Fig. 1. Hydraulis, or water organ, ca. 250 B.C. in Alexandria.

Fig. 2. Pneumatic organ, with bellows, 395 A.D. in Constantinople.

Fig. 3. Portative organ, 12th century England.

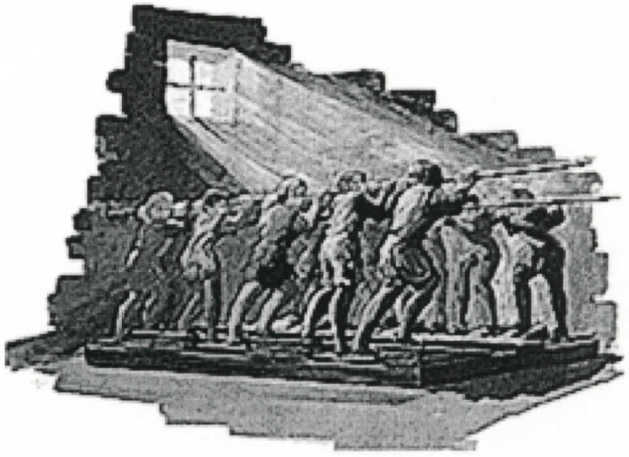

Fig. 4. Medieval cathedral organ, 14th century Europe.

