

# *Sounds of Our Times*

***TWO HUNDRED YEARS  
OF ACOUSTICS***

***ROBERT T. BEYER***

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# Sounds of Our Times

*Two Hundred Years of Acoustics*



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*To all acousticians, both those who are mentioned in this book and those who are not. Together, they have constructed the vast edifice of sound and vibration.*



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# Preface

But at my back I always hear  
Time's wingèd chariot hurrying near.  
Andrew Marvell (1621–1678)

In writing this book, I acknowledge two important predecessors. In 1930, Professor Dayton C. Miller, of Case Institute, wrote his *Anecdotal History of Acoustics*, which followed mainly the individual work of a hundred or so acousticians, up to about 1930. And in 1978, *Origins in Acoustics* by Professor F.V. (“Ted”) Hunt of Harvard appeared. Professor Hunt had not completed his book at the time of his death in 1972, but portions of it were published posthumously under the editorship of Professor Robert Apfel of Yale.

This book begins roughly where the published portions of Hunt’s work left off—the period at the beginning of the nineteenth century—and moves forward into the modern era. Because of the vast amount of acoustical research in this period, the personal and anecdotal style of Professor Miller’s book did not seem appropriate. On the other hand, my age suggested to me that I might not have the time for pursuing the intense but time-consuming scholarship of Professor Hunt (note the quotation above). I have therefore tried to steer a middle course between Miller and Hunt, and have also relied more on secondary sources.

Before going on with the text, I must also cite two remarks from the Preface to Norman Davies’ *God’s Playground: A History of Poland* that have served as guiding principles to this neophyte in the writing of history:

Like all history books [this volume] had to be written through the distorting medium of the mind of the historian. . . . All the historian can do is to recognize the particular distortions to which his work is inevitably subject and to avoid the grosser forms of retouching and excision. [1]

In view of the unfamiliarity of Polish History to most British and American readers, the treatment of weighty events has been sweetened with a mild infusion of anecdotes, epitaphs, *bons mots* . . . and antiquarian curiosities—in short, with a



selection of all those historical whimsicalities which scientific scholars judge unworthy of their genius. [2]

The resultant history of acoustics now lies before you.

## Notes and References

[1] Norman Davies, *God's Playground: A History of Poland* (paperback), Columbia University Press, New York, NY, 1982, 2 vols., vol. 1, p. vii.

[2] *God's Playground: A History of Poland*, p. xiv.

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And as always, my acknowledgment to and appreciation of my wife. At a time when I was supposed to be retired, I seem to have come up with a full-time, four-year occupation that has allowed little time to pause and smell the roses.

Robert T. Beyer



# Contents

Preface	vii
Acknowledgments	ix
CHAPTER 1	
The State of Acoustics in 1800	1
1.1. Introduction	1
Chladni and Young	2
1.2. Sound Propagation	4
Sound Velocity in Air	4
Sound Velocity in Liquids and Solids	6
Diffraction, Reflection	7
Echoes	8
Sound Intensity	8
1.3. Sound Production	9
Measurement of Sound Frequency	9
The Human Voice	11
Artificial Voice	12
Vibrating Strings	13
Vibrating Plates	14
Singing Flames	15
1.4. Sound Reception	17
The Human Ear	17
Teaching of the Deaf	19
Tartini Tones	20
Overview	21
Notes and References	21
CHAPTER 2	
Acoustics 1800–1850	27
2.1. Sound Production	27
Chladni Figures	27

