Chapter 4. Meeting 4, Recording: Microphones and Radio

4.1. Announcements

- Next meeting: discussion workshop meeting
- Next meeting: cover basics of using PD: bring your laptop
- Next meeting: experiment with speakers, tape heads, microphones, and contact microphones
- Things to bring (if you have): an open speaker, small conductive speakers, tape heads, old tapes you want to destroy, a resonant acoustic instrument
- Next meeting: discuss readings by Pinch and Bijker, and Fouché

4.2. Reading: Horning

- Horning, S. S. 2004. "Engineering the Performance: Recording Engineers, Tacit Knowledge and the Art of Controlling Sound." *Social Studies of Science* 34(5): 703-731.
- What is tacit knowledge, and why might audio recording require it?
- What are some of the non-technical skills required of recording engineer, both in the past and present?
- Horning describes the changing technical skills of audio engineers: summarize this trajectory.
- Horning suggest that a focus on microphone technique, starting in the 1950s, was the result of "inadequacies of related technology": explain and argue for or against this view.
- Horning suggests, through quotes of Brian Eno, that presently technology is now a greater impediment to recording and creativity. Explain and argue for or against this view.

4.3. Quiz

- 10 minutes

4.4. The Technology of Radio

- Radio is a broadcast signal, using modulated electromagnetic waves
- Other electromagnetic radiation: microwaves, visible light

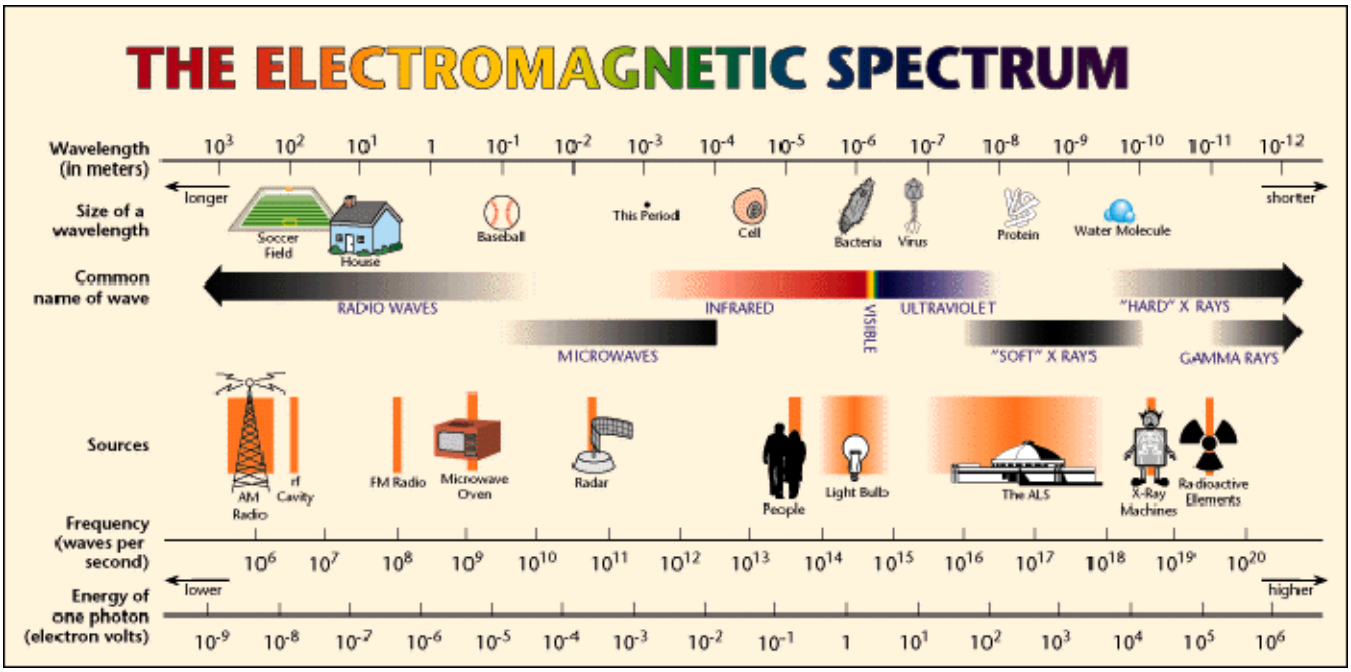


Image: NASA.

- Oscillating electromagnetic fields pass through the air and space
- We can imagine electromagnetic waves as similar to sound waves