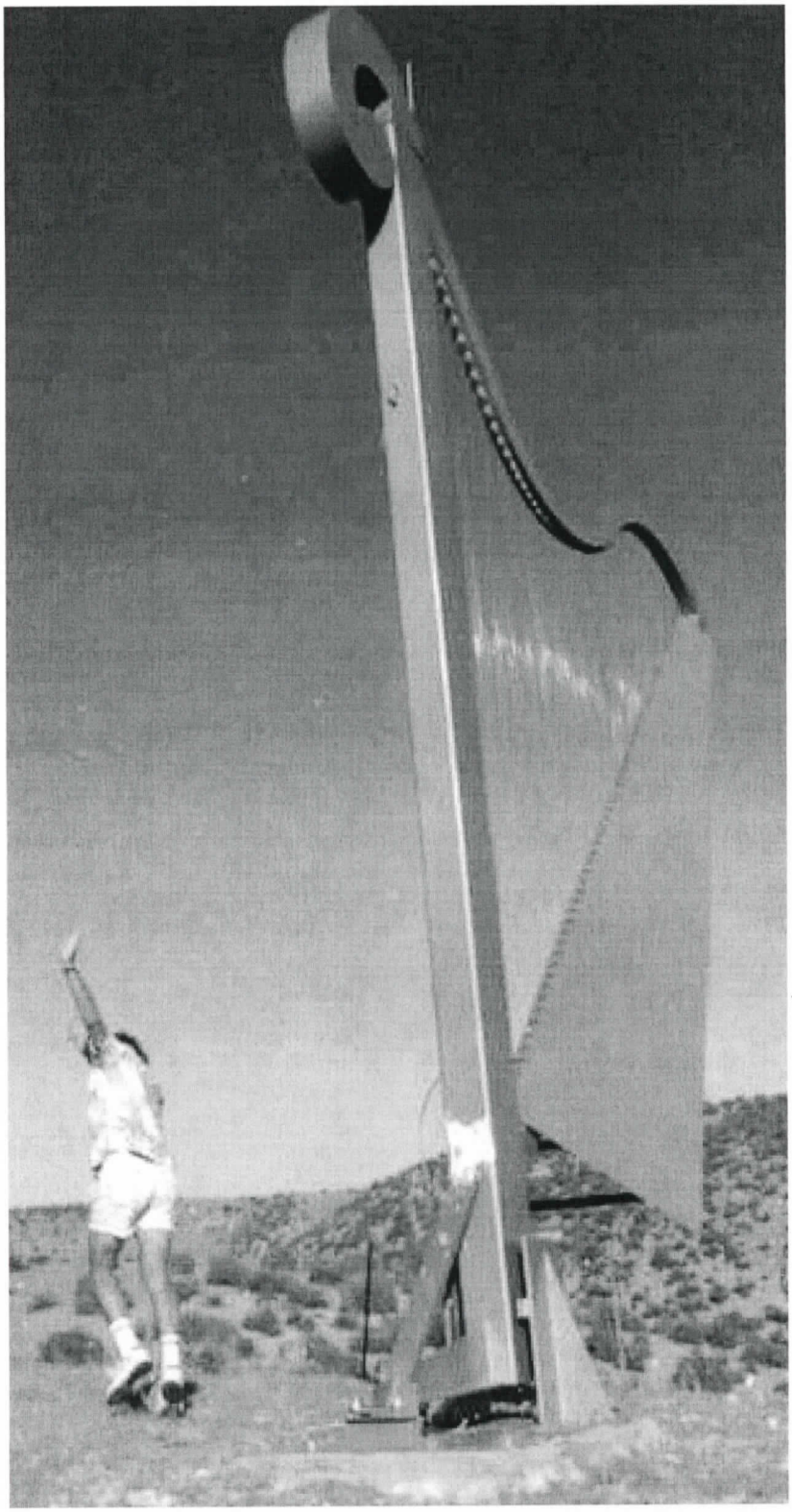

Fig. 5. Modern Aeolian harp, New Mexico.

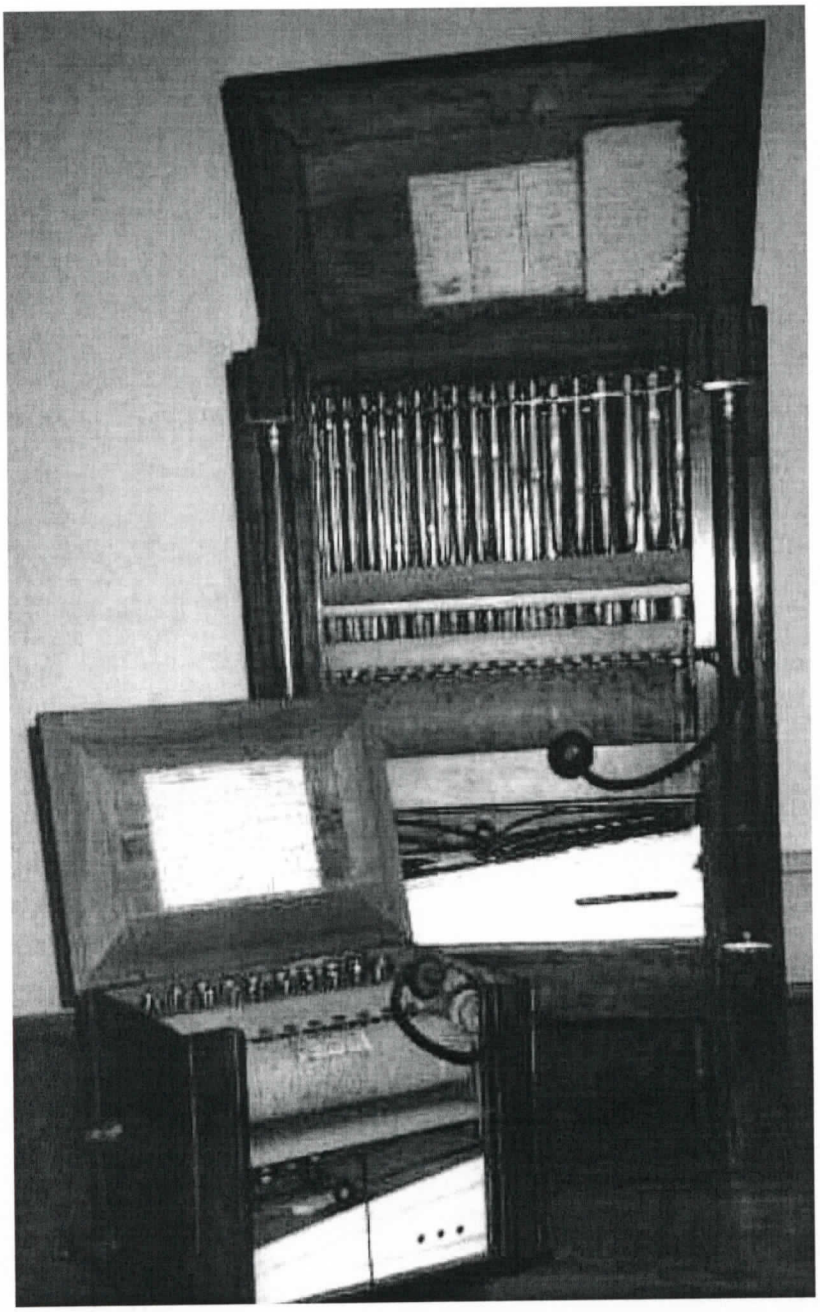

Fig. 6. French barrel organs.

