber coated with collodion.
- C — Lip marker with steel wire frame.
- D — Air tubes. The curved form passes outside jaw and taps mouth cavity behind molars.
- These markers are connected by rubber tubes with the recording tambours of kymograph.

of the movements is of primary importance, the tracings must be simultaneous. For simplicity the speech mechanism may be divided into three divisions, although the mechanism functions as an

# Summary, experimental phonetics

- Impressive and ingenious instrumentation
  - But all of it eclipsed soon by electronics
- Major ideas of Russell and Stetson were wrong
- But a valuable appreciation of the dynamic and overlapping nature of speech articulations

# Acoustic phonetics

Controversies on the way to  
the source/filter theory  
of speech acoustics

“(...) we still have advocates of the two theories.”

-- Harvey Fletcher (1929),  
*Speech and Hearing*

# Speech soundwaves

- First phonetics paper in *Language*: **G. Oscar Russell** (1928) “Some Terms of Physics for Linguists” – mostly about soundwaves (as opposed to airflow out of the mouth)
- Transducing/recording/displaying soundwaves *linearly* was not yet possible, despite efforts by e.g. **A. G. Bell, Rousselot, Scripture**
- Breakthroughs in electronics, especially from Bell Labs: **Miller** (1916), **Crandall** (1925)

# Audio recording before 1926

(reproduced in Fletcher (1929))



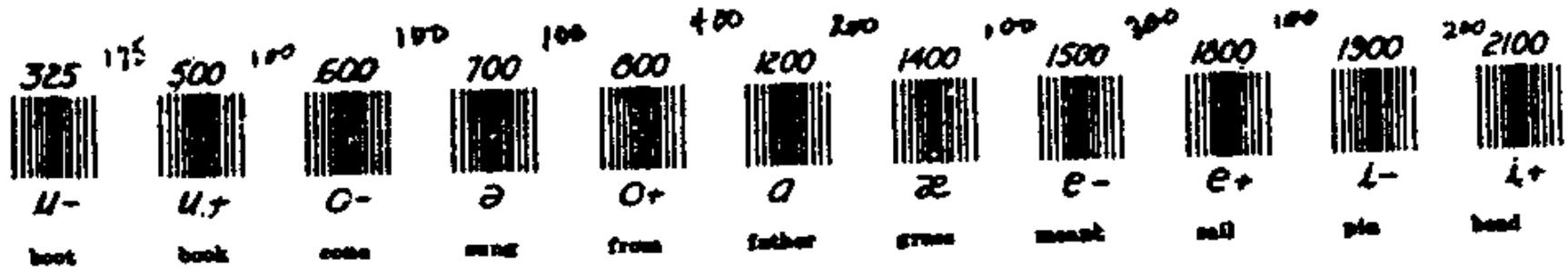
# Harmonic structure

- Relation of voice **pitch** (“**cord tone**”) to vocal fold **vibration frequency**, and harmonic structure of voice source and of speech signal (a complex periodic waveform), were well-understood, and described by **Russell**
- But Russell (and others) thought the source was different for each segment type
- **Fourier analysis** was tedious – and controversial for speech, which is not a steady signal – but again Bell Labs developed electronic methods

# “Vowel Theory”:

## How many vocal tract resonances?

- One: Willis (1829); Scripture, Russell (“cavity tone”), Mark. H. Liddell (1924), *Physical Characteristics of Speech Sound*:



- One for back vowels, but two for front vowels: Helmholtz (1862), Stetson (1928)

