Chapter 10. Meeting 10, Interfaces: Mechanical Automations and Innovations

10.1. Announcements

- Music Technology Case Study Draft due 3 November

10.2. Interfaces and Instruments

- A musical interfaces is a place of interaction between sound production and/or compositional ideas
- An interface, more than sound production method, quantity, or source, defines an instrument

10.3. The Organ

- A wind instrument controlled by a keyboard and pedals
- Sometimes with multiple manuals (keyboards) and stops (timbral controls)
- With the clock, one of the most complex mechanical devices developed up until the 19th century
- A locus of technological innovation: new technologies quickly adapted and incorporated
- A very old "unnatural" and "modern" instrument
  - Bellows permit continuous sound
  - Tuned pipes provide fixed pitch
  - Multiple interface types: multiple manuals, pedals, and stops
  - Custom instrument installation motivates diverse designs

10.4. The Organ: Valves as Triggers and Selectors

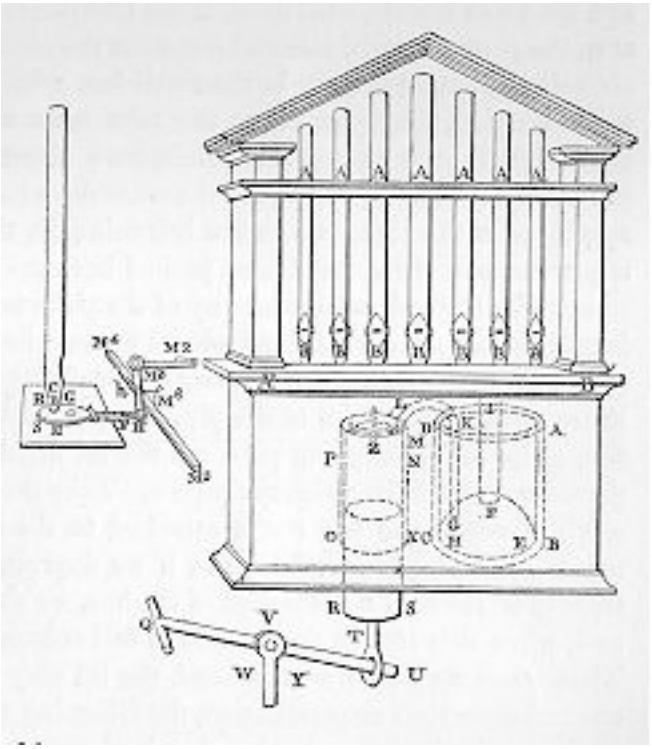
- Modern single-manual organ with suspended action

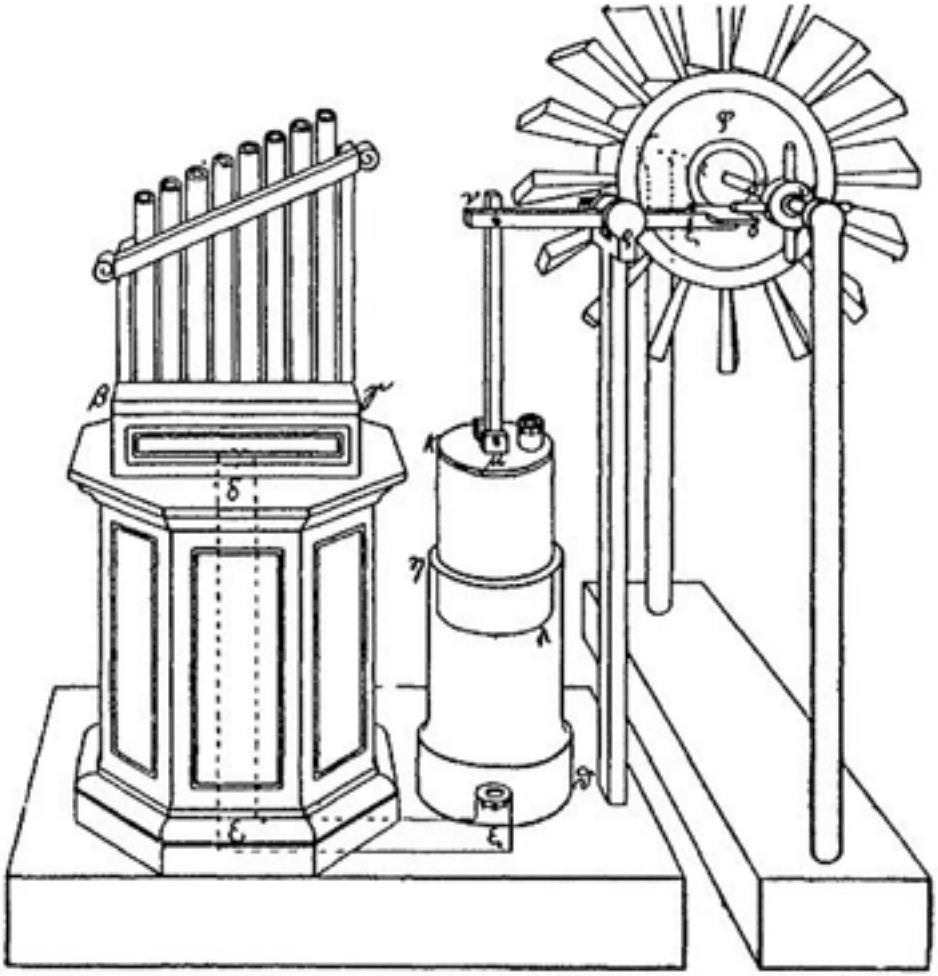
Image removed due to copyright restrictions.
"Key- and stop-mechanism of a single-manual organ with suspended action"
from Grove Dictionary of Music (Online).

- By pulling different stops, the operator could change the timbre of the instrument while playing
- Switches and slides (in addition to keys) become a musical interface