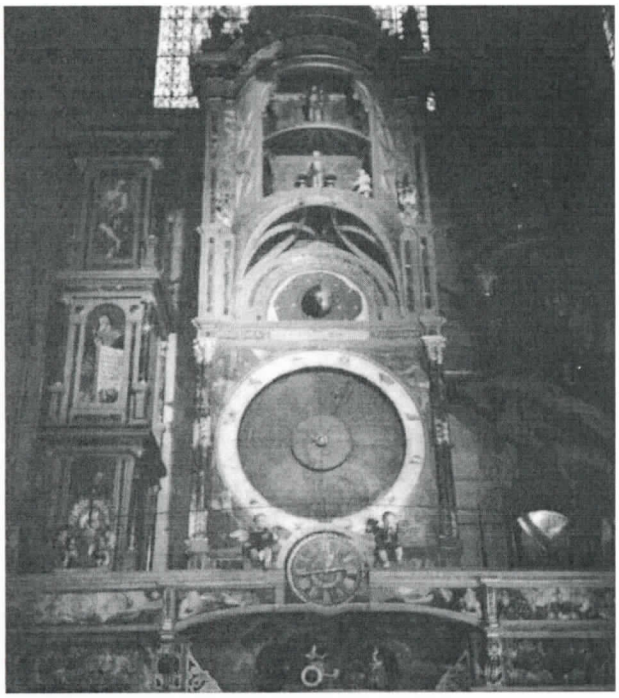

Fig. 7. First astronomical clock with automata, built in 1352-54 in the Strasbourg Cathedral. Shown is 19th century reproducation.

Fig. 8. 19th century juggler automata.

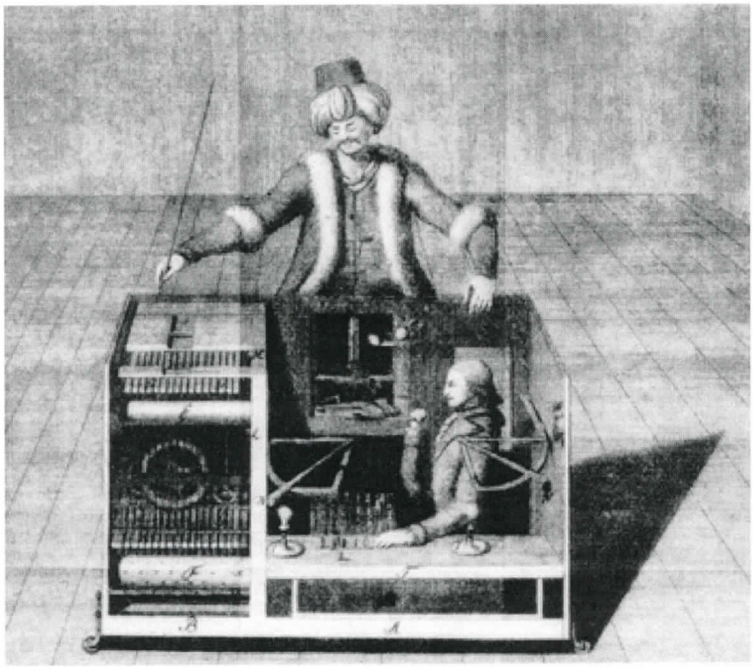

Fig. 9. Farkas de Kempelen's Turkish Chess-Player, 1769.

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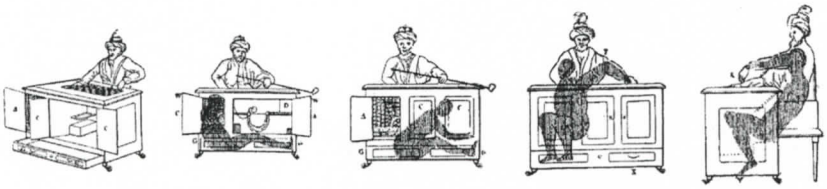

Fig. 10. Human inside the Turkish Chess-Player.

