University of California
Berkeley

College of Engineering
Department of Electrical Engineering
and Computer Sciences

Professors : N.Morgan / B.Gold

EE225D

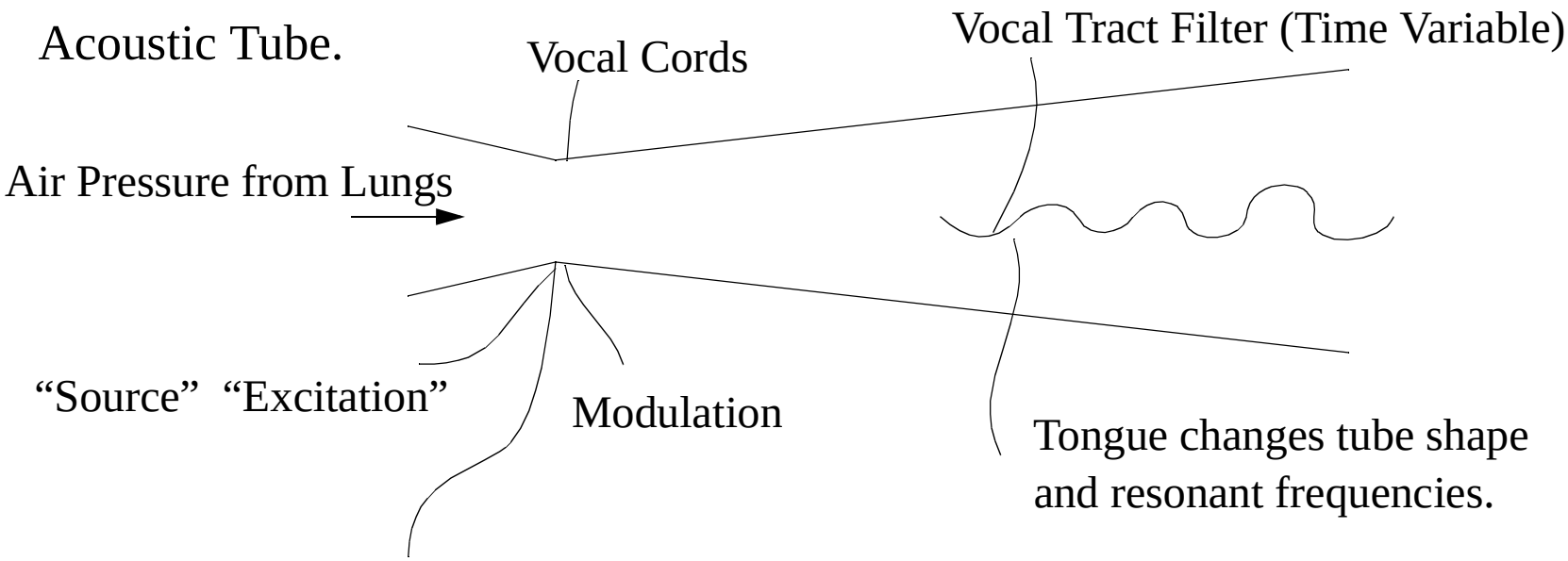
Spring,1999

Synthetic Audio

Lecture 2

a) Black Board

Acoustic Tube.



b) Trumpet has more or less the same model (- excitation) is created by

lip vibration that produce pressure waves (- acoustic).