2.2. Artificial Sources of Sound	29
2.3. The Human Voice	31
2.4. The Tuning Fork	32
2.5. Sound Propagation	32
The Adiabatic Sound Velocity	33
2.6. Velocity of the Sound in a Solid	36
2.7. Sound and Vibrations in Two Dimensions	37
2.8. The Stokes–Navier Equation	37
2.9. Sound Absorption in Fluids	39
2.10. Finite-Amplitude Sound	40
2.11. Sound Reception	41
Work of Charles Wheatstone	41
The Stroboscope	42
2.12. The Doppler Effect	42
2.13. Fourier Analysis	44
2.14. The Stethoscope	45
2.15. Hearing	46
2.16. Room Acoustics	48
2.17. Teaching of the Deaf	50
Overview	50
Notes and References	50
CHAPTER 3	
von Helmholtz and Tyndall	55
3.1. Hermann L.F. von Helmholtz (1821–1894)	55
3.2. <i>On Sensations of Tone</i>	57
Combinations of Vibrations	58
The Ear	63
Interruptions of Harmony	65
The Relationship of Musical Tones	68
3.3. John Tyndall (1820–1893)	70
<i>On Sound</i>	71
Notes and References	79
CHAPTER 4	
Lord Rayleigh and his Book	83
4.1. Rayleigh’s Early Life	83
4.2. His First Researches	85
4.3. His Interaction with Tyndall	87
4.4. Summary of His Later Career	89
4.5. Other Early Work in Acoustics	89
4.6. <i>The Theory of Sound</i>	90
4.7. The Period 1877–1894—Between Editions	91
Threshold of Audibility	91
The Rayleigh Disk	92
Vibration Theory	93

Musical Acoustics	94
Aeroacoustics	95
Surface Waves	97
Nonlinear Acoustics	97
4.8. The Second Edition of <i>The Theory of Sound</i> (1894)	99
Notes and References	99

CHAPTER 5	
Inventors to the Fore!	103
5.1. Electromagnetism	103
5.2. Joseph Henry	104
5.3. Henry and the Telegraph	107
5.4. Cooke and Wheatstone	107
5.5. The Telephone: First Stirrings	108
5.6. Alexander Graham Bell. The Early Years	111
5.7. Bell's Telephone	114
5.8. Thomas Alva Edison	119
5.9. Further Work on the Telephone	120
5.10. The Phonograph	123
Overview	126
Notes and References	126

CHAPTER 6	
The Last Half of the Nineteenth Century	131
6.1. Sound Velocity Measurements	131
6.2. Sound Absorption in Fluids	133
6.3. Vibrating Systems	134
6.4. Structural Vibrations	136
6.5. Heat-Generated Sound	136
6.6. The Birth of Seismology	137
6.7. Devices for Making Sound Visible	138
6.8. Shock Waves	144
6.9. Nonlinear Acoustics	148
6.10. Hearing	150
6.11. Speech	154
6.12. Music	155
6.13. Architectural Acoustics	158
6.14. Harbingers of the Future	160
Ultrasonics	160
Magnetostriction	162
Piezoelectricity	163
Acousto-Optics	166
Density of States	166
Response to Stimuli	168
Overview	169
Notes and References	169

## CHAPTER 7

<b>The Twentieth Century: The First Quarter</b>	<b>177</b>
7.1. Electroacoustics	177
The Microphone	178
The Loudspeaker	178
Amplifiers, Vacuum Tubes, and Vacuum Tube Amplifiers	182
The Oscillator	183
The Oscilloscope	184
Acoustic Impedance	185
7.2. Architectural Acoustics	186
7.3. Physical Acoustics	191
Ultrasonic Propagation Measurements	191
Atmospheric Acoustics	195
Aeroacoustics	197
7.4. Underwater Sound	197
Cavitation	202
7.5. Bioacoustics	202
7.6. Structural Vibrations	204
Surface Waves in Solids	204
7.7. Noise	206
7.8. Hearing	207
7.9. Speech	210
7.10. Musical Acoustics	216
7.11. The Origin of the Decibel	219
Overview	222
Notes and References	222

## CHAPTER 8

<b>The Second Quarter of the Twentieth Century</b>	<b>231</b>
8.1. The Acoustical Society of America	232
8.2. Ultrasonic Absorption and Dispersion	234
Gases. Theoretical	234
Gases. Experimental	234
Liquids. Experimental	235
Liquids. Theoretical	238
8.3. Other Ultrasonic Effects in Fluids	241
Rao's Rule	241
Acoustic Streaming	241
Low-Temperature Acoustics	242
8.4. Ultrasound in Solids	244
8.5. Medical Ultrasonics	245
8.6. Other Applications of Ultrasonics	246
8.7. Nonlinear Acoustics	247
8.8. Atmospheric Acoustics and Aeroacoustics	248
8.9. Underwater Sound	249
8.10. Bioacoustics	254
Echolocation by Bats	258
8.11. Structural Acoustics and Vibration	258