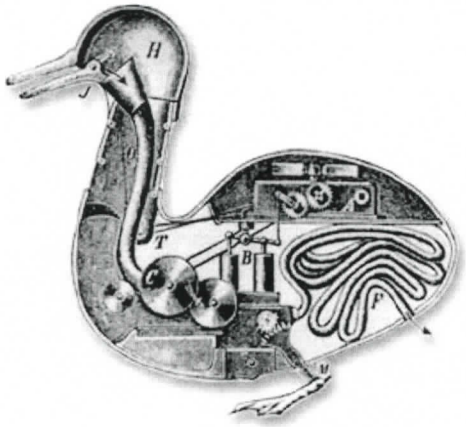

Fig. 11. Vaucanson's Mechanical Duck, ca. 1737.

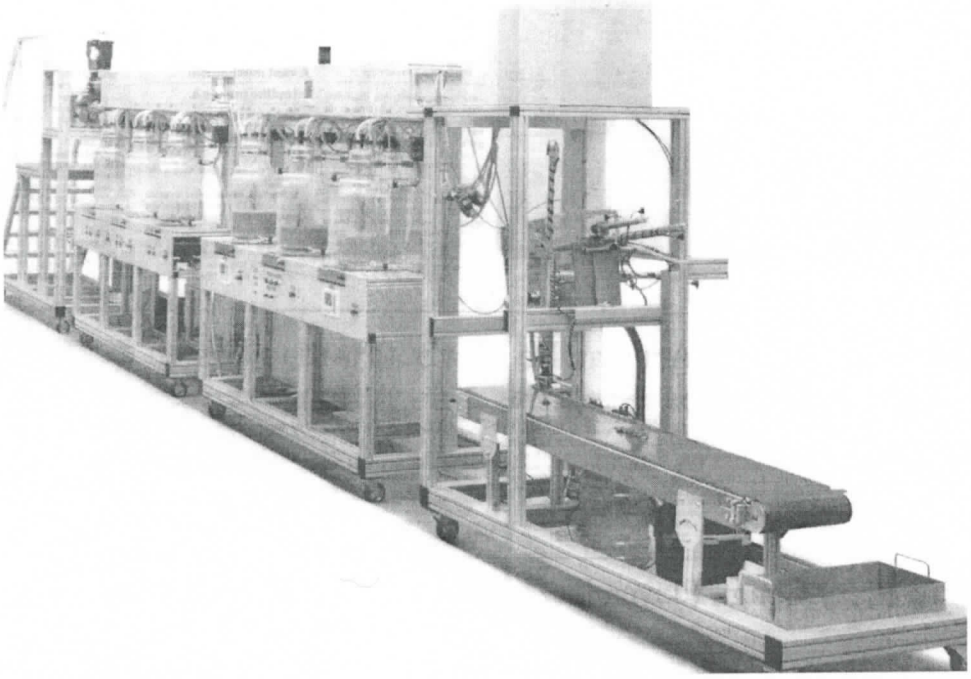

Fig. 12. Wim Delvoye's "Cloaca," 2000.

Fig. 13. Johann Maelzel's Panharmonicon, ca 1813.