4.5. Encoding Messages with Modulation

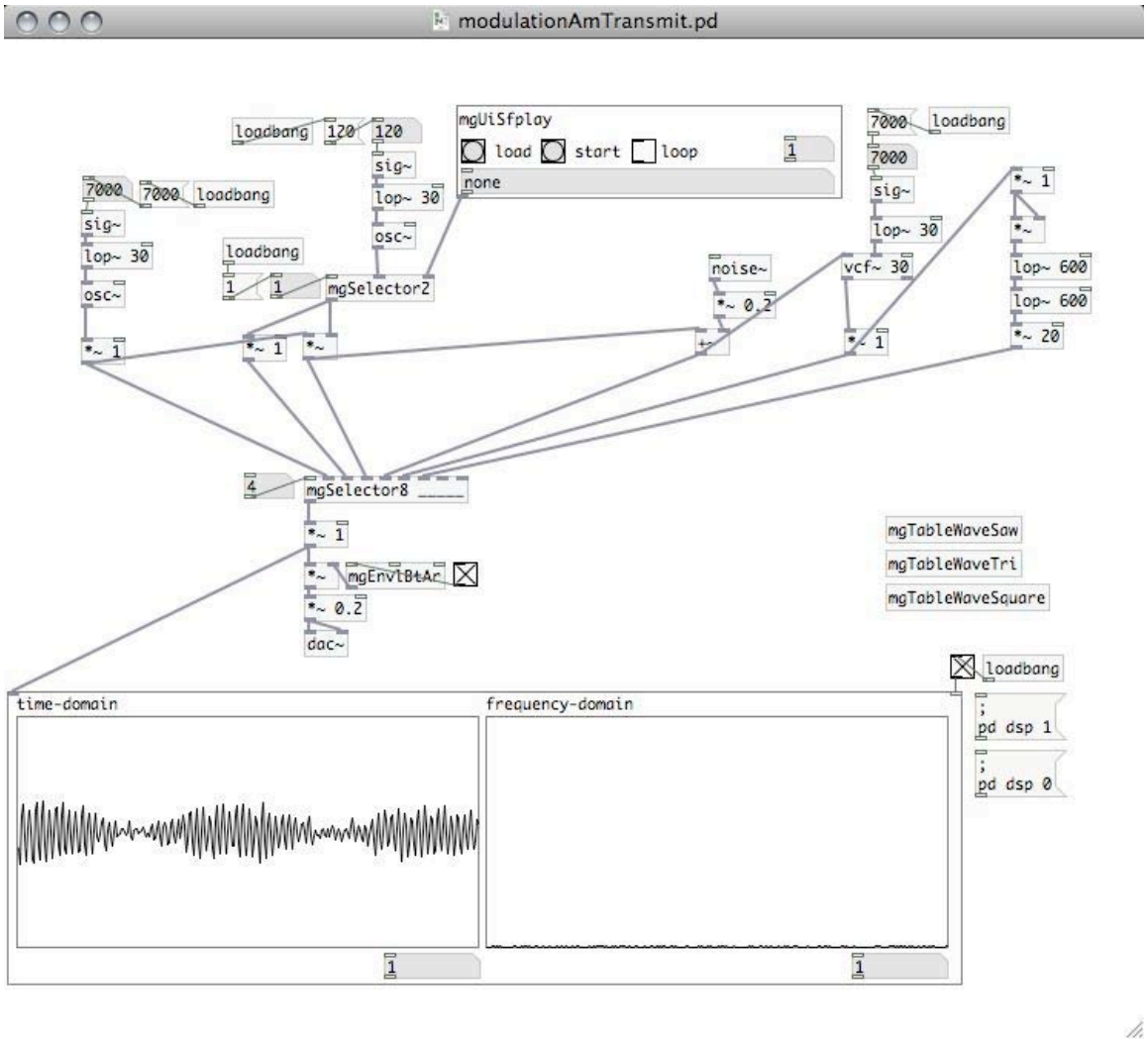
- Take a sine wave as a carrier
- When transmitting, vary (modulate) the sine wave's amplitude or frequency in some pattern
- Derive (encode) the modulator from a different signal (the message you want to send)
- When the carrier is received, the modulation (the message) is decoded from the carrier

4.6. Amplitude Modulation

- Encode by modifying the amplitude of the carrier in proportion to another signal; decode (demodulate) by finding the carrier frequency and measuring the change in amplitude
- Carrier Frequencies between 300 kHz and 3 MHz
- Common usage frequencies in US between 535 kHz and 1.7 MHz
- Short wave radio: 2.3 MHz to 26 MHz: long distance
- Frequency response from 40 to 7000 Hertz
- AM modulation has applications in sound synthesis [modulationAmBasic.pd]

4.7. Amplitude Modulation with Sound Waves

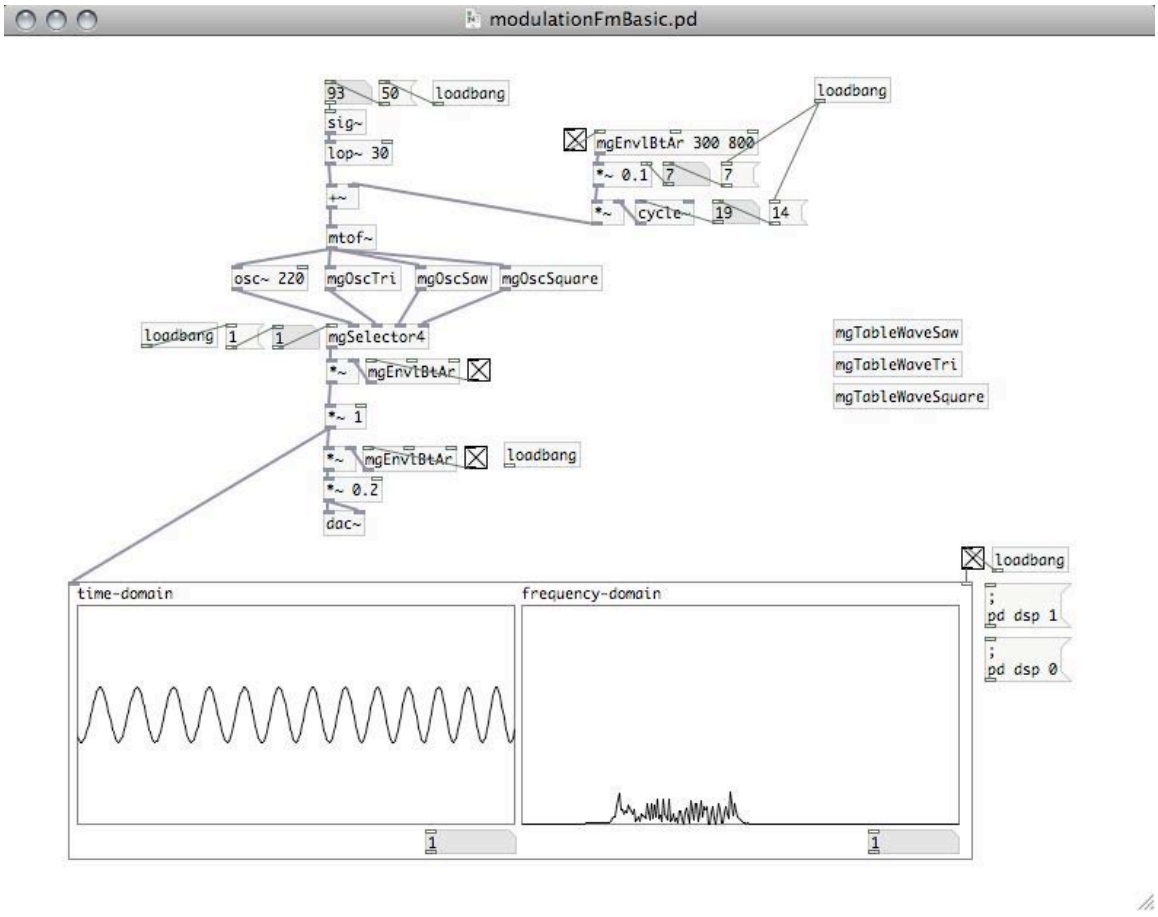
- Carrier is within range of hearing (20-20000 Hertz) [modulationAmTransmit.pd]