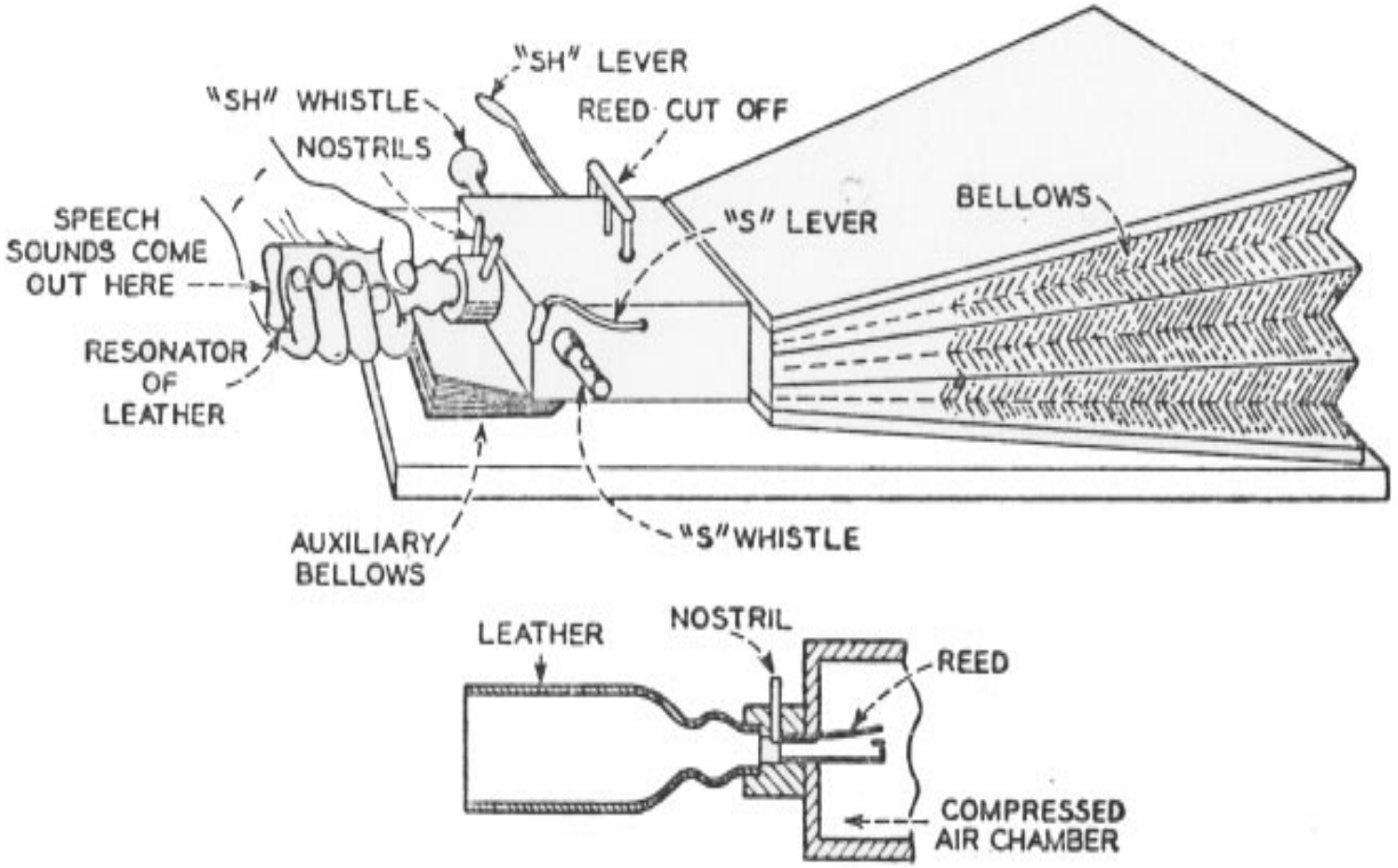


Figure 2.1 : Wheatstone Speaking Machine (after Von Kempelen)

Important Features on Wheatstone Speaking Machine (after Von Kempelen).

1. Vibrating Reed to Simulate Vocal cords.
2. Nasal Passage.
3. Bellows for producing pressure.
4. Leather “Vocal Tract”

Question : How is “ S ” or “ Sh ” produced?

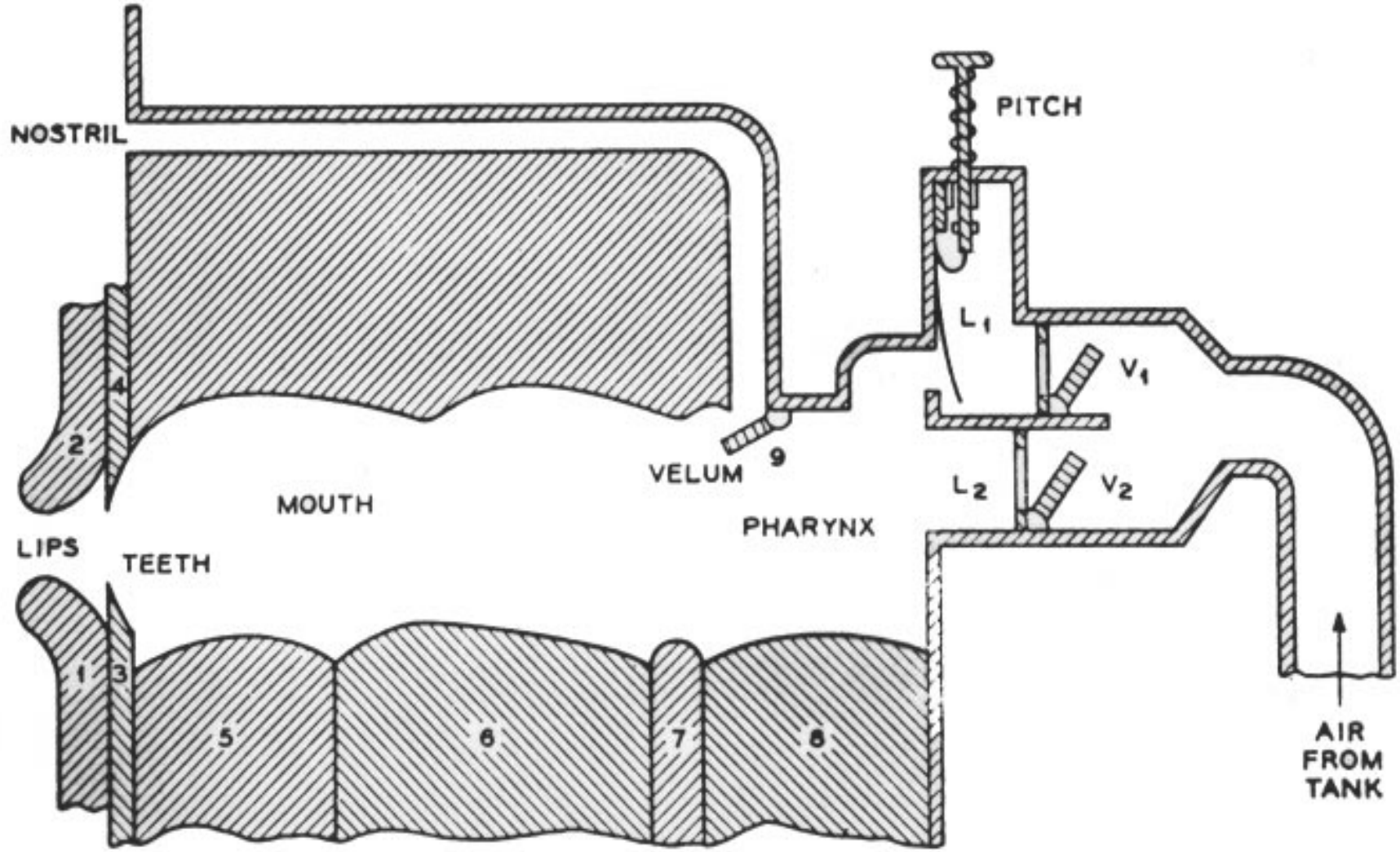


Figure 2.2 : Riesz's Speaking Machine

Important Points :

a) First Electronic Synthesizer

b) Long Period of Operator Training

c) Filter Bank to Emulate Vocal Tract

d) Relation to Human Voice Production

Figure 2.4 : Sketch of the Voder.

a) V-UV explicit

b) Pitch controlled by pedal.

c) 10 Filters

d) Special keys for consonants.