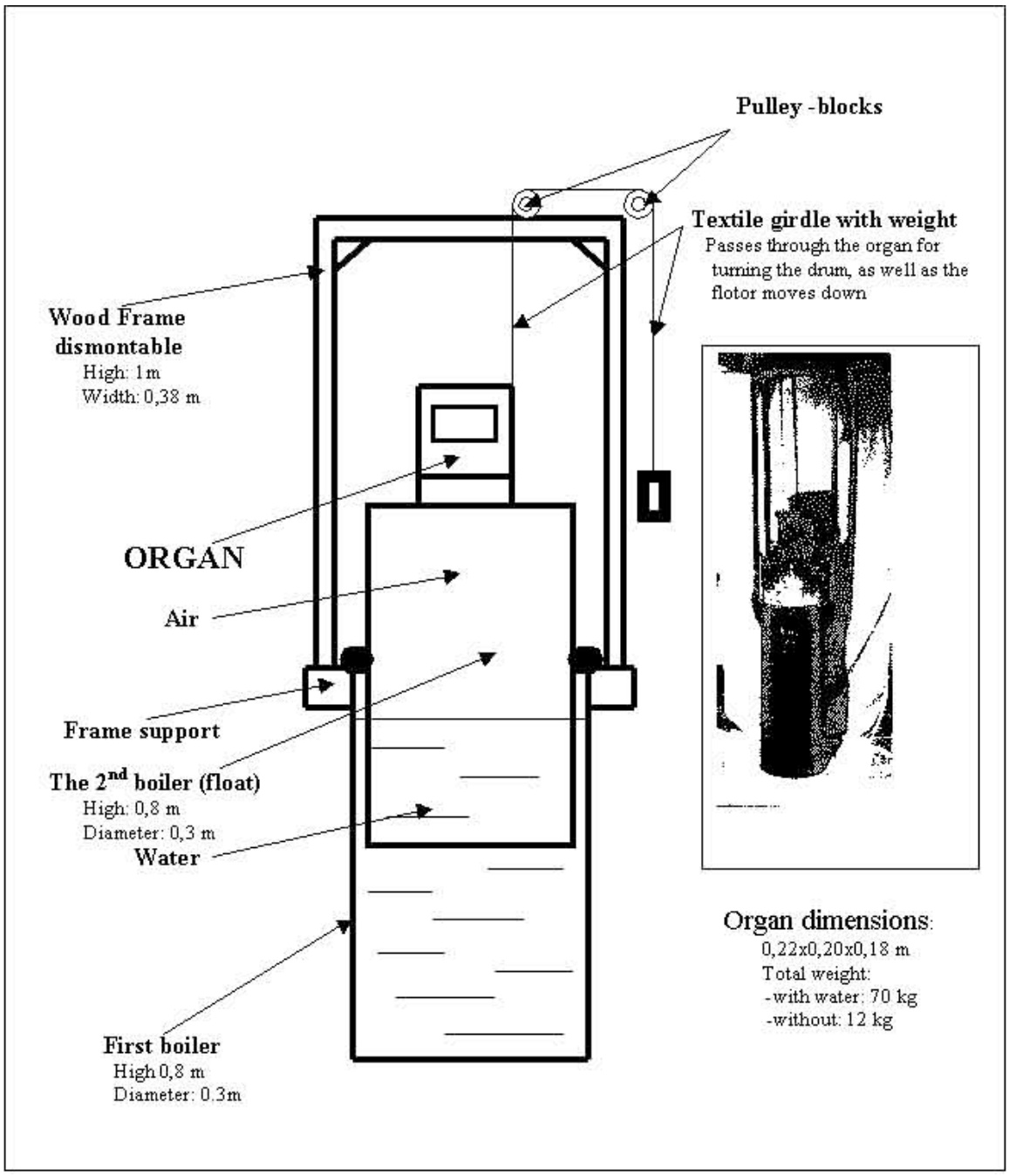
10.5. The Organ: The Hydraulic Organ (Hydraulis)

- Greeks explored pneumatics and hydraulic devices: Hero of Alexandria
- The hydraulis, hydraulos, hydraulus or hydraula: a Greek invention of 3rd century BCE
- Possibly invented by Ctesibius of Alexandria in 246 BCE
- Wind supply to the pipes regulated by water pressure





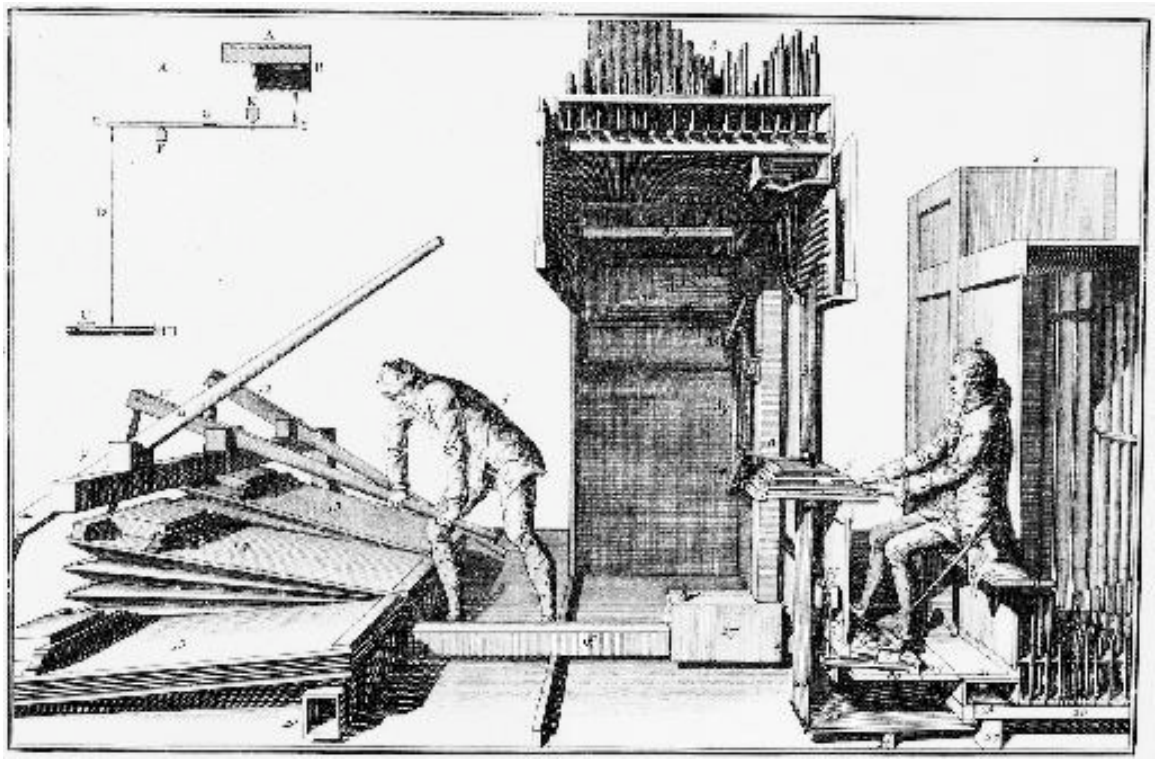
Heron's Windwheel. (1899, public domain, via Wikipedia.)



10.6. The Organ: Bellows and the Need for Air Pressure

- Need for regular air pressure leads to numerous technological solutions
- Late 15th century

- 18th century multifold bellows



YouTube (http://www.youtube.com/watch?v=qccBF1beTmY)

- Mid 19th century: steam power

  Calliope

  YouTube (http://www.youtube.com/watch?v=odMCKR54VRc)

- Early 20th century: electrical fan blowers

Courtesy of James H. Cook. Used with permission.

Courtesy of B.O.B. Stevenson Ltd. Used with permission.