4.8. Frequency Modulation

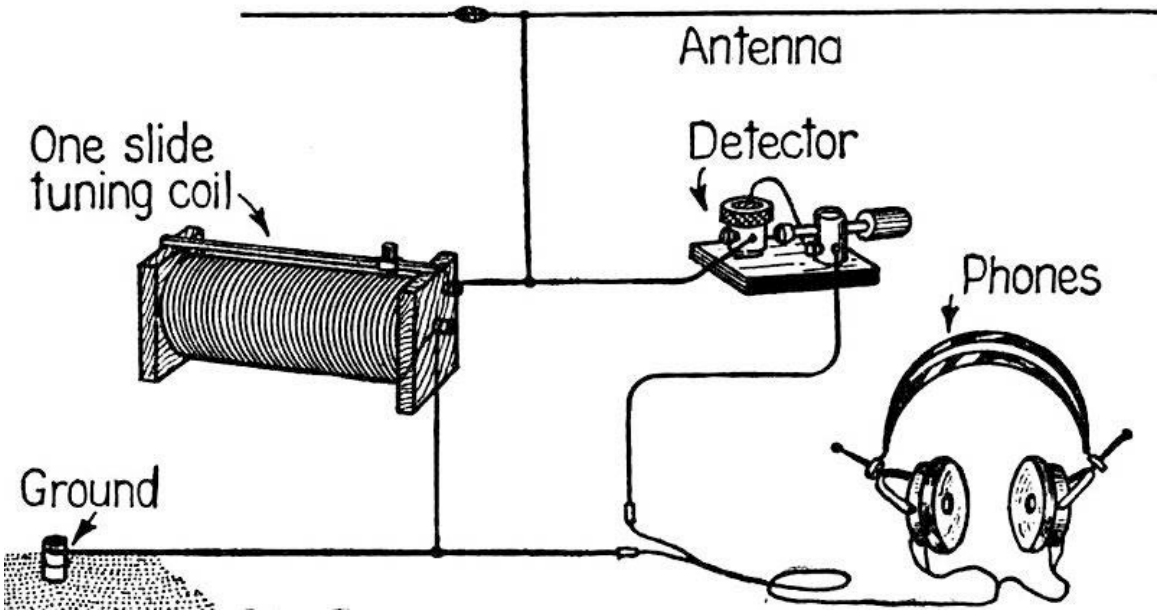
- Carrier Frequencies between 30 MHz and 300 MHz
- Common usage frequencies in US between 88 and 108 MHz
- Frequency response from 30 (50) to 15000 Hertz
- Encode by modifying the frequency of the carrier at a rate in proportion to another signal; decode (demodulate) by finding the carrier frequency and measuring the change rate of change in the frequency

- FM modulation has applications in sound synthesis [modulationFmBasic.pd]



4.9. The History of Radio

- First called wireless telegraphy (Marconi) and used for transmitting telegraph messages with spark-gap radio transmitters
- Numerous inventors and contributors: Guglielmo Marconi (1894-1897), Nikola Tesla (1893), Alexander Stepanovich Popov
- 1897: First radio station established by Marconi
- 1906: Reginald Fessenden employs Amplitude Modulation for radio broadcast
- 1910: M. H. Dodd Wireless Receiver (Rogers 2009)



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- 1915: speech first transmitted from New York City to San Francisco
- 1920s: first entertainment broadcasts
- 1921: Westinghouse Radiola Senior and Radiola A.C. (Rogers 2009)

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- Edwin H. Armstrong invents Frequency Modulation, with help from Radio Corporation of Americas (RCA) in mid 1930s
- 1934: RCA Victor Model 143 (Rogers 2009)

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- 1940s: regular use of radio to transmit television
- By 1941 over 50 FM stations on the air
- 1940: Scott Radio Laboratories: AM-FM Philharmonic

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- 1954: first pocket transistor radio, Regency TR-1

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4.10. Radio, Music, and Speech

- Used for entertainment
- Used to market and distribute music
- Competition with gramophones as medium of music consumption (from the 1920s onward)
- Used as a unique aural medium

4.11. Radio as a Medium: Glenn Gould

- Glenn Gould: Pianists and radio artists
- Well known for piano playing: Bach: The Goldberg Variations, The Well-Tempered Clavier
- In the early 1960s, grew disinterested in concert performance: "that way of presenting music is passe. If there is a more viable way to reach audiences, it has to be through recordings. Concerts as they are now known will not outlive the 20th century" (1965)
- Series broadcast on CBC Canadian radio in 1960
- The Idea of North (1967), from The Solitude Trilogy

4.12. Listening: Glenn Gould

- Audio: Glen Gould: "The Idea of North," 1967

- What sort of musical features are shown in the use of speakers, voices, and stories?
- What sounds, other than spoken words, are used? How do they contribute to the stories?
- How is music used in this work?
- What are some of the issues faced by people in The North
- What are some of the features of the relationship between The North and the rest of Canada?
- Is the ending of this piece climatic, and/or concluding?

4.13. Radio as a Medium: Joe Frank

- Worked at WBAI in New York, National Public Radio
- 1986: moved to Santa Monica and started "Joe Frank: Work in Progress"
- 1986-2002: "In the Dark," "Somewhere Out There," "The Other Side" (over 230 hours)
- Can still be heard weekly on WNYC AM, Sunday from 11 PM to 12 AM

4.14. Listening: Joe Frank

- Audio: Joe Frank: "Eye in the Sky," 1996

- What sort of musical features are shown in the use of speakers, voices, and stories?
- What sounds, other than spoken words, are used? How do they contribute to the stories?
- How is music used in this work?
- How are conventions of radio used?

- Frank uses long lists of specific details: how does this contribute or detract from the narrative and work?
- Frank uses irony in a number of ways: what are a few?
- We hear different sonic and acoustic environments; how do these build the narrative?
- We hear other speakers, both in the voice of Joe Frank and in other speakers; how do these build the narrative?
- What is this radio show about?
- Is the form balanced?