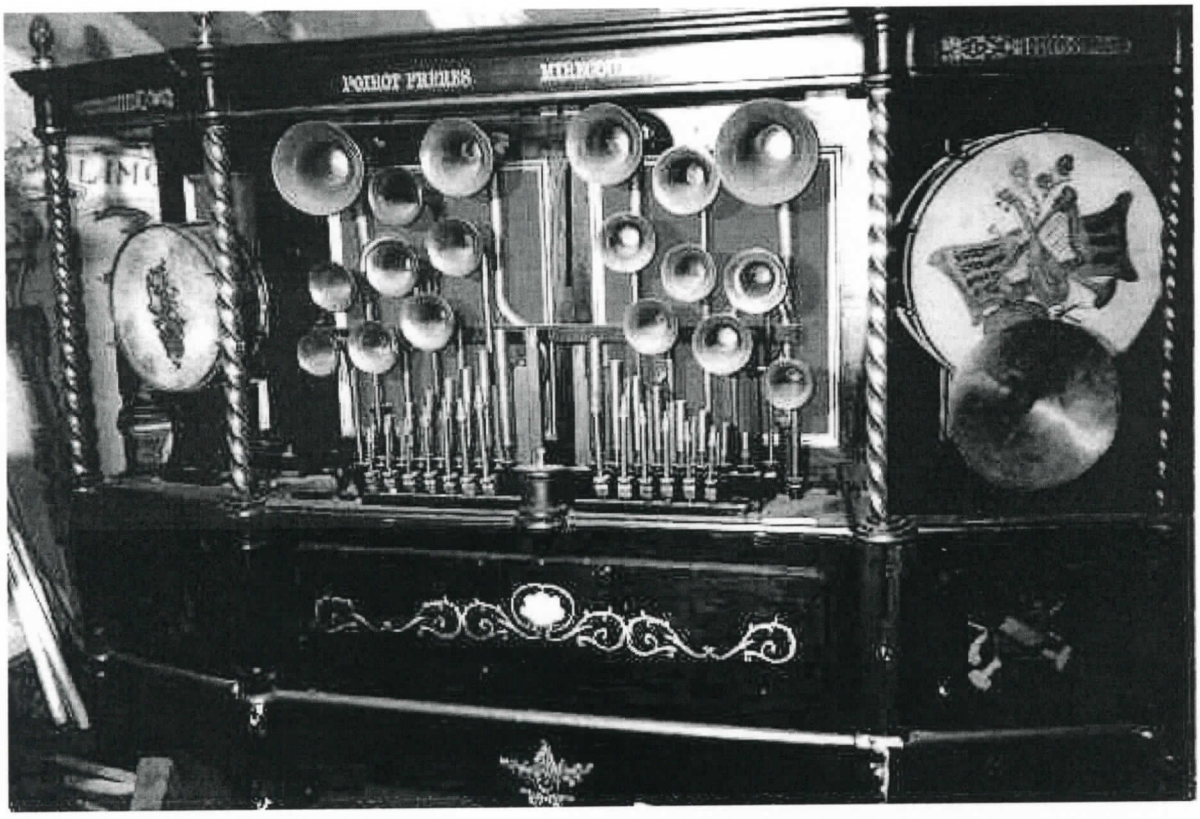

Fig. 14. Military Band Organ, 1885.

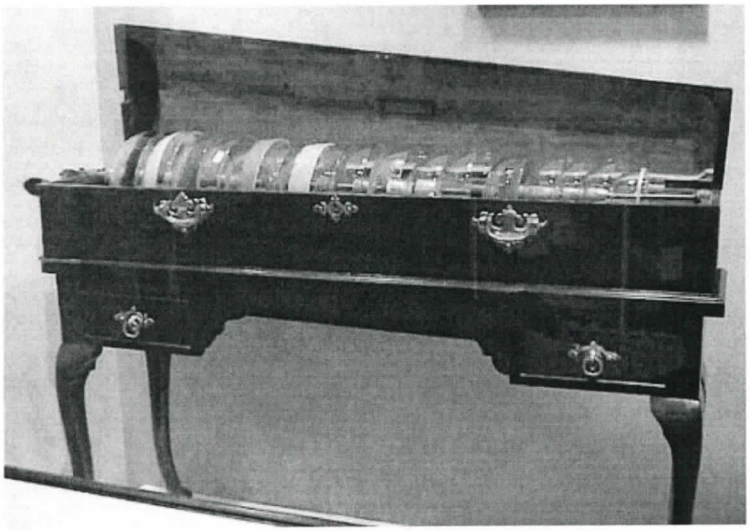

Fig. 14. Benjamin Franklin's Glass Harmonica, 1763.

Fig. 15. Franklin playing the Glass Harmonica.

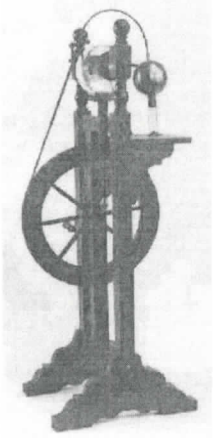

Fig. 16. Replica of Franklin's static-generating machine, ca. 1760.

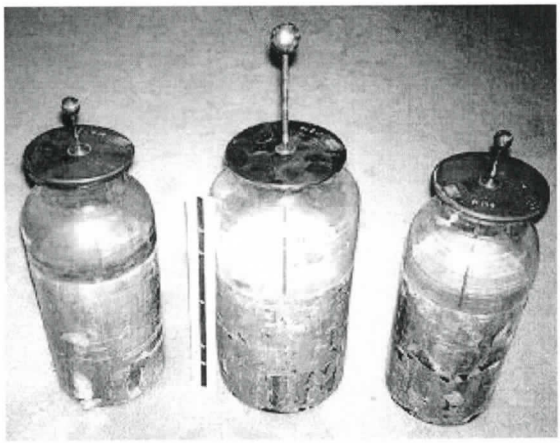

Fig. 17. Leyden jars, ca. 1760.