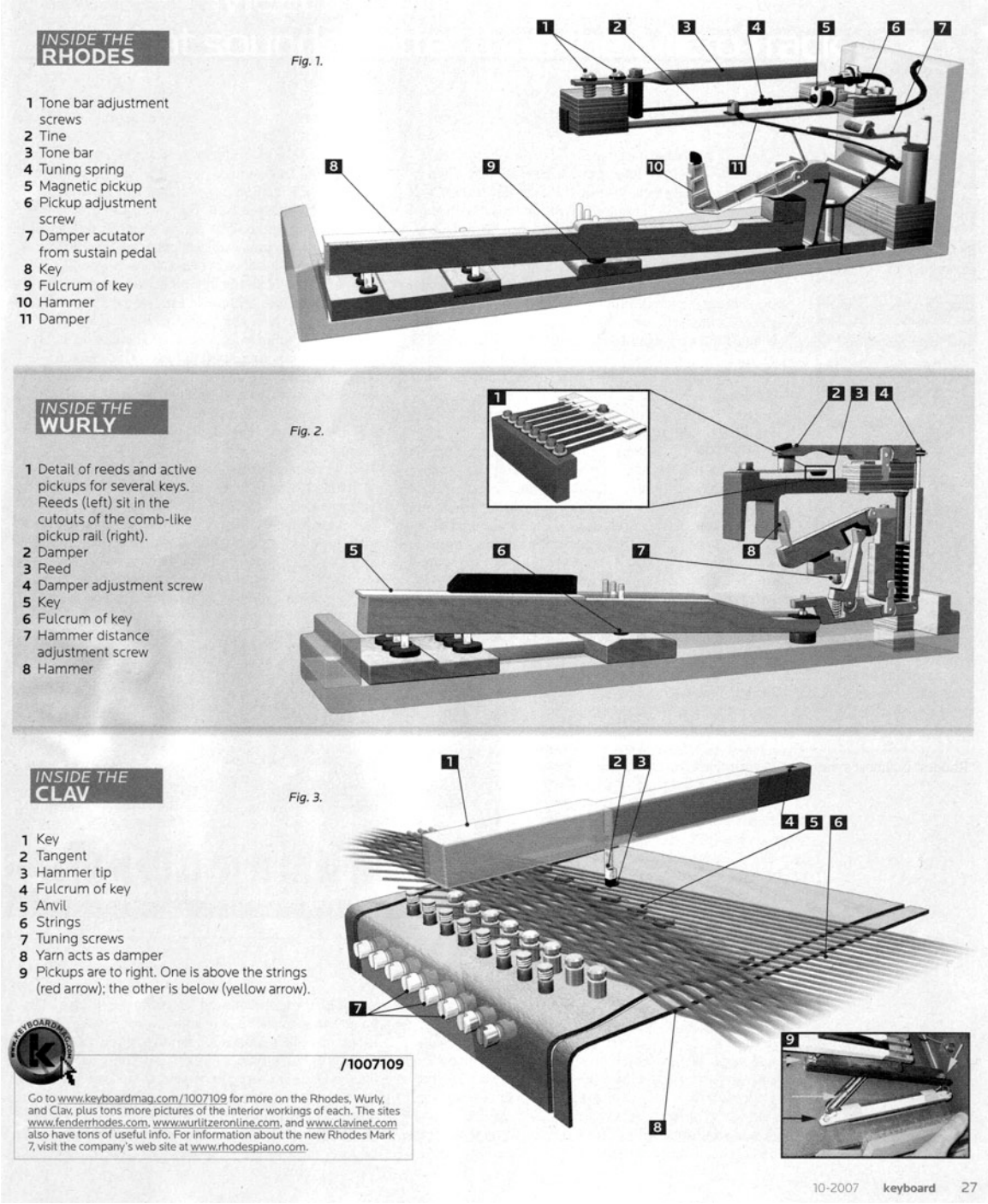
10.7. Electroacoustic Keyboard Instruments

- Electroacoustic instrument: acoustic sounds are electronically amplified

- Common approach to use brass reeds that vibrate and are then amplified with pickups
- 1934: Everett Orgatron
- 1947: Wurlitzer electric piano, based on Orgatron, produced in New York

  YouTube (http://www.youtube.com/watch?v=3bGqHuJoB9M)

  YouTube (http://www.youtube.com/watch?v=2aEL5AQG2fQ)
- Rhodes, Wurlitzer, Clavichord



- Internals of the Rhodes

  YouTube (http://www.youtube.com/watch?v=cZW00m81WW8)

10.8. Hammond B3: History

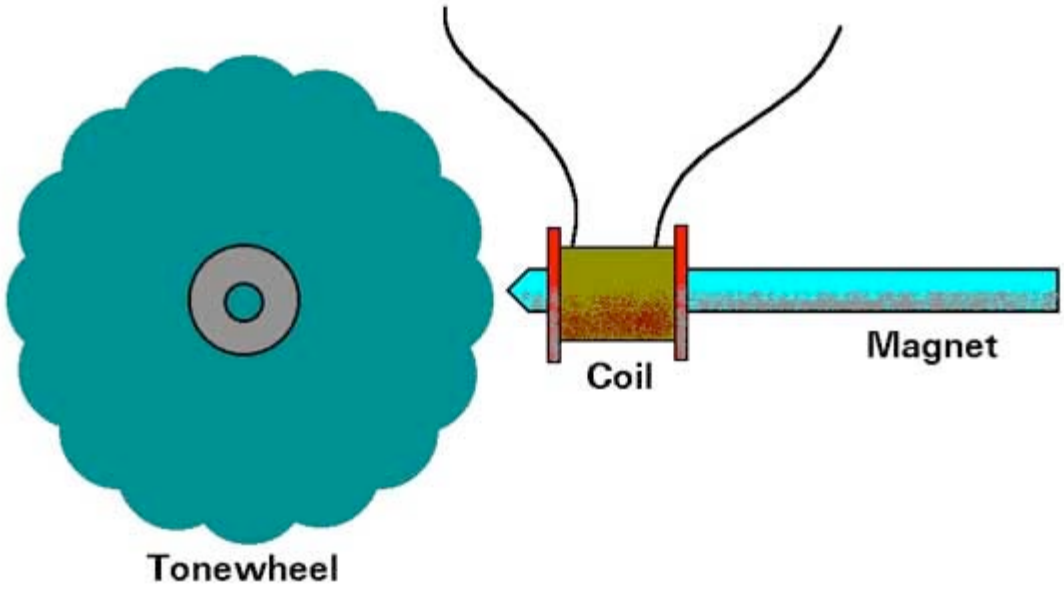
- 1935: Laurens Hammond with his instrument