4.15. Electric Transduction: the Microphone

- Early mechanical quasi-microphones

Sir Edward Elgar conducting "The Symphony Orchestra," 1914.

- Modern transduction from air pressure to electricity
- Many ways of converting mechanical movement into analogue voltages
- Most microphones translate movement of air into movement of a diaphragm that in-turn creates an analog voltage

4.16. Early History of the Microphone

- The microphone was the critical component of the telephone

- Alexander Grahm Bell gets patent 174,465 in 1876 for (March): "… the method of, and apparatus for, transmitting vocal or other sounds telegraphically … by causing electrical undulations, similar in form to the vibrations of the air accompanying the said vocal or other sound"

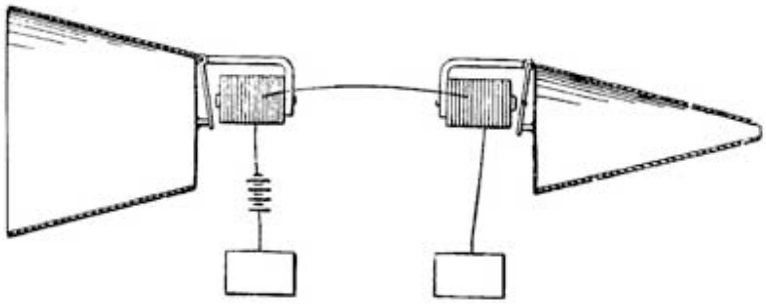
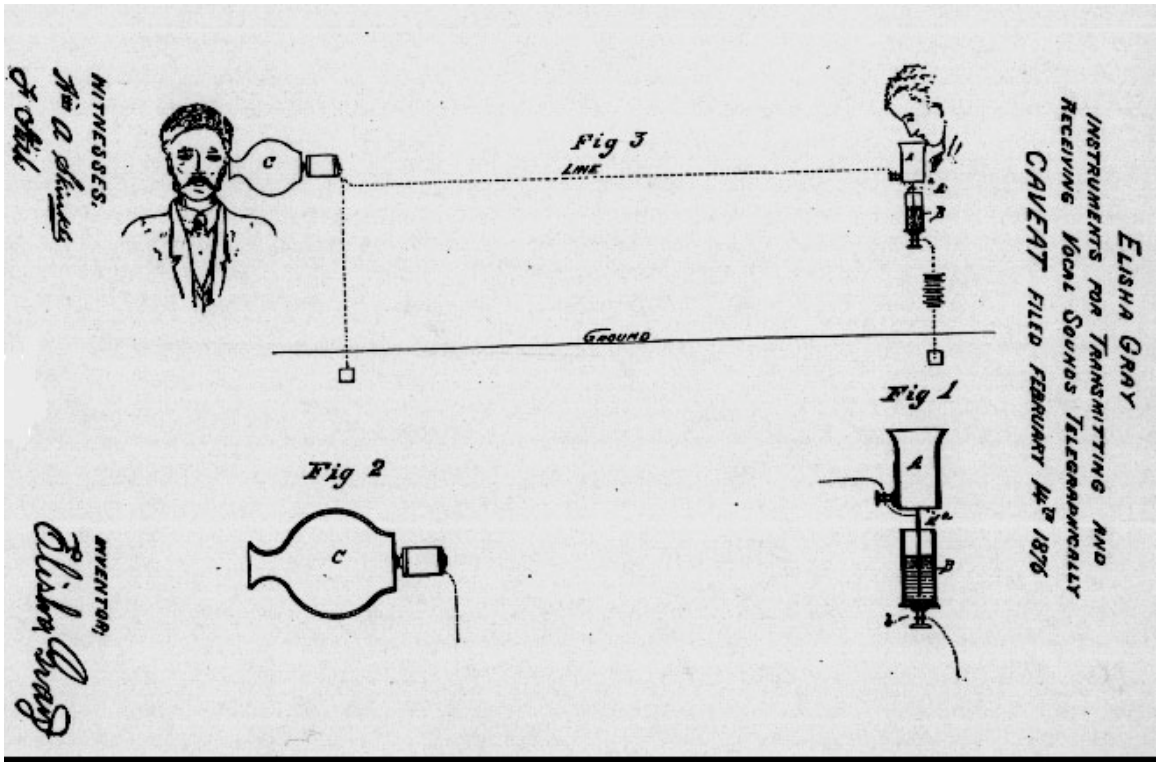