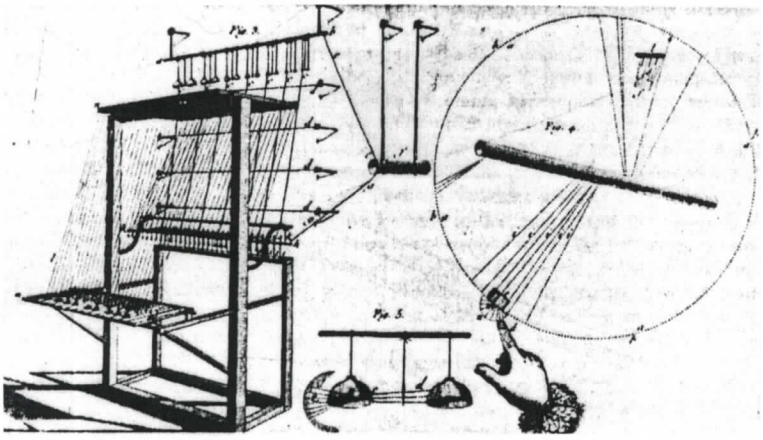

Fig. 18. Jean-Baptiste de la Borde's Clavecin Electrique, 1761.

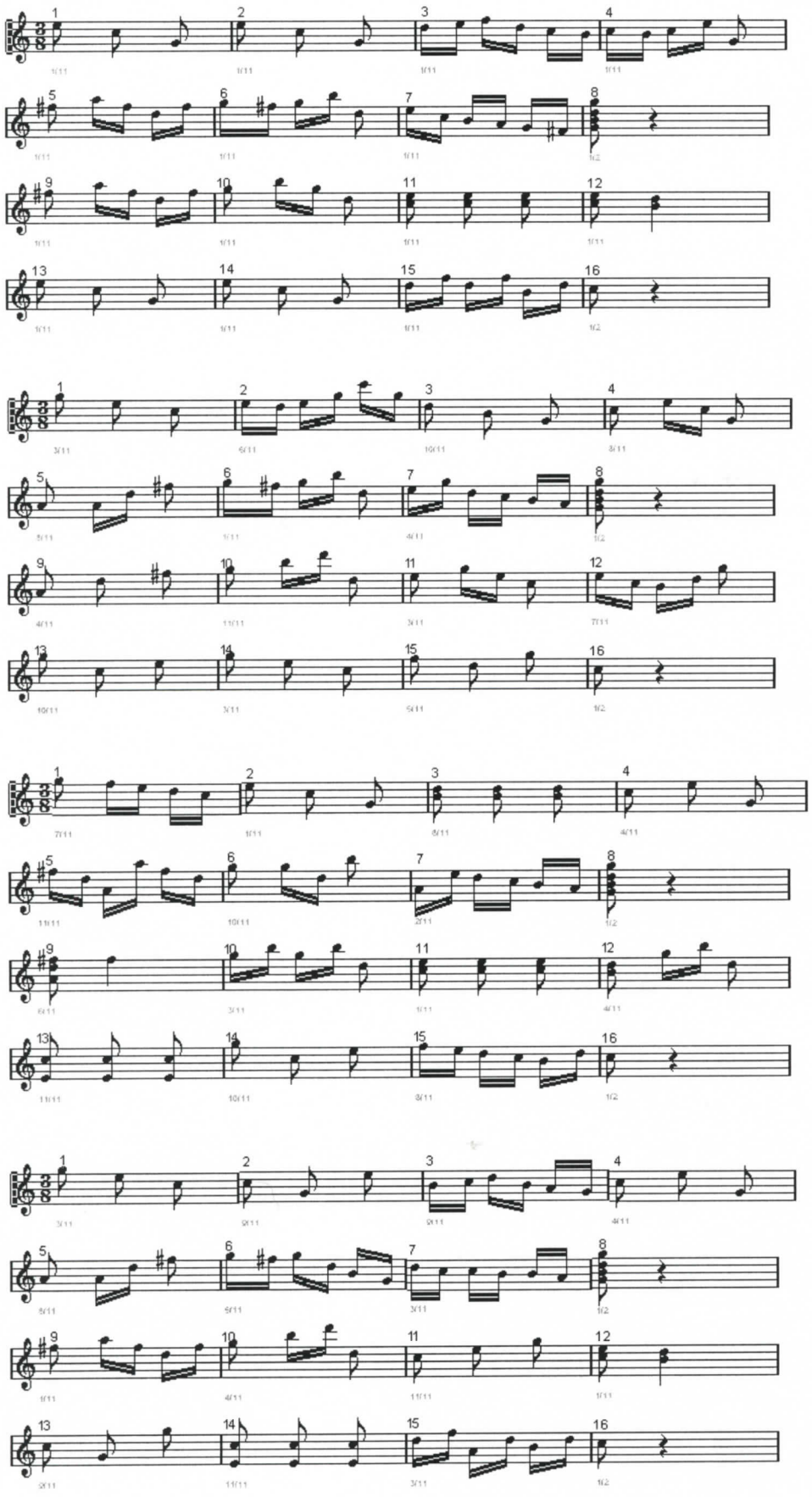

Fig. 19. Four versions of minuet generated by Mozart's Musical Dice Game, 1787.

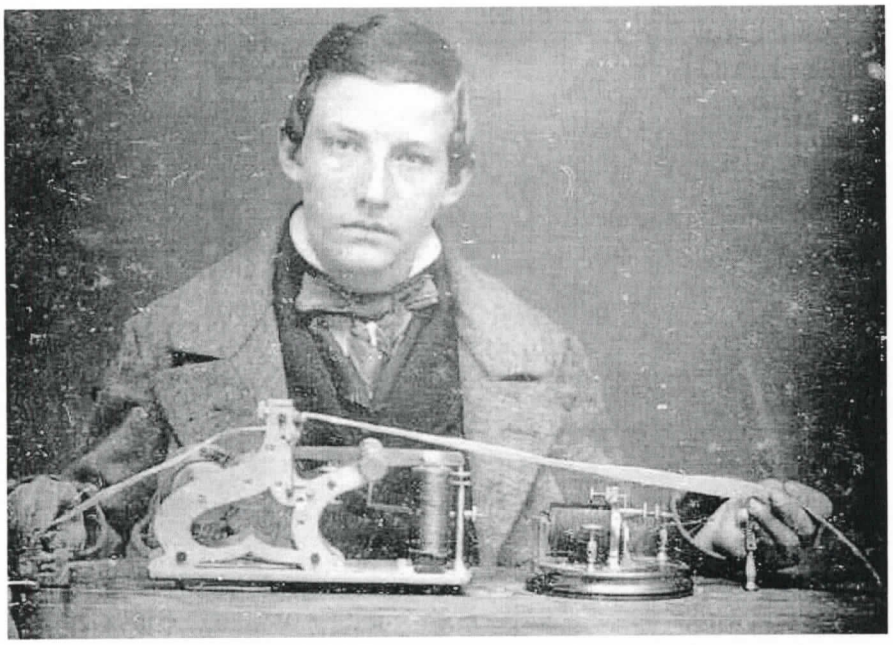

Fig. 20. Early telegraph operator, ca. 1850.

Fig. 21. Elisha Gray's Musical Telegraph, 1874.

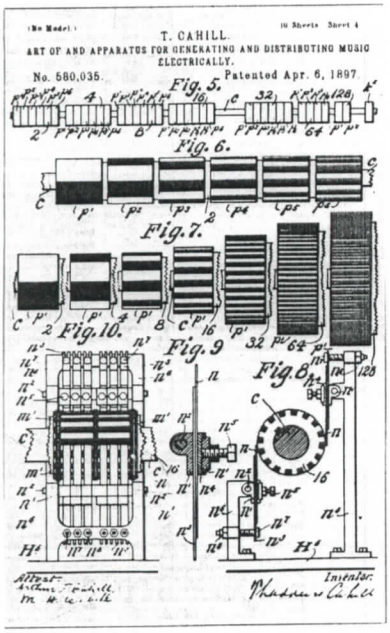
T. CAHILL.
ART OF AND APPARATUS FOR GENERATING AND DISTRIBUTING MUSIC ELECTRICALLY.
No. 580,035. Patented Apr. 6, 1897.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 10.
Fig. 9
Fig. 8.