- 1939: Hammond demonstrates B3 at AES in New York
- Two 61 note keyboards

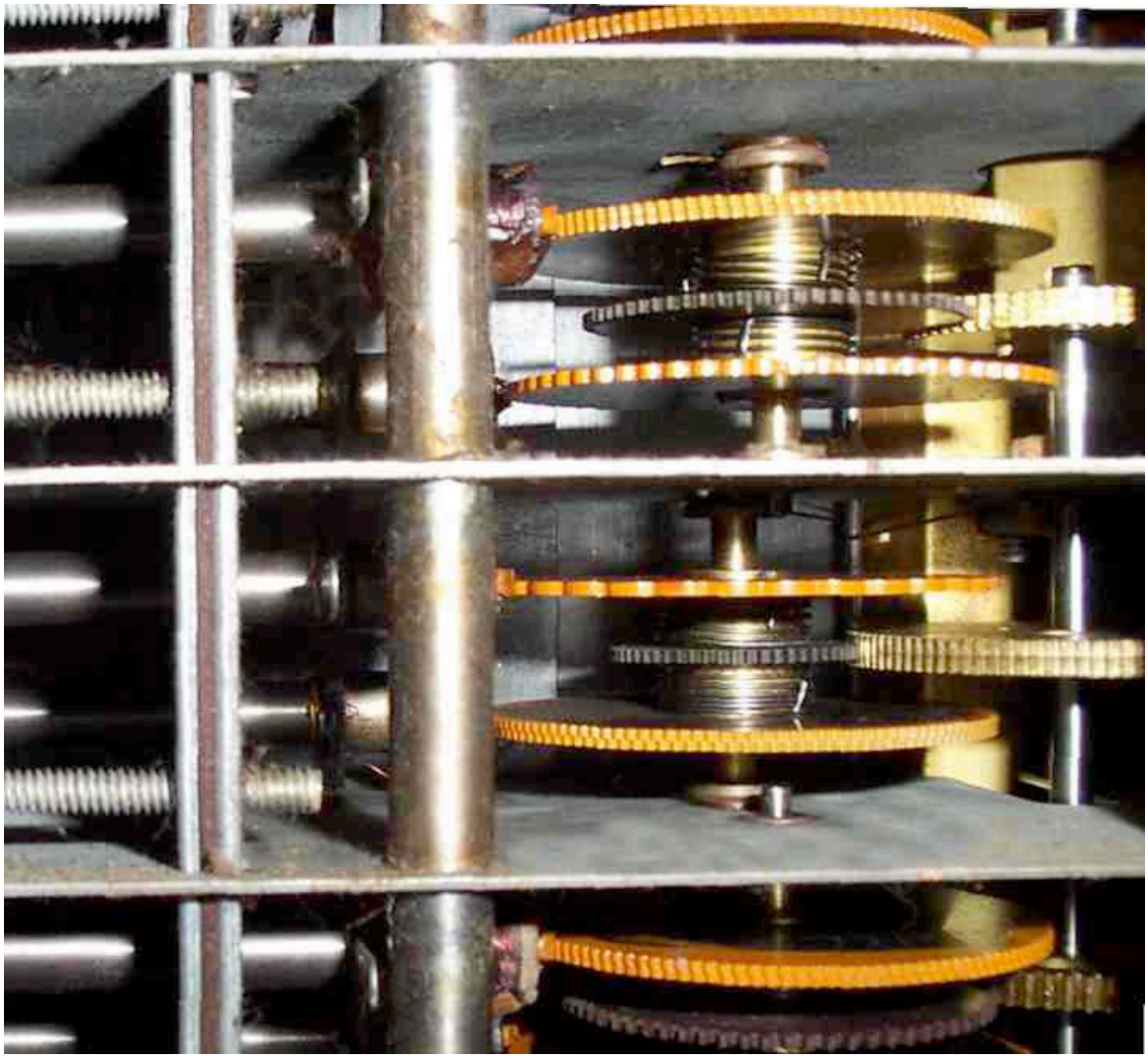
- 400 pounds

10.9. Hammond B3: Technologies

- 91 tone wheels: rotating discs that electro-magnetically generate a tone
  - Similar to a dynamic microphone, tone wheels generate a tone through electromagnetic induction

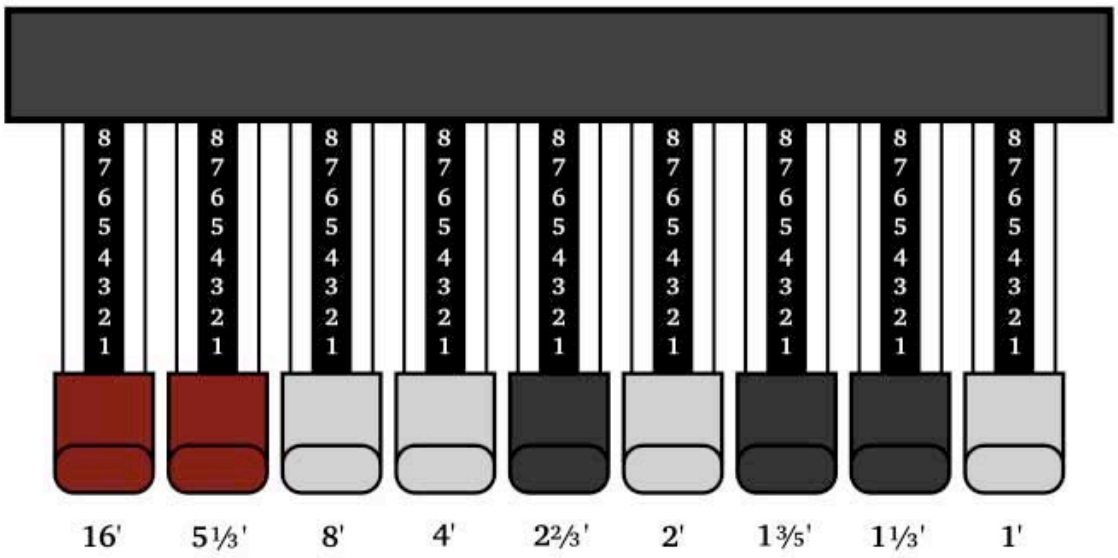


Courtesy of Eric C. Larson. Used with permission.



Courtesy of Eric C. Larson. Used with permission.