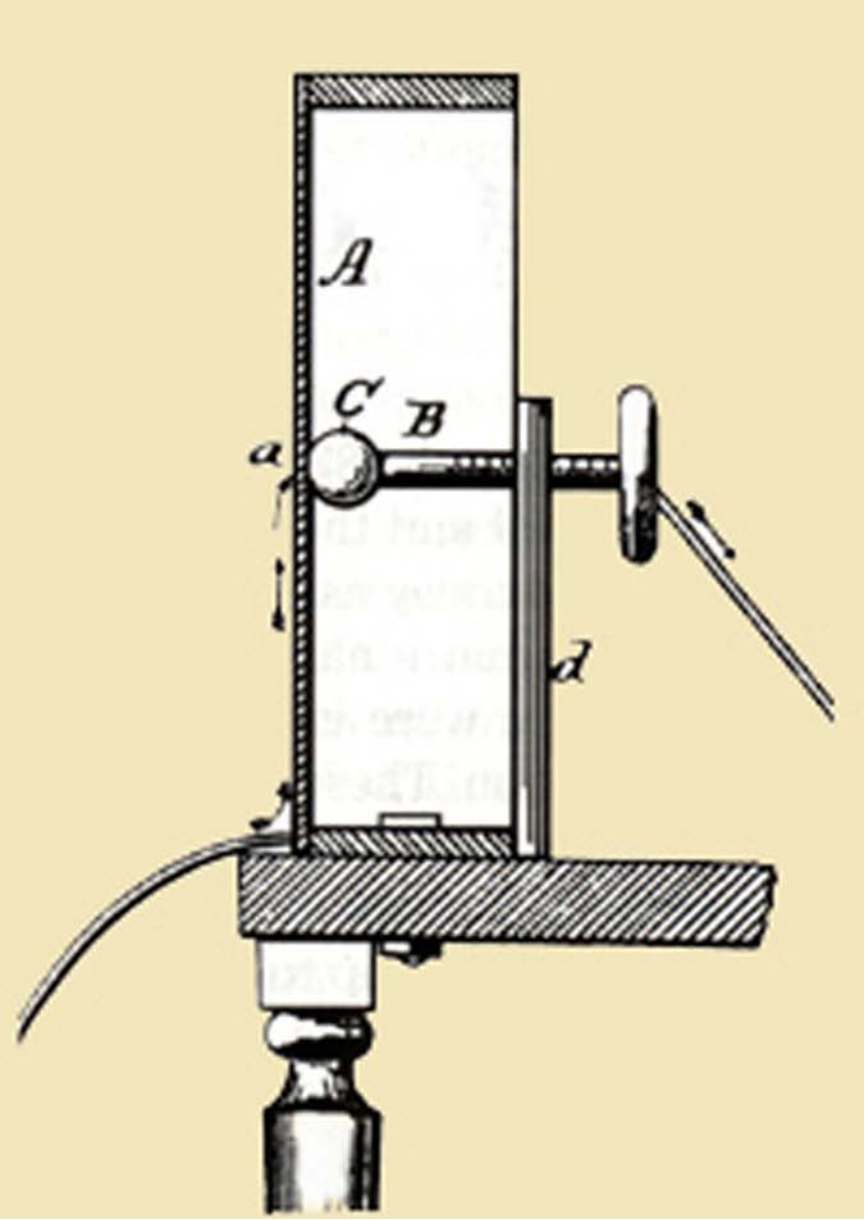
FIGURE 1-1

The beginnings of telephony; Bell's original patent.

- Elisha Gray: patents similar device



- Berliner, 1877 (March): a steel ball against a stretched diaphragm



Berliner's variable contact microphone (1877)

- Francis Blake, 1881: platinum bead against a carbon disc: 50 dB dynamic range, 380 to 2,000 Hertz frequency response
- Carbon microphone from the 1920s; varying pressure on carbon granules results in variable resistance (Rogers 2009)

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4.17. Broadcasting and the Need for Better Microphones

- 19th century technology was fine for telephones
- With the rise of radio in the 1920s there created a need for better microphones
- Two basic methods were perfected: electrostatic (capacitor or condenser) and electromagnetic (dynamic or moving conductor and ribbon)
- 1930s: Western Electric Condenser Microphone - 660 (Rogers 2009)

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- Turner Variable Impedance Dynamic Microphone - U9S (Rogers 2009)

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- Shure Brothers, Inc. "Voice Unidyne" Dynamic Microphone Model 55CV (Rogers 2009)

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- 1931: RCA 44-BX - Velocity Ribbon Microphone (Rogers 2009)

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4.18. Modern Microphones

- Two common types: condenser (electrostatic) and dynamic (electromagnetic)
- Ribbon microphones are a type of electromagnetic
- Piezo-electric microphones: piezo crystals
- Anything that can transduce a vibration: lasers, etc.

4.19. Modern Microphones: Condenser

- Two metal plates with electrostatic capacitance between them; air pressure causes changes in capacitance; produces a change in voltage
- Early capacitor microphones in 1917 (Wente)

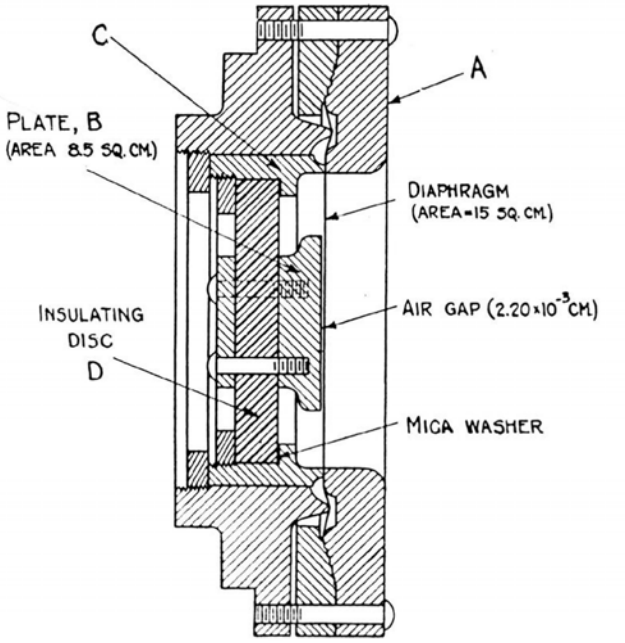

Fig. 2.

Sectional drawing of transmitter.

Wente condenser microphone, from *Physical Review* (1917)

- Used in broadcasting since 1940s
- Requires power for amplification inside of the microphone
- Very small movement of diaphragm displacement: very accurate response