8.12. Noise and its Control	260
8.13. Architectural Acoustics	263
8.14. Physiological Acoustics	264
8.15. Psychological Acoustics	270
Quantification of Psychoacoustics	271
Loudness	272
Pitch	274
Masking and Time Resolution	275
Localization and the Role of Binaural Hearing	275
8.16. Speech	276
8.17. Music	282
Overview	285
Notes and References	285
 CHAPTER 9	
The Third Quarter: 1950–1975	299
9.1. Societies and Journals	300
9.2. Physical Acoustics	301
Scattering	301
Creeping Waves	302
Transducers	302
Ultrasonics in Fluids	304
Low-Temperature Acoustics	307
9.3. Ultrasonics in Solids	310
9.4. Aeroacoustics	314
9.5. More Nonlinear Acoustics	316
9.6. Underwater Sound	317
9.7. Animal Echolocation	324
9.8. Signal Processing	325
9.9. Structural Sound and Vibration	325
9.10. Seismic Waves	326
9.11. Noise	326
Sources	327
Noise Directionality	327
Effects of Noise on Man and Animals	331
Noise Reduction	332
9.12. Architectural Acoustics	334
9.13. Physiological Acoustics	340
The Ear Passage	341
Cochlear Mechanics	342
Treatment of Hearing Impairment and Deafness	342
9.14. Psychological Acoustics	344
Sensitivity	344
Pitch	346
Masking and Time Resolution	346
9.15. Speech	347
Speech Production	348
Speech Intelligibility	352

Speech Processing	352
Speech Perception	352
Speech Recognition	353
9.16. Music	356
Overview	358
Notes and References	359
CHAPTER 10	
Acoustics: 1975–1995 and Beyond. Fin de siècle—Again	375
10.1. Linear Acoustics. Scattering	375
10.2. Nonlinear Acoustics. Radiation Pressure and Levitation	376
10.3. Solitons	377
10.4. Chaos	379
10.5. Sonoluminescence	379
10.6. Underwater Sound. Internal Waves	383
10.7. Global Scale Acoustics	384
10.8. Ultrasonics. Optoacoustics	384
10.9. Weakly Absorption Media	386
10.10. Structural Acoustics and Vibration	387
Fuzzy Structural Acoustics	387
Active Sound and Vibration Control	389
10.11. Architectural Acoustics. Auditorium Design	390
10.12. Acoustic Instrumentation	393
Acoustic Engines	393
Ultrasonic Refrigerators	393
10.13. Physiological Acoustics	393
The Cochlea	393
Otoacoustic Emission	397
Aids to the Deaf and Hard of Hearing	398
Hearing Aids	399
Cochlear Implants	401
Hair Cell Regeneration	404
10.14. Psychological Acoustics	406
Minimal Audible Pressure	406
Speech Perception in the Young	406
A Final View	409
Notes and References	410
Book Reviews	419
Name Index	429
Subject Index	441



# 1

## The State of Acoustics in 1800

The sighing of the wind,  
the tuneful noise of birds in the spreading branches,  
the measured beat of water in its powerful course,  
the harsh din of the rocky avalanches,  
the invisible swift course of bounding animals,  
the roaring of the savage wild beasts,  
the echoes rebounding from the cleft in the mountains.  
*The Book of Wisdom, Chapter 17*

### 1.1. Introduction

Two of the commonest words describing sound are acoustics and phonics, deriving, respectively, from the Greek *akouein*, to hear, and *phonein*, to speak, and with only these two words, we can conjure up the beginning of the science of acoustics with one human being communicating with another. This must have been followed by the discovery that pleasing sounds could be made by vibrating strings, by blowing across open tubes or by striking stretched membranes, i.e., the birth of music. This appreciation of music has been a hallmark of humanity almost from the beginning.

To limit the scope of this volume, the writer has thought it appropriate to choose the turning of the eighteenth century into the nineteenth as a convenient point at which to begin. Professor Frederick Vinton Hunt (1905–1972), in his admirable *Origins in Acoustics* [1], had covered the origins of the subject from the earliest days through those of Newton (1642–1727). There are a few further flashes in that book that illuminate certain portions of acoustics in the eighteenth and nineteenth centuries, but little coverage of later periods [2]. Both Hunt and his editor have also acknowledged the excellent treatment of eighteenth century acoustics in the prefaces written by Clifford Truesdell (1919– ) that appear in the reprinting of the complete works of Leonhard Euler (1701–1783) [3]. We shall therefore begin our story with a review of acoustics as it existed in and around 1800, with a few flashbacks of our own into earlier times, to provide some continuity with the published work of Hunt and Truesdell.