- Two sets of 9 drawbars
    - Drawbars control amplitude of harmonics: sub-octave, unison, 8th, 12th, 15th, 17th, 19th, 22nd



  - Drawbars provide an interface to additive synthesis
- Required external amplification
- Examples

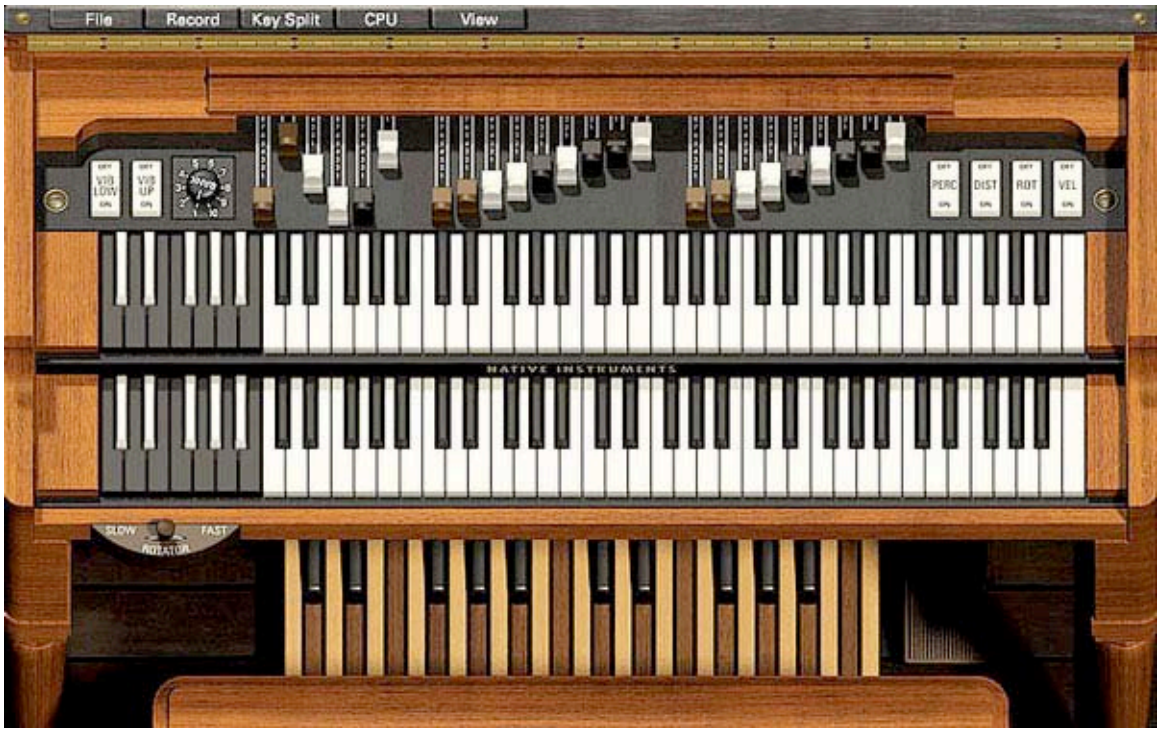
  YouTube (http://www.youtube.com/watch?v=vQUr-TKC76g)

  YouTube (http://www.youtube.com/watch?v=0nsPgSl52qY)

10.10. Hammond B3: Dynamic Timbre Control

- Drawbars permit dynamic timbre: sliders instead of stops
- Drawbars become an interface
- Hammond XK-3 ($2195): 96 Digital Tone Wheels/Vacuum Tube

- Native Instruments B4 ($199): Virtual Instrument



- Native Instrument B4D

10.11. Listening: Jimmy Smith and Wes Montgomery

- Jimmy Smith and Wes Montgomery: "O.G.D. (Road Song)" (Jimmy & Wes: The Dynamic Duo, 1966

- What gives Jimmy Smith's solo (from 2:26) a compelling forward momentum?

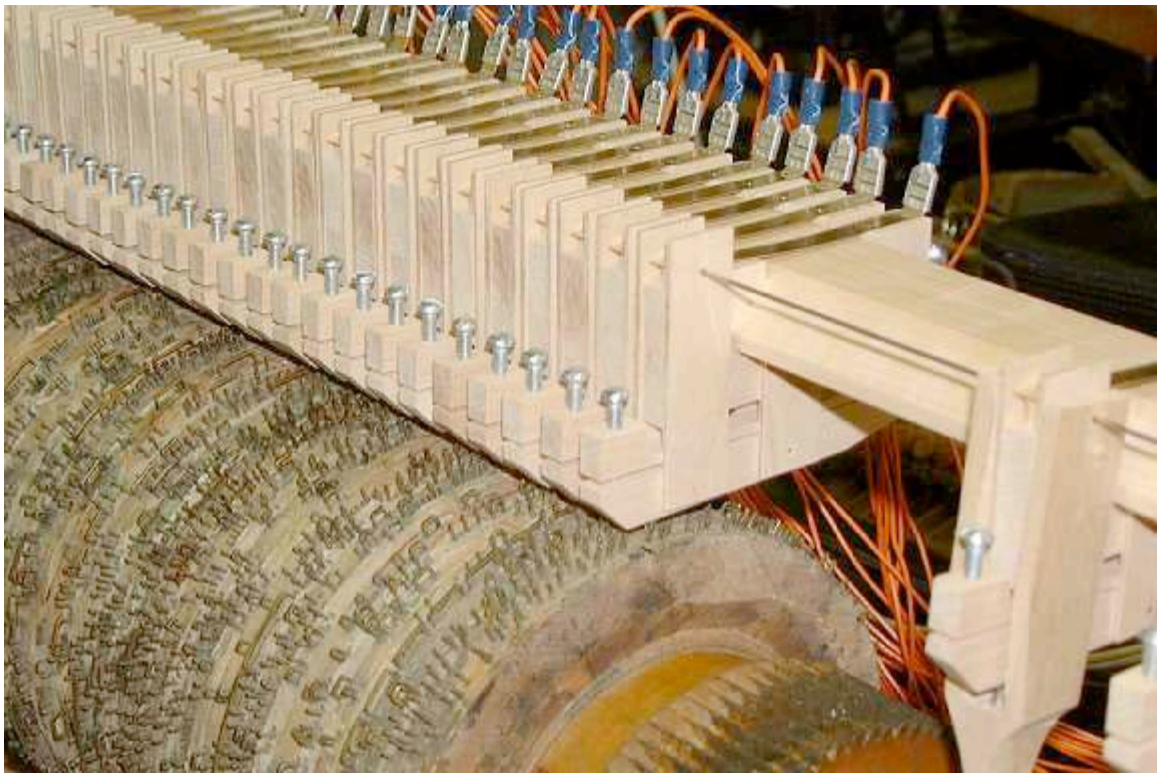
10.12. Listening: Medeski, Martin, and Wood

- Medeski, Martin, and Wood: "Hypnotized," 1998

- How is the sound of the Hammond transformed, and to what creative ends?