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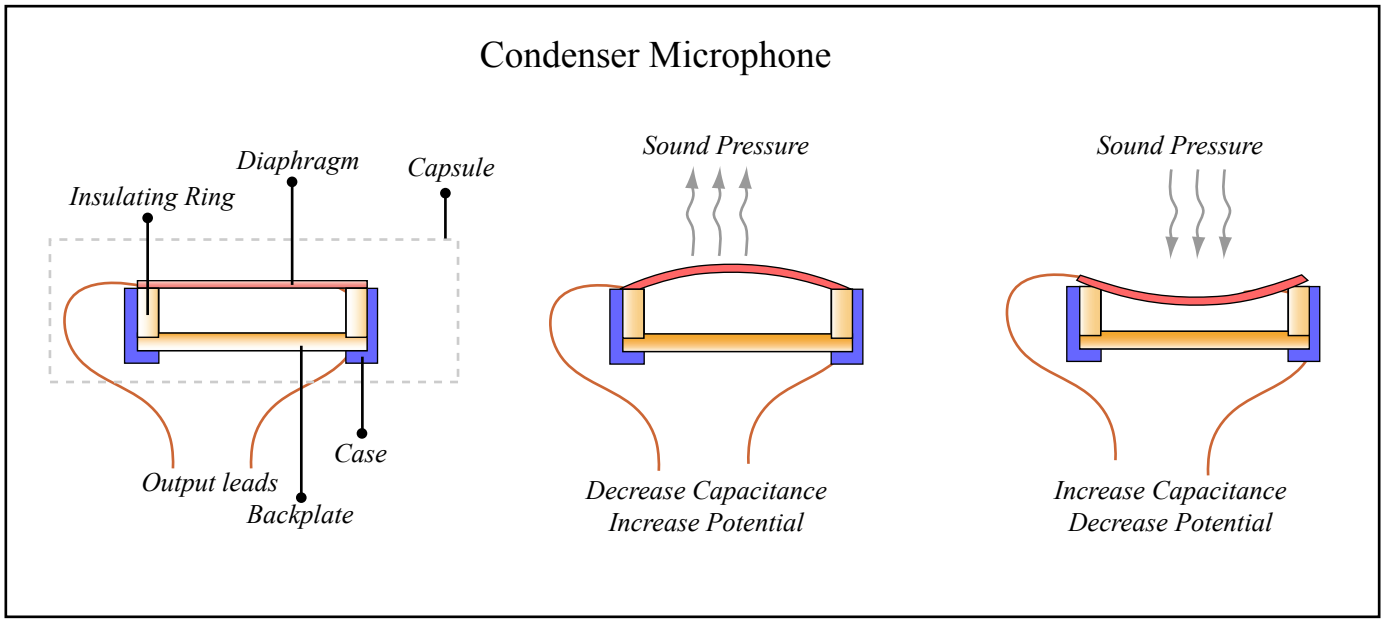

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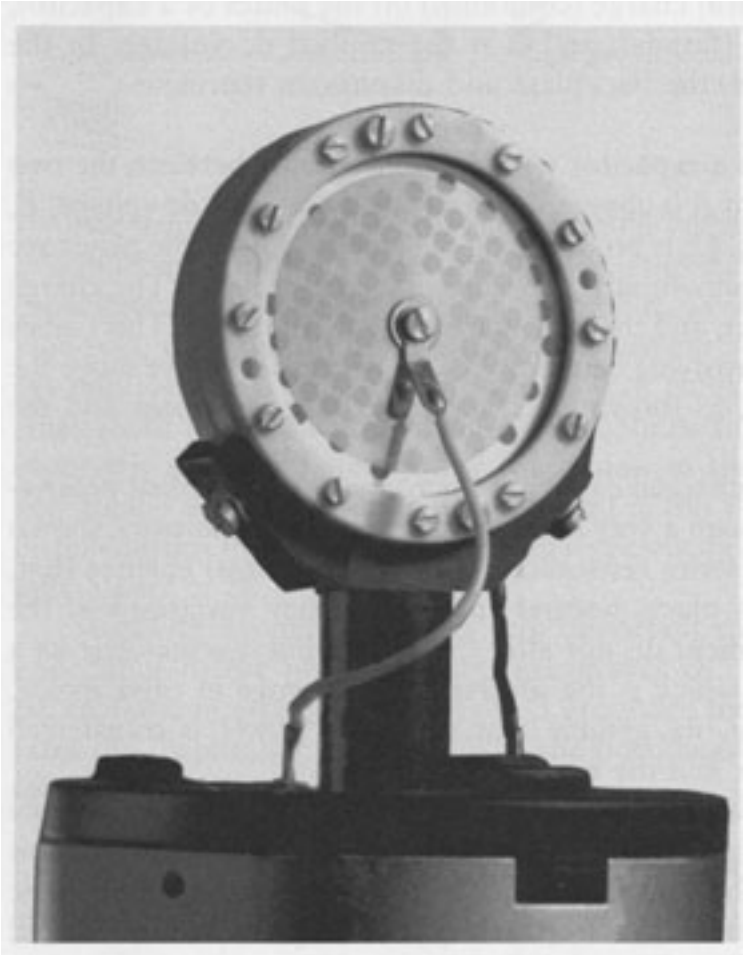

Neumann center-clamped condenser microphone capsule. © Neumann/USA. All rights reserved.
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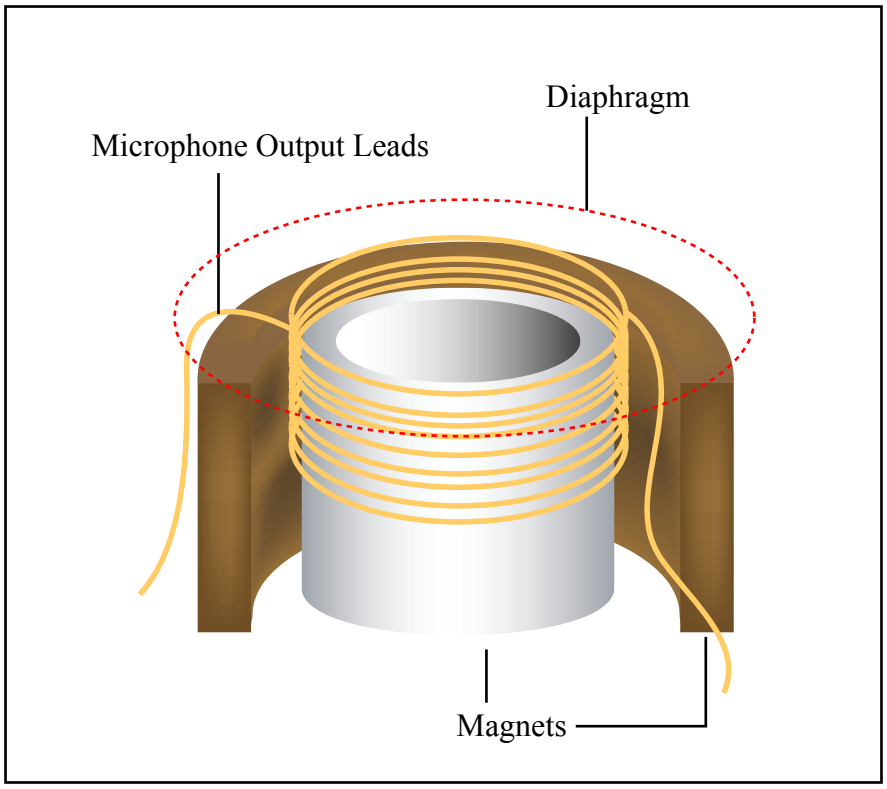
4.20. Modern Microphones: Dynamic