The choice of the year 1800 is good in another sense. The dying decades of the eighteenth century marked the fading of the *ancien régime*. The new age, enflamed by the American and French Revolutions, saw the struggling

development of democracy, the ascendancy of Napoleon and, in science and engineering, the beginnings of modern chemistry, steam power, mass production, and a growing knowledge of optics and electricity. All these events marked the period as one of tremendous change. Since it has been widely recognized that acoustics lives by its interaction with the other sciences and engineering, as well as with society in general, we shall be examining the literature for any corresponding surge in the field of acoustics.

### *Chladni and Young*

We are greatly aided in this task by two texts that appeared in the first decade of the new century. In 1802, Ernest F.F. Chladni (1756–1827) (Fig. 1-1) [4] published *Die Akustik* [5]. Chladni himself translated the book into French (a book “in which I have abridged, changed and added a great deal” [6]). He published this volume in 1809, dedicating it to Napoleon (a wise choice, no doubt, during that “sun of Austerlitz,” especially since the French government contributed funds to support the translation and revision). By just glancing through this volume, we can see several features that distinguish the book from a modern one. The first is the almost complete absence of mathematics. Acoustics, as it was studied at the time, at least, in the mind of Chladni, and aside from music and vibrating structures, was largely one of observations and descriptions. Magnificent mathematics had been developed by Euler, Jean LeRond d’Alembert (1717–1783), and



(a)



(b)

FIGURE 1-1. (a) Ernst F.F. Chladni (1756–1827) and (b) Thomas Young (1773–1829). (From D. Miller [4].)

Joseph Louis Lagrange (1736–1813) in the eighteenth century [3] and applied by them to acoustical problems, but Chladni clearly passed over the details of this mathematics in writing his treatise.

A second difference is the emphasis on vibrations. If one had any doubt that vibrations have long been recognized as an integral part of acoustics, a reading of Chladni would eliminate that misconception. Of the four sections of Chladni's book, the one devoted to vibrations comprises more than 60% of the text. Propagation of sound through air and other gases covers about 15%, while the remaining 25% of the volume is divided among propagation in liquids and solids, musical scales, speech and hearing. (Parenthetically we might note that, even though the period around 1800 was far from a quiet time in the world, there is virtually nothing in the book on noise.)

In the French edition, Chladni identified himself as the son of a Professor of Law at Wittenberg. The younger Chladni was evidently heavily under his father's thumb, and wrote ruefully of his lack of freedom as a youngster and of his attendant unhappiness. He studied at both Wittenberg and Leipzig Universities, taking a degree of Doctor of Law from the latter, and had every expectation of following in his father's footsteps. The death of his father in this period apparently changed everything for him. Chladni tells us that he then gave up jurisprudence and turned his attention to the study of music. There he found that "the theory of sound was more neglected than the several other branches of physics, which gave birth in me of a desire to remedy this defect [7]."

Our second author was the English physician and polymath, Thomas Young (1773–1829) (Fig. 1-1 [4]). Young was a master of many languages, both contemporary and ancient, a practicing physician, and a student of Egyptology (he pioneered in translation work on the hieroglyphics of the famous Rosetta stone before Champollion). He was also a first class physicist, especially in optics and elasticity. He was elected a Fellow of the Royal Society of London at the age of 21, primarily for his work on the eye. Early in his medical education career, a course that took him from London to Edinburgh to Göttingen, and, finally, to Cambridge, Young made a bet with his fellows that "Young will produce a pamphlet or paper on the theory of sound more satisfactory than any thing that has already appeared, before he takes his Bachelor's Degree" (March 14, 1799) [8]. He did publish a paper on the "Theory of Sound and Light" in 1800 [9], but history records that the decision of his peers was against him and he lost the bet. His biographer Alexander Wood observed in 1954 "It is doubtful whether a competent tribunal would now uphold the decision on appeal [10]."

In 1807, Young published a two-volume text, entitled *A Course of Lectures on Natural Philosophy and the Mechanical Arts* [11]. These lectures were given at the Royal Institution in London, and the books contain three chapters on sound that give an good summary of the then current