10.13. The Player Piano: History

- late 1800s: Barrel piano: stubs on cylinder encode music
- 1804: John Longman introduces drawing-room barrel piano with no keyboard
- 1800s: Portable barrel pianos popular street entertainment



- 1863: Henri Fourneaux develops Pianista: first pneumatic piano playing machine
- 1895: Edwin Scott Votey creates the Pianola
- 1904: Edwin Welte completes first "reproducing piano"
- 1904: Welte in Germany records a performer for use in creating player piano rolls (2002, p. 84)
- 1900-1930: 2.5 million instruments sold in U.S.
- Gramophones and radio reduced demand by 1930s
- Depression up until WWII led to demise of industry

10.14. The Player Piano: Mechanics

- Pneumatic power: paper-as-a-valve system

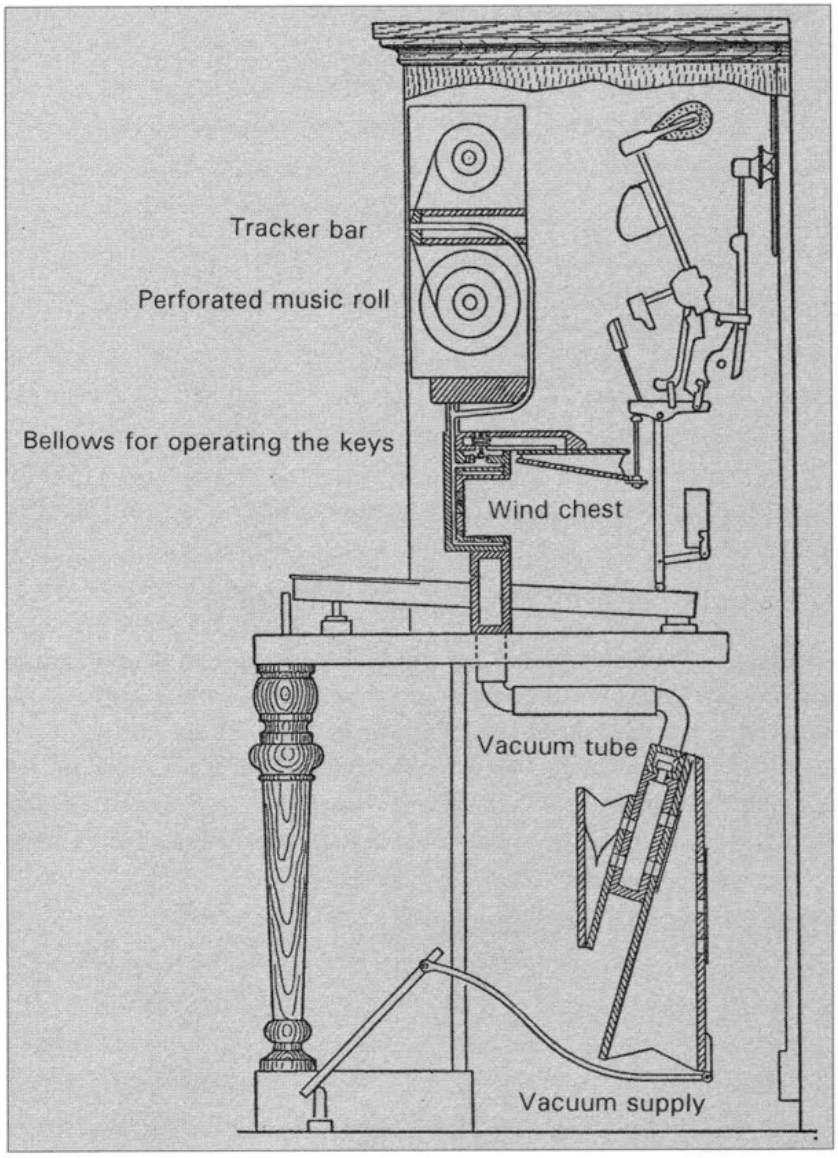


Fig. 3: Principle of a player piano

Courtesy of Jürgen Hocker. Used with permission.

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Player piano "Reproducing mechanism diagram" from Grove Dictionary of Music (Online).

- Ampico system: 98 tracks per line, 83 for controlling piano notes, 1 track for left pedal, 1 track for right pedal, 6 tracks for controlling bass dynamics, 6 tracks for controlling treble dynamics (Hocker 2002, p. 88)

- Player piano in motion

  YouTube (http://www.youtube.com/watch?v=MhSnUprw7XY)

YouTube (http://www.youtube.com/watch?v=0GfKEv12-sg)

- Alternative approaches

10.15. Conlon Nancarrow

- Conlon Nancarrow (1912-1997)
- Born in Arkansas, fought in Spain against Franco, emigrates to Mexico
- Influenced by Henry Cowell's recommendation perform complex rhythms on player piano (Hocker 2002, p. 87)
- Frustrated with limitations of human players
- 1947: Bought a player piano roll cutting machine
- 1949: First original composition for player piano
- Composes 49 studies for player piano
- First 20 studies written out in standard notation (Hocker 2002, p. 90)

- Explored speeds and densities idiomatic to the player piano
  - Player piano: 200 notes / second (Human: 15 notes per second)
  - Player piano: 40 notes at once (Human: 12-15 notes at once)