- Air pressure moves a diaphragm that is connected to a coil wire within a magnetic field; produces a change in voltage
- Early dynamic microphones in 1920s: RCA, Shure Brothers, and Electro-Voice

- No power required in the microphone; heavy magnets
- Larger movement of diaphragm displacement: less accurate response



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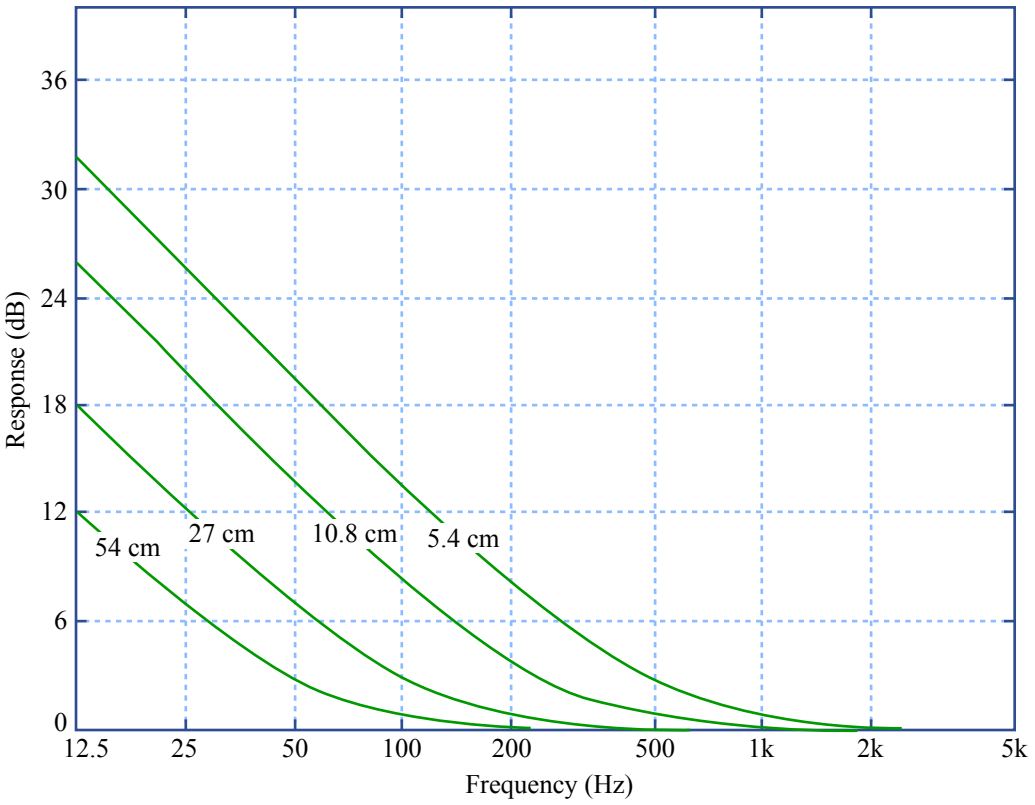
4.21. The Proximity Effect and Crooning

- Within six inches of a directional microphone, a low frequency emphasis results



Graph of the proximity effect vs. distance for a cardioid microphone, on axis.

Figure by MIT OpenCourseWare.

4.22. The Proximity Effect and Crooning

- Crooning: a style from 1920s to 1950s
- Sliding up to and around notes; singing very softly with a low frequency emphasis
- An artificial sound of intimacy
- Associated with Rudy Vallee, Bing Crosby, Perry Como, Frank Sinatra
- Sinatra says he and Bing were singers, not crooners; Russ Colombo and Rudy Vallee were crooners

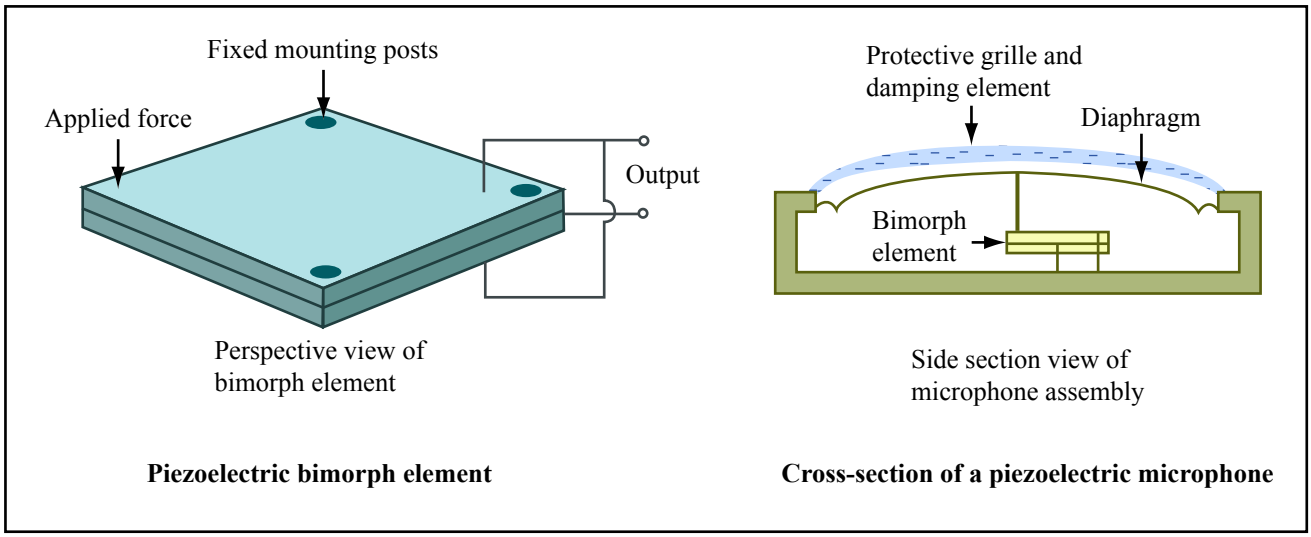
  Sinatra as "the first to master microphone technique" (Horning 2004)