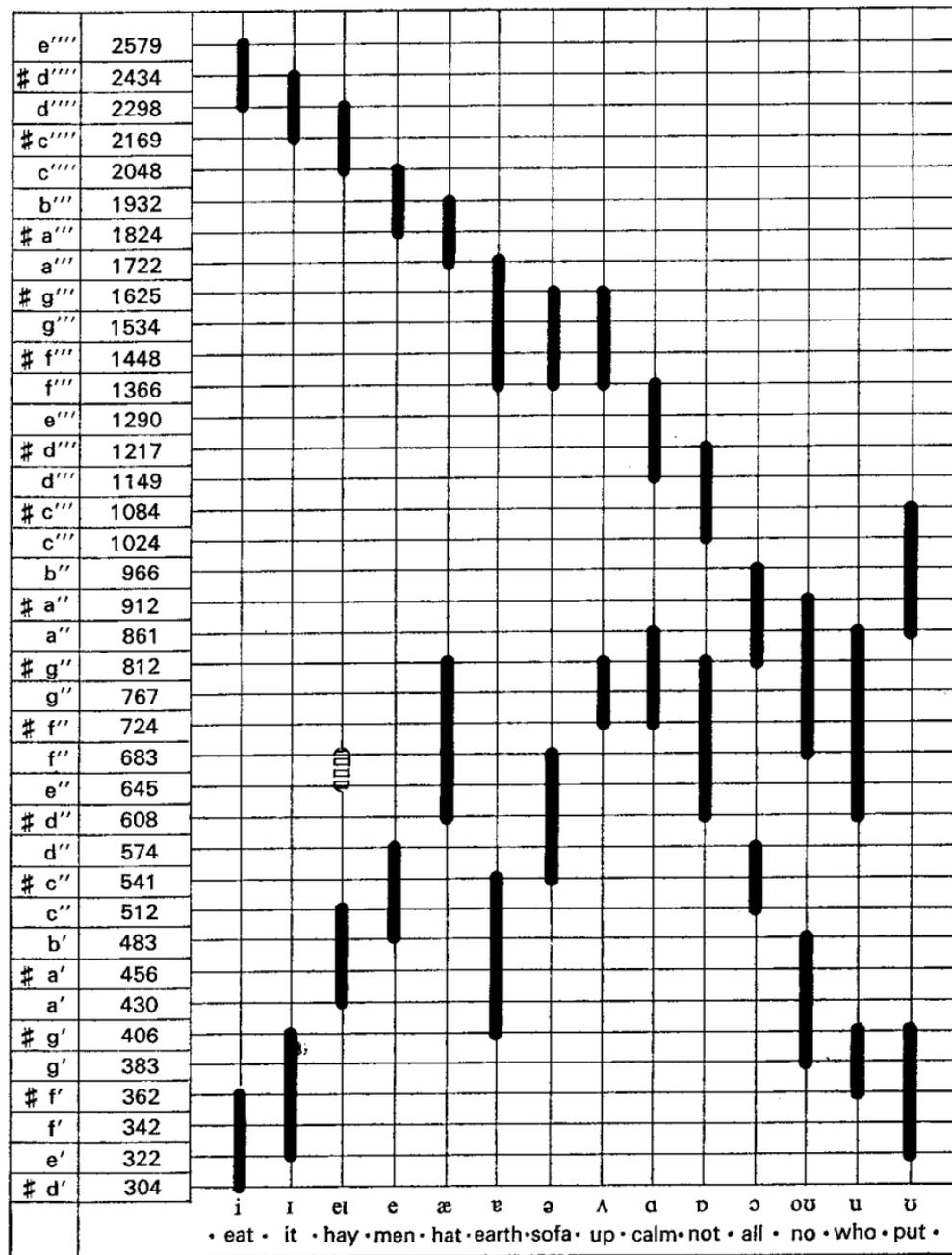
# “Vowel Theory”:

## How many vocal tract resonances?

- Always two: Bell (1879), **Paget (1922)** (next slide)
  - Lower resonance is from back-tube; higher resonance is from front tube
- More than two: Wheatstone (1837), Crandall (1925)

**Modern understanding**: Chiba & Kajiyama (1941)

# Sir Richard Paget (1922), *Vowel Resonances*



# “Vowel Theory”:

## Harmonic or inharmonic resonances?

Long-standing debate on whether vocal tract resonances are

- “**harmonic**”: enhanced harmonics, so always harmonically related to the fundamental  
(Wheatstone-Helmholtz-**Miller (1922)**)
- “**inharmonic**”: unrelated to the fundamental, i.e. frequencies that are not in the source but instead added by the vocal tract  
(Willis-Hermann-**Scripture (1902)**)

# Both were right

- Vocal tract resonances are *not* harmonically related to the fundamental
- But they are seen in a voiced speech signal **only through their effects on source harmonics** (next slide)
- This is **Fant**'s “resonance” vs. “formant”