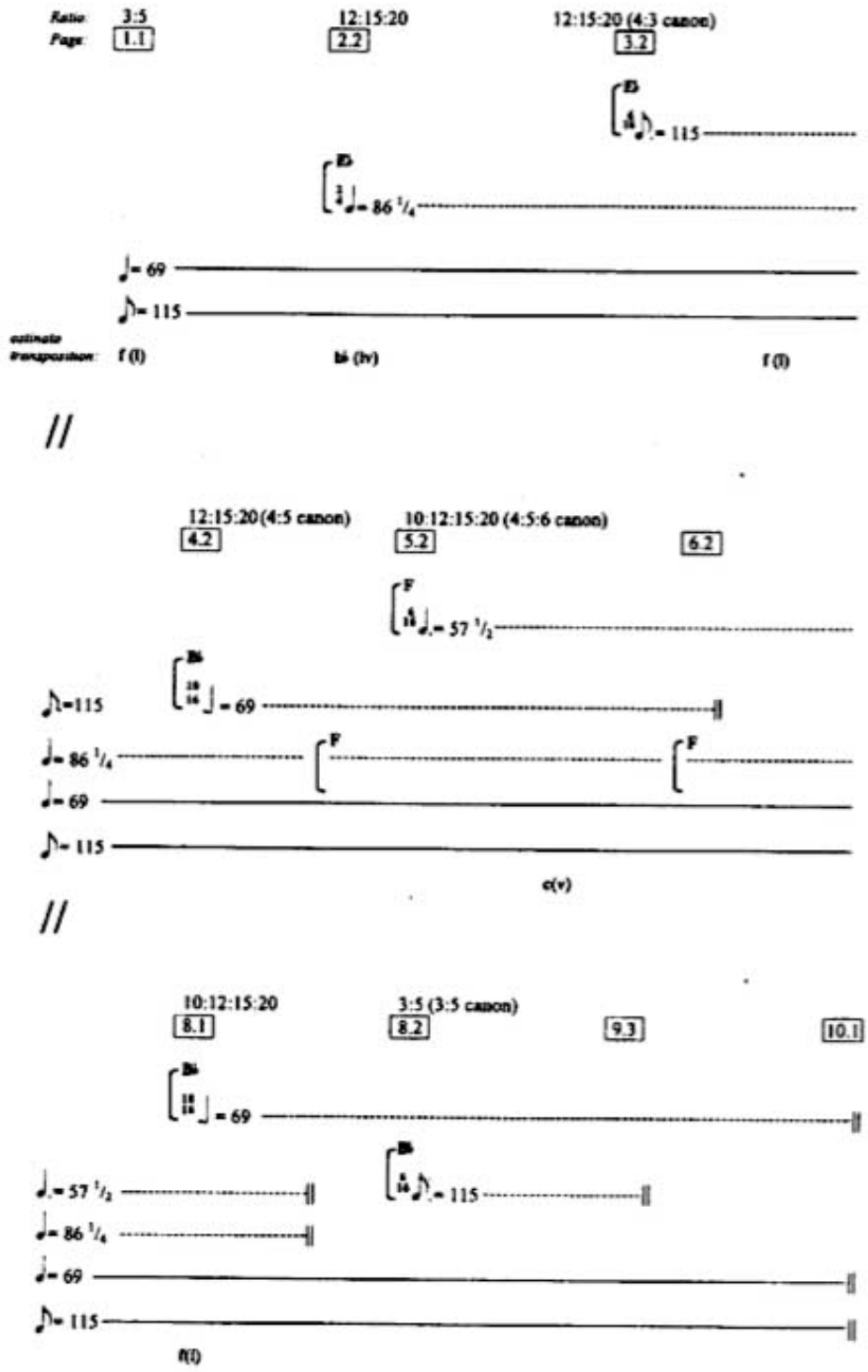
10.16. Conlon Nancarrow: Music

- Idea of temporal dissonance (Hocker 2002, p. 93)

  Examples via Frere Jacques
  (http://willshare.com/willeyrk/creative/papers/study37/tempdiss.htm)

- Often used poly-tempi and poly-meter
- Complex temporal canons
- Precise ratio-based acceleration and deceleration
- Study 2

Example 5. Nancarrow, Study No. 2.
Summary of tempos and material.



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- Study 25

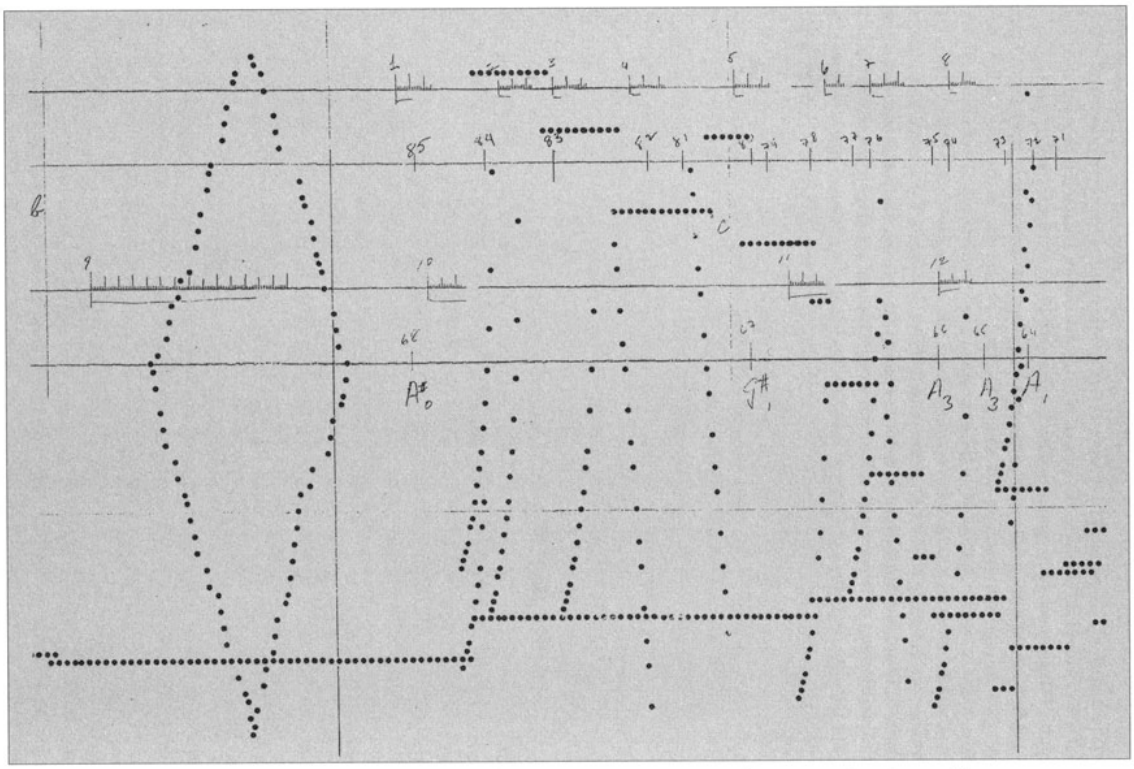


Fig 4: Conlon Nancarrow, Study No. 25. Section of the piano roll. Single points (perforations in the piano roll) are staccato notes. Horizontal rows of perforations show sustained notes. Nancarrow used different scales for the different speeds of voices.

Courtesy of Jürgen Hocker. Used with permission.

10.17. Listening: Conlon Nancarrow

- Conlon Nancarrow: "Study #1"

- Conlon Nancarrow: "Study #36"

10.18. Reading: Hocker

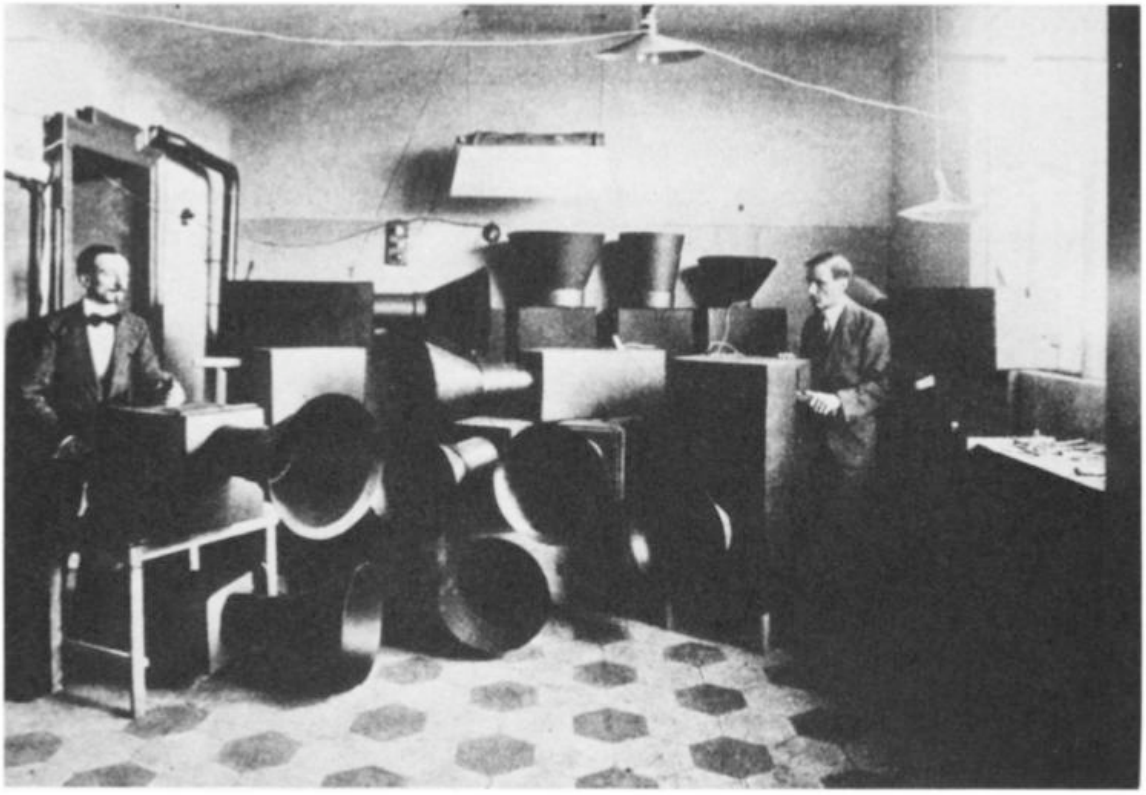
- Hocker, J. 2002. "My Soul is in the Machine — Conlon Nancarrow — Composer for Player Piano — Precursor of Computer Music." In *Music and Technology in the Twentieth Century*. H. Braun, ed. Baltimore: The Johns Hopkins University Press. 84-96.
- How is the composer's interface altered if permitted to draw compositions on paper rolls?
- Is unplayability an important feature for Nancarrow?