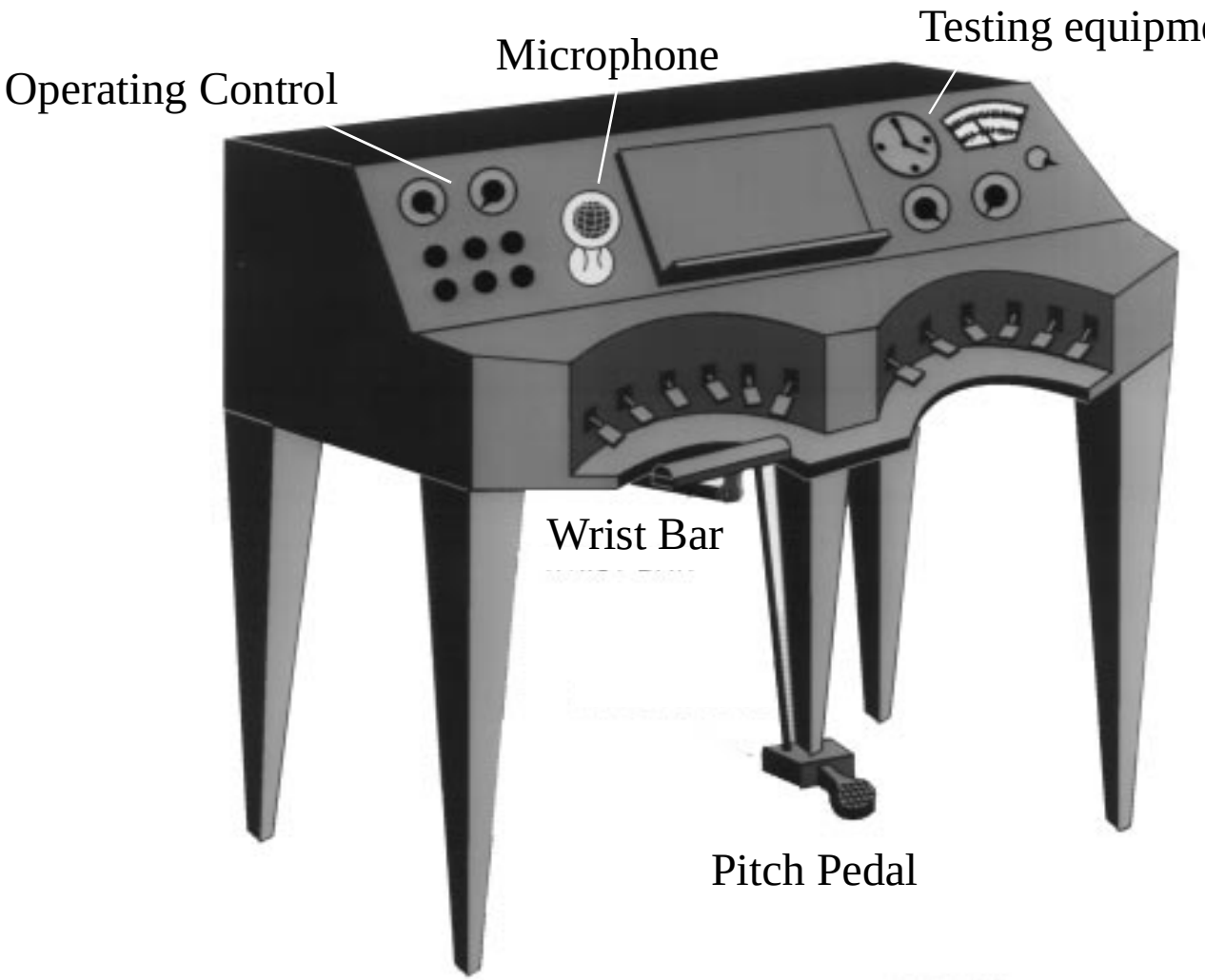
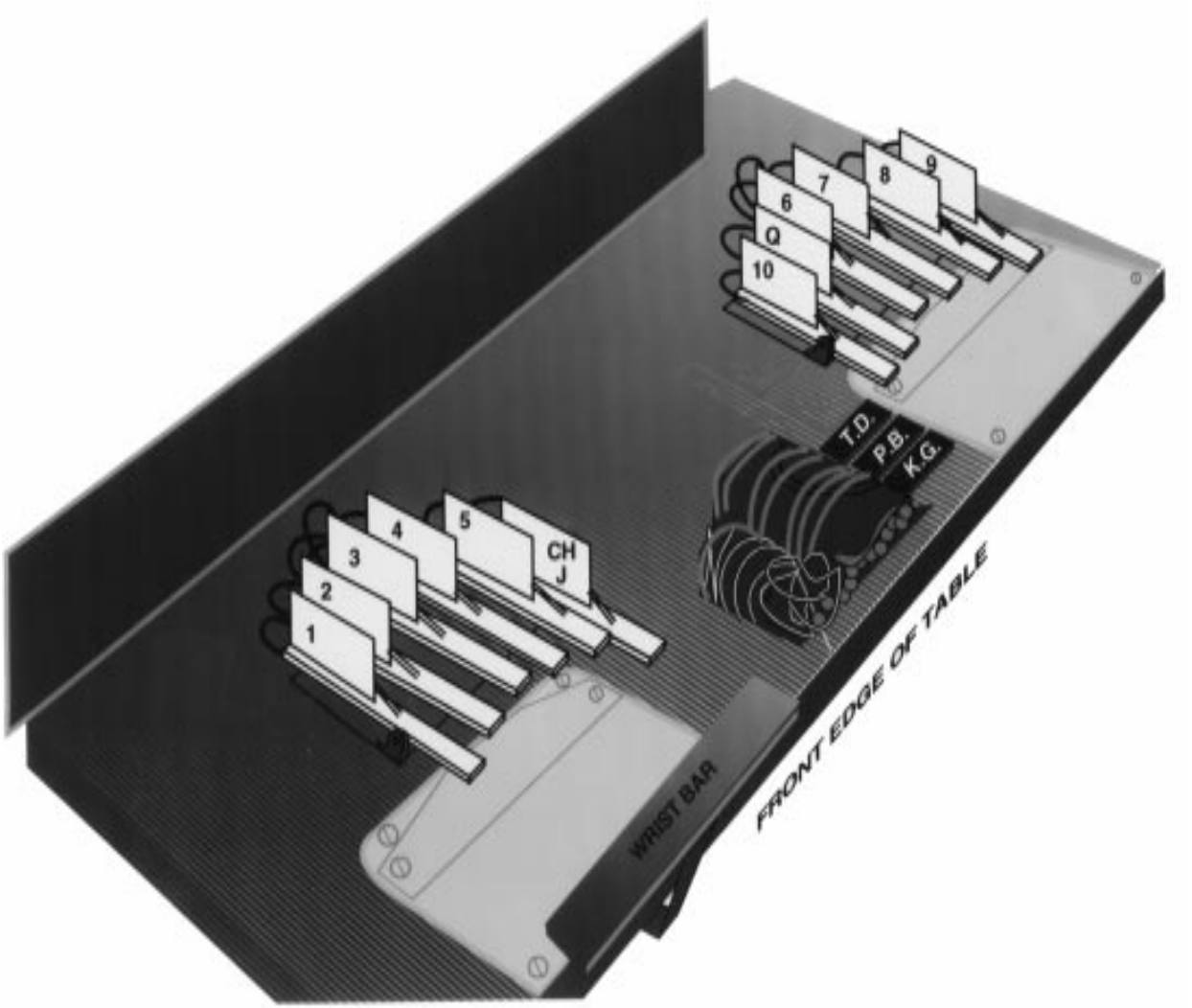