  Audio: Frank Sinatra: from a documentary with Walter Cronkite

- Audio: Rudy Vallee, "Brother can you spare a dime?" (The Great Depression - American Music in the 30s)

4.23. Piezoelectric (Contact) Microphones

- Piezoelectricity: ability of materials to generate electricity when stressed
- Crystalline structures that develop voltages on opposite faces when bent



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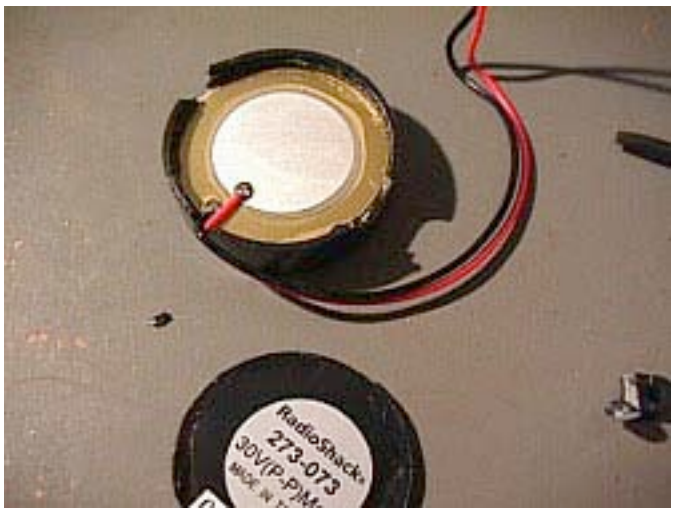
- Does not require power to operate
- Can be used for direct sound transduction
- A piezo element that acts as a direct transducer of vibrations



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- 1933: D-104 Astatic Microphone Laborartory (Rogers 2009)

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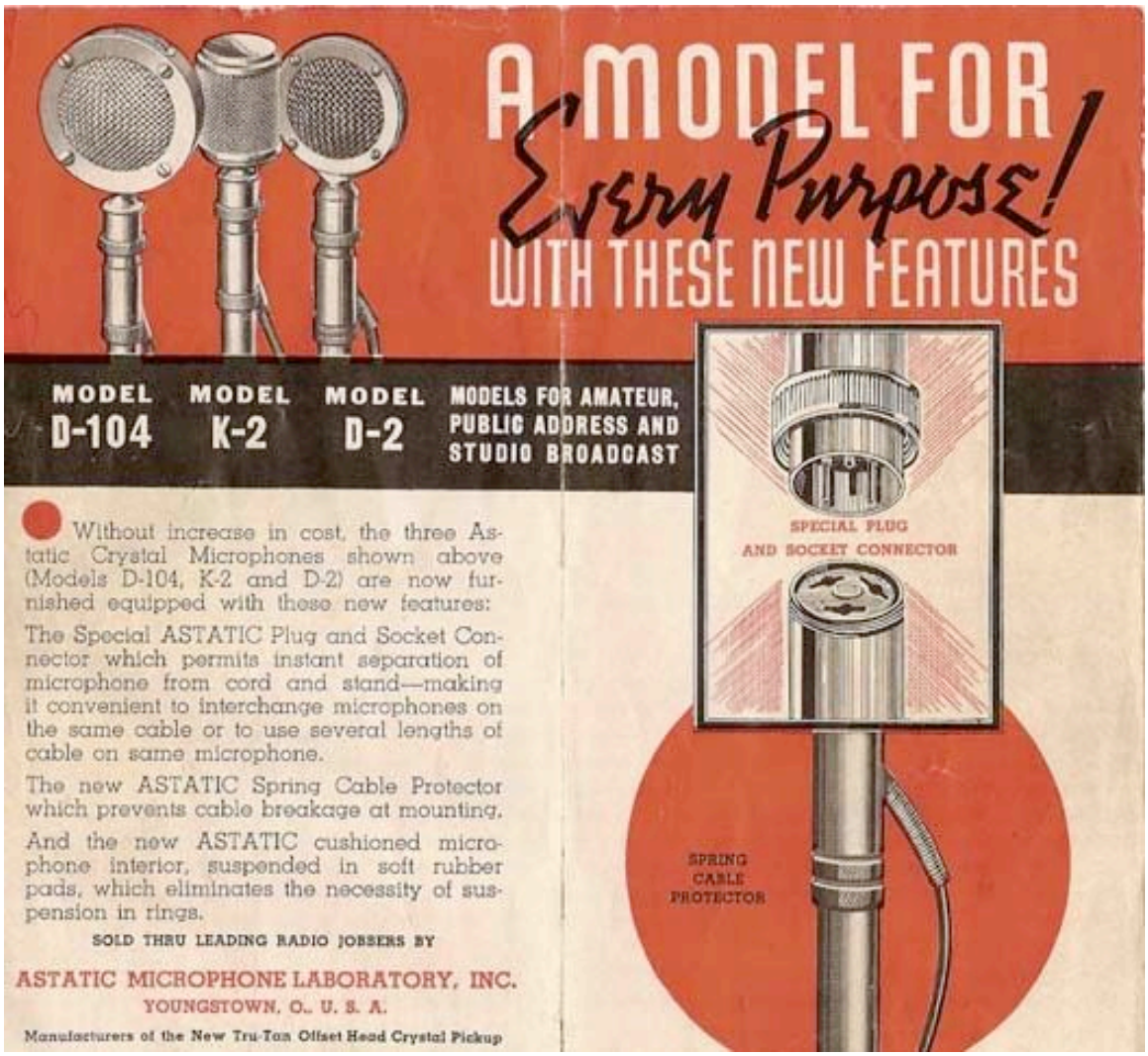

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4.24. Piezoelectric (Contact) Microphones

- Can be attached to any vibrating surface

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- Audio: the Sound of the Ants, Adriano Zanni
- Recording wind resonance through a post

  YouTube (http://youtube.com/watch?v=gbxSrvhdDFc)
- Audio: Contact microphone on a grand piano (by Christopher Ariza)

4.25. Reading: Collins

- Collins, N. 2009. *Handmade Electronic Music: The Art of Hardware Hacking*. 2nd ed. New York: Routledge.
- Coils and electromagnetism, and motor as oscillator: we will explore this later
- The Victorian oscillator: next class

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