10.19. Ideas of a new Music

- 1907: Ferruccio Busoni: *Outline of a New Aesthetic of Music*
- 1910-1912: Manifesti of Ballila Pratella
- 1913: Russolo: *Art of Noises*
- 1919-1930: Henry Cowell: *New Musical Resources*

10.20. Reading: Brown

- Brown, B. 1981. "The Noise Instruments of Luigi Russolo." *Perspectives of New Music* 20(1-2): 31-48.
- From where did Russolo get his inspiration?
- What was the basic sound producing mechanism of the intonarumori



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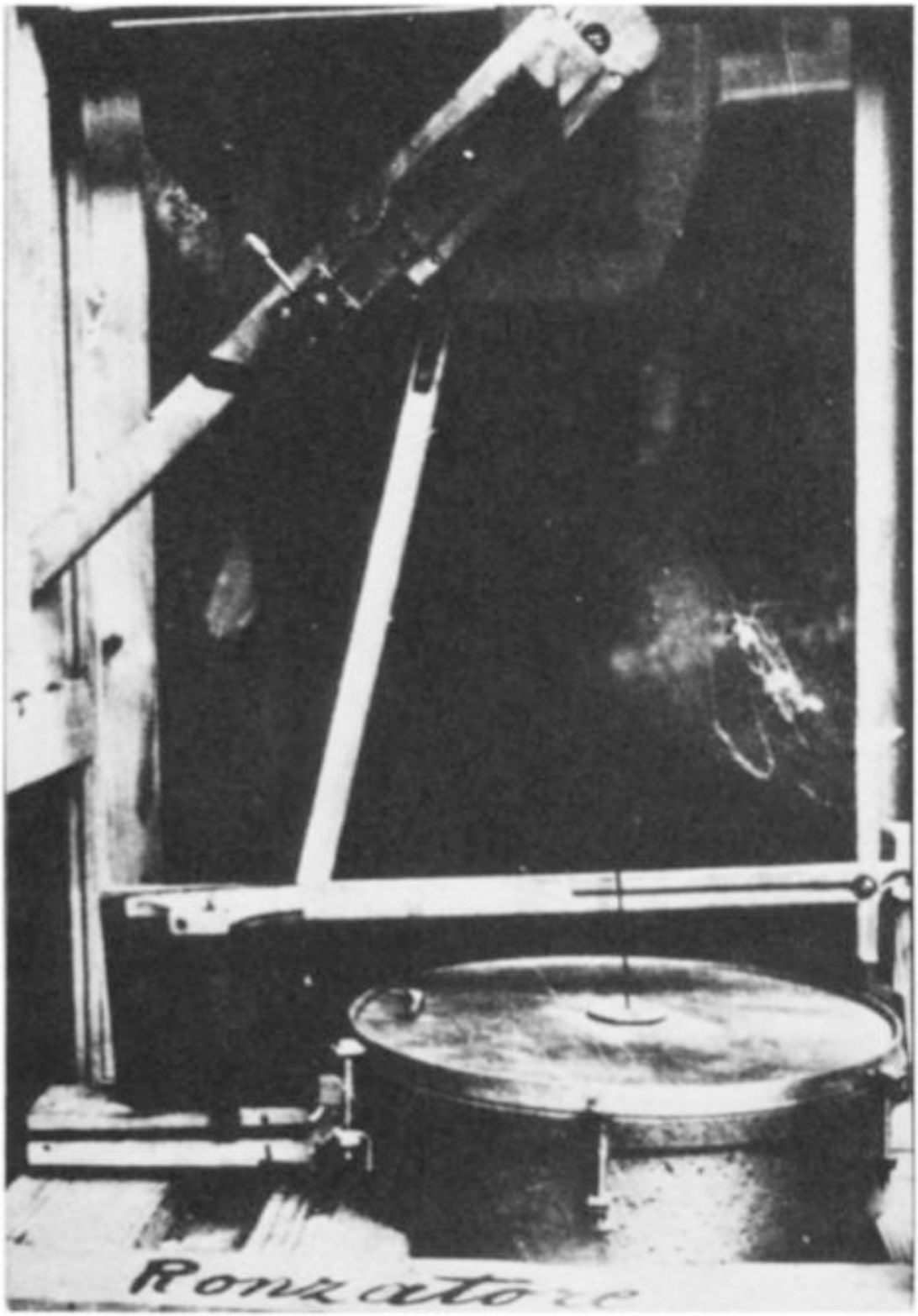

Public domain photo.

- What was the interface of the Intonarumori?

- What were Russolo's goals of developing and extending the Intonarumori?

10.21. Reading: Bijsterveld

- Bijsterveld, K. 2002. "A Servile Imitation. Disputes about Machines in Music, 1910-1930." In *Music and Technology in the Twentieth Century*. H. Braun, ed. Baltimore: The Johns Hopkins University Press. 121-135.

- Was Russolo a (sonic/musical) revolutionary?

- What motivated Russolo to say the following: "... the ear must hear these noises mastered, servile, completely controlled, conquered and constrained to become elements of art" (2002, p. 124)

- What were some of the criticisms of Russolo's instruments and compositions?

10.22. Listening: Russolo

- Listening: Luigi Russolo, "Intonarumori: crepitatore (crackler)," 1977

- Luigi Russolo, "Intonarumori: gorgogliatore (gurgler)" 1977

- Luigi Russolo, "Risveglio di una Citta (Extract)," 1977

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