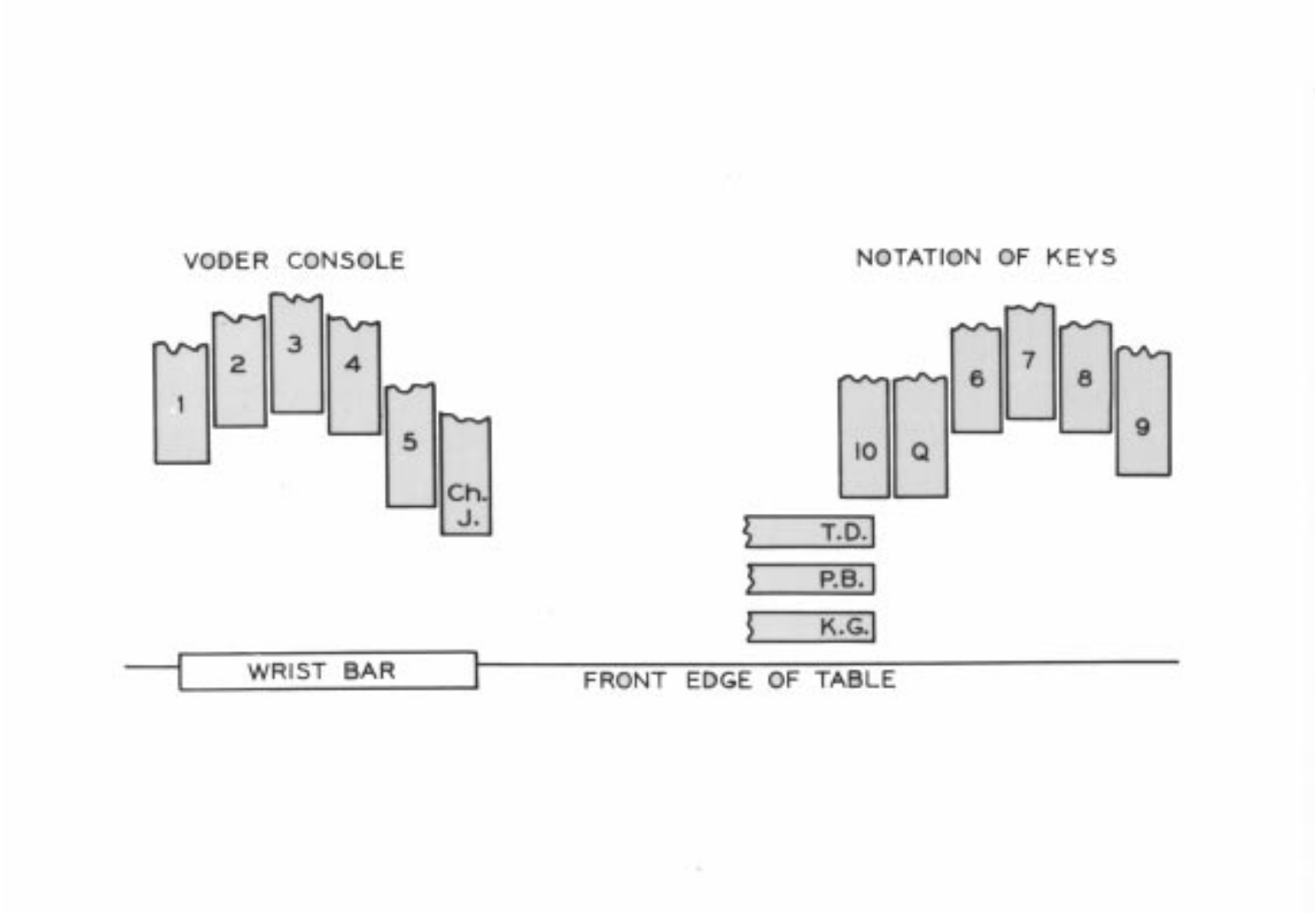
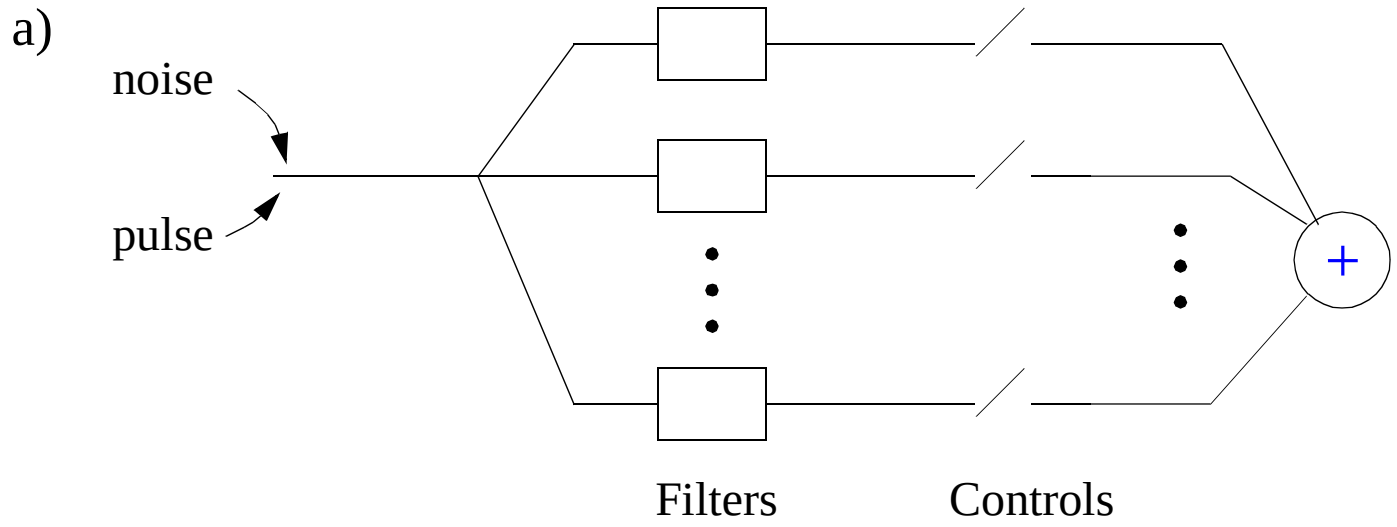