# Fletcher (1929): same vowel at 2 pitches

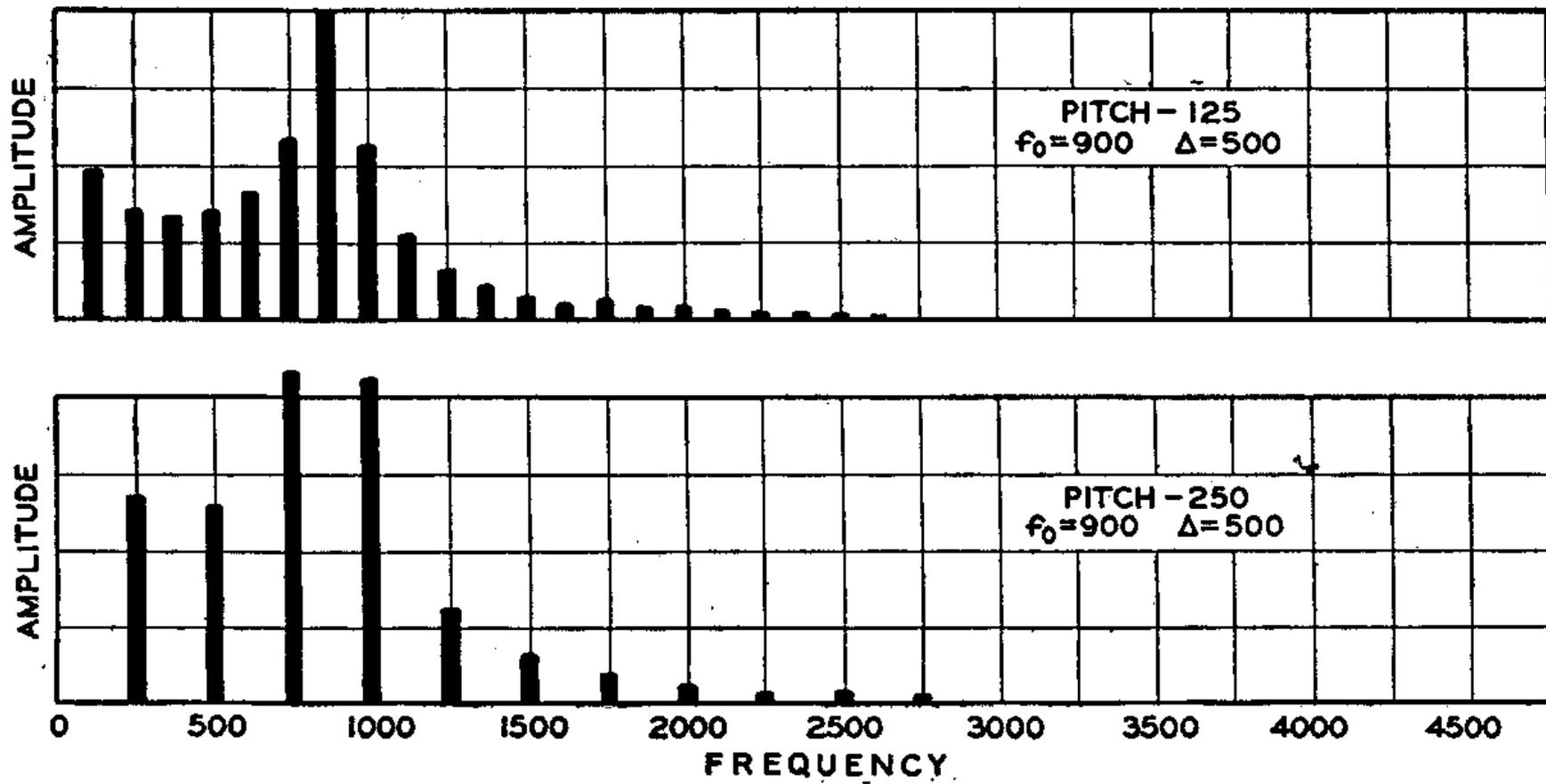


FIGURE 38.