Figure 2.4 : The Voder



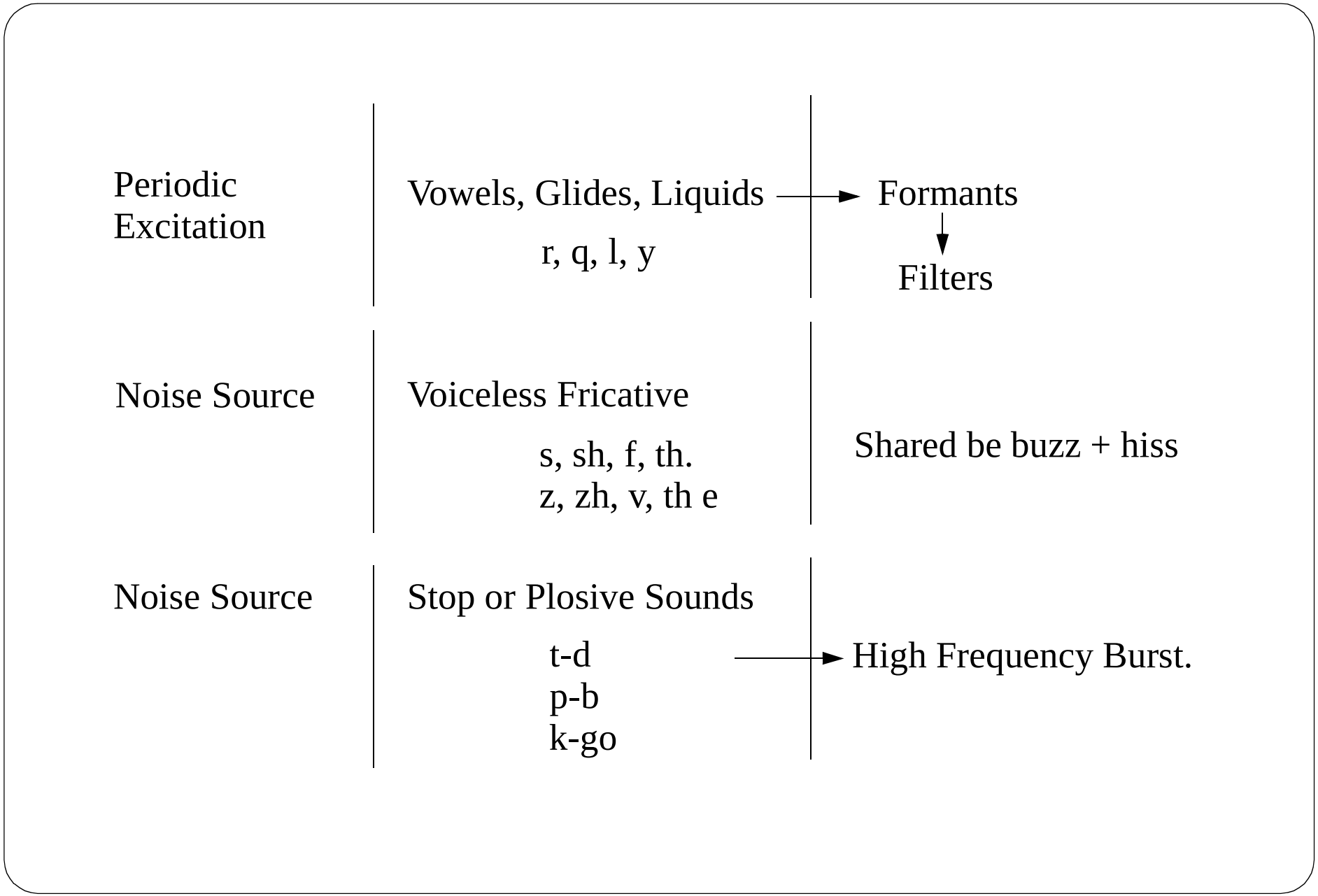
Voder Console


VODER CONSOLE
1
2
3
4
5
Ch.
J.
NOTATION OF KEYS
10
Q
6
7
8
9
T.D.
P.B.
K.G.
WRIST BAR
FRONT EDGE OF TABLE



All Sounds were produced from this configuration.

Nasals were produced by key switching on the low filters.


Periodic Excitation
Vowels, Glides, Liquids
r, q, l, y
Formants
Filters
Noise Source
Voiceless Fricative
s, sh, f, th.
z, zh, v, th e
Shared be buzz + hiss
Noise Source
Stop or Plosive Sounds
t-d
p-b
k-go
High Frequency Burst.

Sounds	Wrist Bar	Keys
S	up	9.
Sh	up	7.8. Light & Smooth
M	down	1.
ē (seen)	down	1.8.
aw (dawn)	down	3.

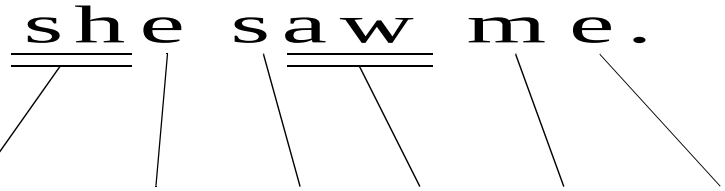
She saw me.
See me seesaw.

WORDS Think of how they are pronounced, not how they are written.

Cease	Sauce	See	She
Me	Saw	Seesaw	

Figure 2.6 : Lesson 1 of Voder Instructions

Simple Example



Lesson 1
of
Voder Instruction

Keys	7 & 8	1 & 8	9	3	1	1, 8
Wrist Bar	up	down	up	down	down	down

Exercises

Do the Voder Program for “ See me Seesaw ”.

Do the Voder Program for “ Shake it off ”.

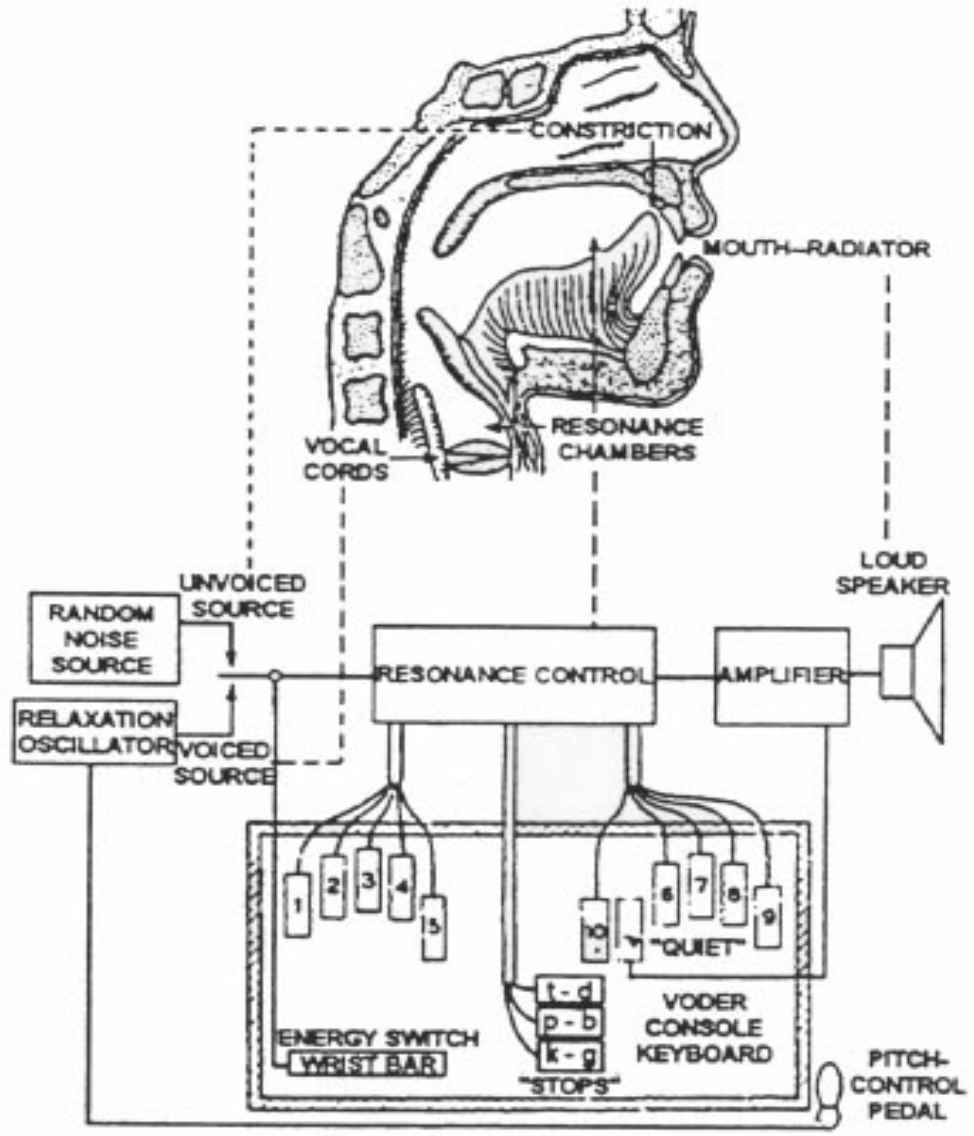
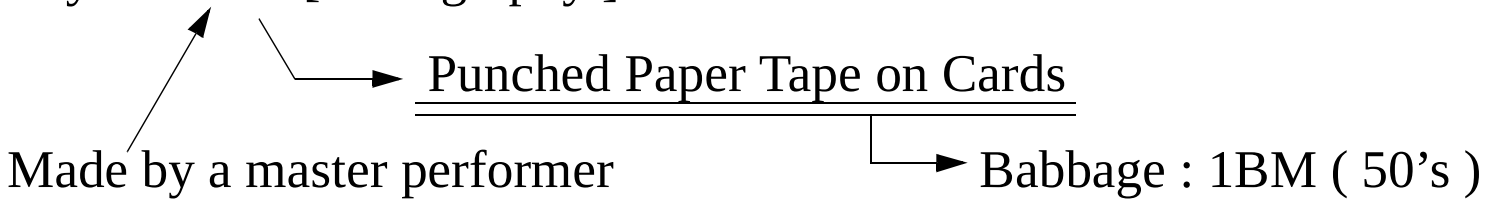