# Summary, acoustic phonetics

- Speech waveforms were a major object of study, spectra less so
- The source-filter acoustic theory of speech production was still in the future, with key ideas about vocal tract resonances still controversial
- None of the people who understood the relation of resonances to harmonics (**Rayleigh, Fletcher**) fully explained the nature of the confusion to everyone else, so the controversy continued for a long time

# Speech science for telecommunications

Speech acoustics to improve  
speech intelligibility

“It has recently been felt that the wave forms of the speech sounds required more precise determination, and indeed research in the art of telephony has emphasized this need.”

-- Irving B. Crandall (1925),  
“The Sounds of Speech”

# Harvey Fletcher (1929)

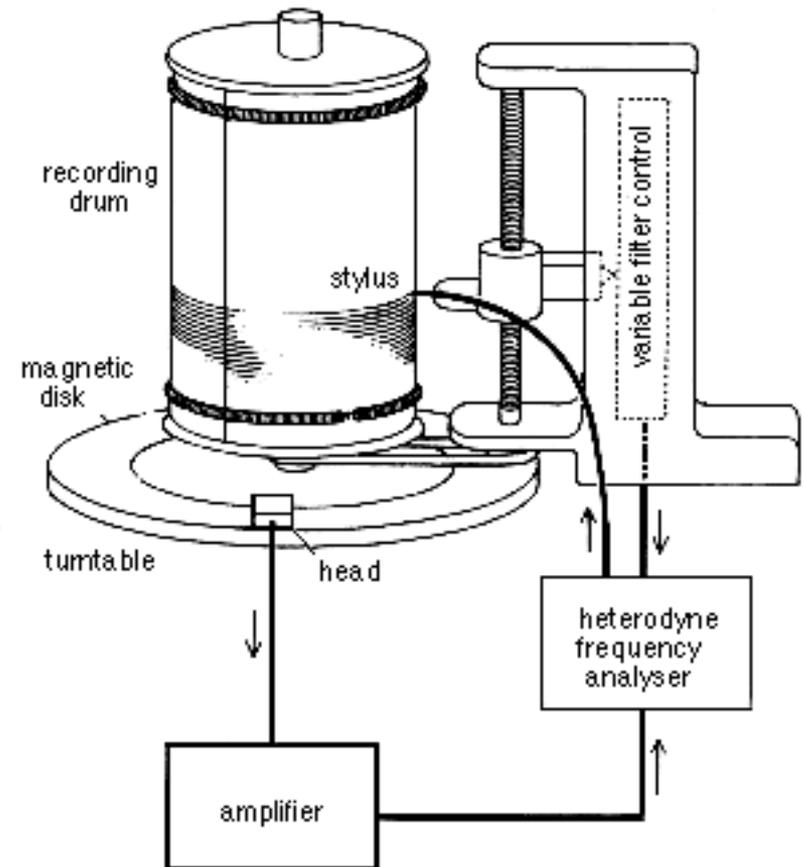
## *Speech and Hearing*

- Summarizing a decade of impressive work at **Bell Labs** on speech transmission, acoustics, noise, perception, and intelligibility
- Statistics of occurrence of English words, syllables, segments – telephone transmission should be optimized for these
- “**Articulation Index**”: How intelligible are different sounds when degraded in transmission? What frequencies are critical?

# Two key developments in the next decade

## 1) New instrumentation from Bell Labs

- Spectrograph for analysis:
- Vocoder for transmission
- Voder for synthesis:



# Two key developments in the next decade

## 2) First International Congress of Phonetic Sciences, Amsterdam, 1932

- Bring together: practical and experimental phoneticians, phonologists, others
- To discuss: physiology of speech and voice, speech development in individuals and in evolution, anthropology, phonology, linguistic psychology, pathologies (“clinical experimental phonetics”), comparative animal vocalization, musicology

# Summary: Phonetics in the 1920s

- Widespread use, and expansion, of the IPA for **phonetic description of languages**, including major works on English
- New **speech production laboratories** in the U.S. with many specialized instruments
- Beginnings of the **acoustic theory** of speech production
- Benefits from **telecommunications** research for basic speech science
- **Participation** of linguists and non-linguists

Many thanks to these UCLA students  
who helped with this project:

- Franny Brogan
- Martha Clayton
- Malone Dunlavy
- Edward Nguyen
- Khoa Tran

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