Figure 2.5 : Voder Controls

Music Machine

1. Barrel Organs [Pure Synthesis - no Analysis]
   (Music Boxes)

2. Player Pianos [melography]



Note : Player pianos were very popular about a century ago.

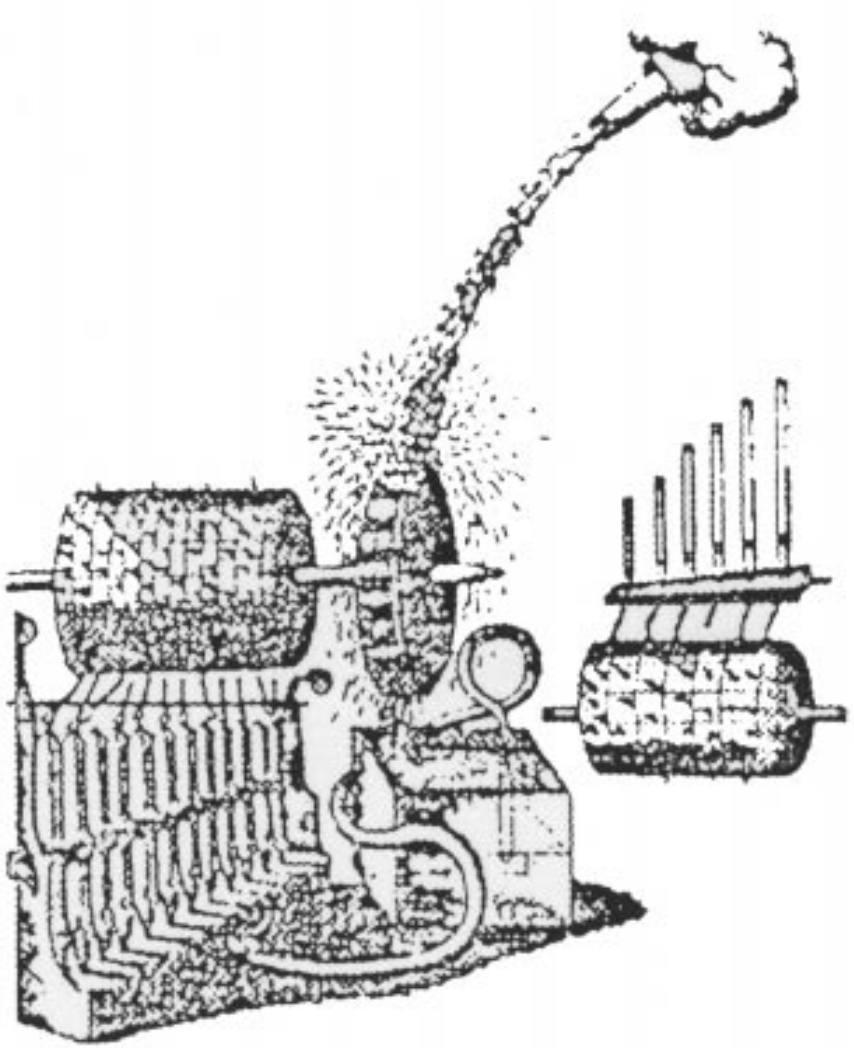


Figure 2.9 : Seventeenth-Century Drawing of a Water-Powered Barrel Organ.

Alvin Fu's Bosendorfer

Alvin wanted to enhance an old piano roll by Rachmoninoff by using it to control the Bosendorfer.

Telharmonium → Additive Synthesis

↓

Still used in both Speech and Music.

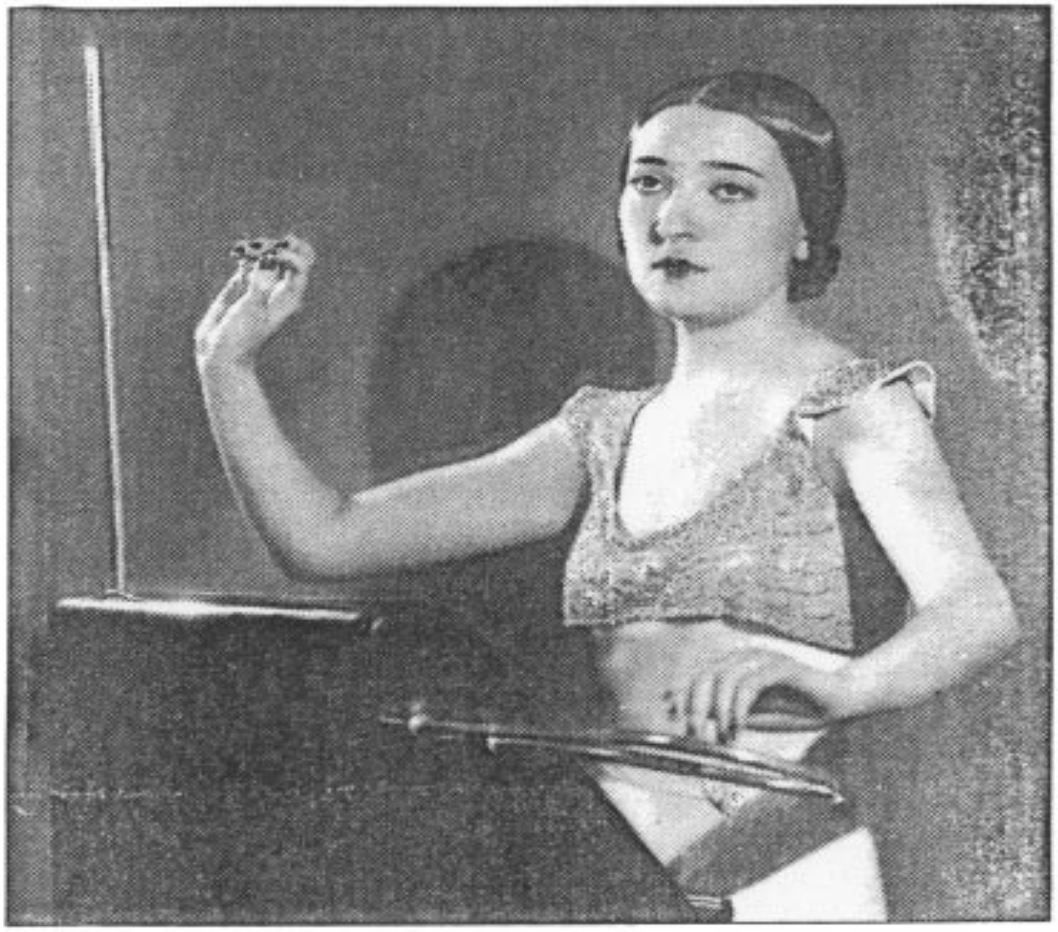
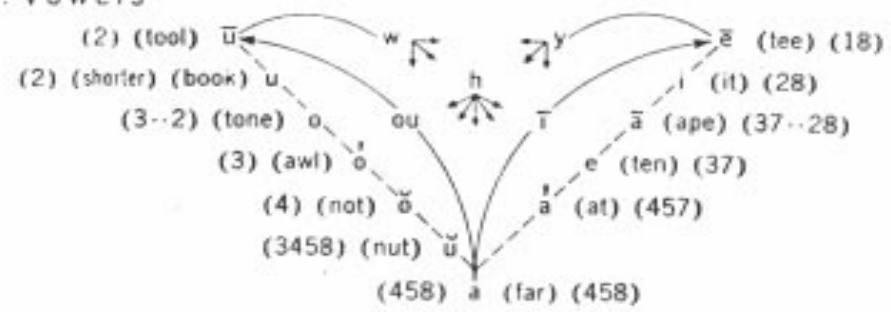


Figure 2.10 : Clara Rockmore at the Theremin.

Classification of the Speech Sounds

1. Vowels



2. Combinational and Transitional Sounds

w·y·ou·ī h·ā (pay)·ō (woe)

3. Semi Vowels

Initial l (268) final l (2)
Initial r (256) final r (36)

4. Stop Consonants

Voiced		Unvoiced		Nasalized	Formation of Stop
(BK2)	b	(BK2)	p	m (1)	lip against lip
(BK3)	d	(BK3)	t	n (1)	tongue against teeth
(789)	j	(789)	ch	—	tongue against hard palate
(BK1)	g	(BK1)	k	ng(18-1)	tongue against soft palate

5. Fricative Consonants

Voiced		Unvoiced	Formation of Air Outlet
(67Q)	v	f (67Q)	lip to teeth
(9)	z	s (9)	teeth to teeth
(10Q)	th (then)	th (thin) (10Q)	tongue to teeth
(789)	zh (azure)	sh (78)	tongue to hard palate

(Numbers in parentheses indicate key designations on VODER console)

Voder Demo

20 separate sounds.

She saw me. - She saw me. - She saw me. - She saw me.

Greetings everybody

G	r	ee	t	i	ng	s
BK1	2, 5, 6	1, 8	13, k, 3	2, 8	18, 1	9

- high pitch
- low pitch
- Speech transformations
  - Mary had a little lamb.
  - Ha Ha Ha
  - Yes, I feel very old.

1.	0 - 300	Telephone Band
2.	300 - 600	
3.	600 - 900	
4.	900 - 1200	
5.	1200 - 1500	
6.	1500 - 1800	
7.	1800 - 2100	
8.	2100 - 2400	
9.	2400 - 2700	
10.	2700 - 3000	

Vowel Vibrator

Singing

Concentration - 13 Sounds - 5 Wrist bar

1 Year of constant practice

Foreign Speech - Parlez vouz francais.

Cow, Pig, Alphabet

Practical Applications