Fig. 26. Telharmonium tone wheel design.

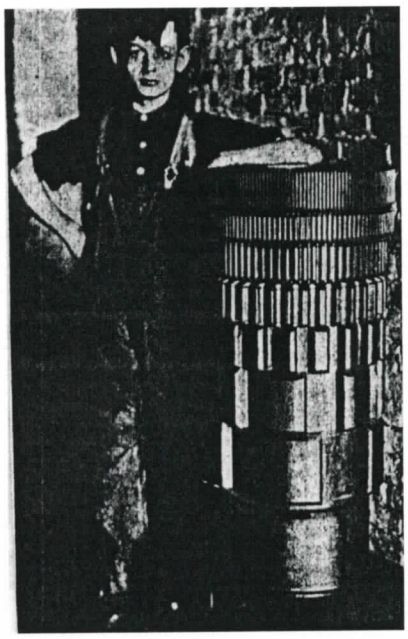

Fig. 27. Tone wheel.

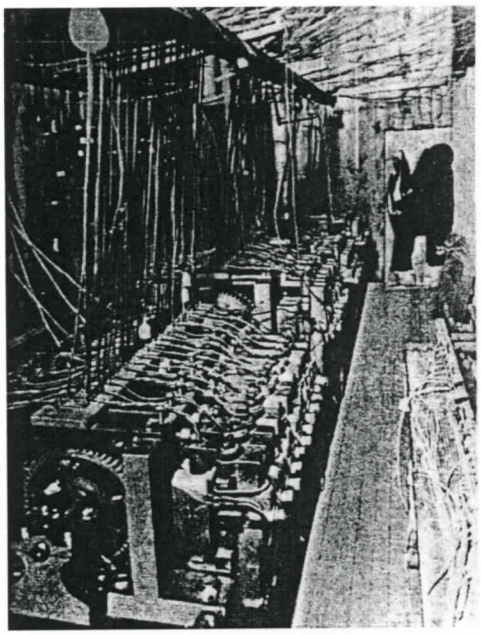

Fig. 28. Drive shaft.

Fig. 29. Keyboards.

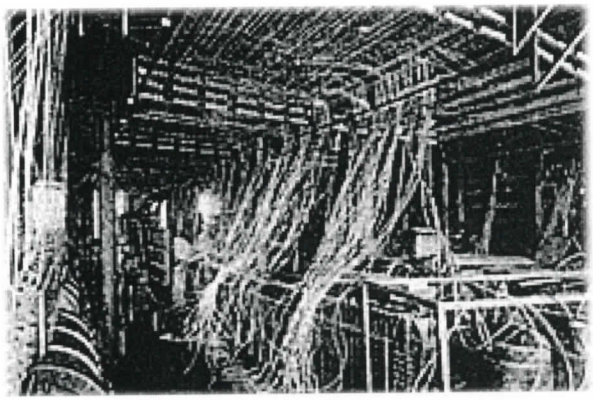

Fig. 30. Wiring.

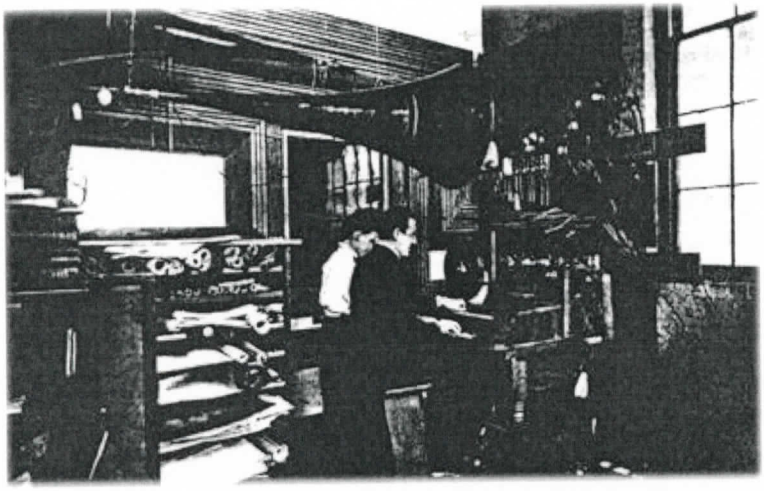

Fig. 31. Wooden horn.

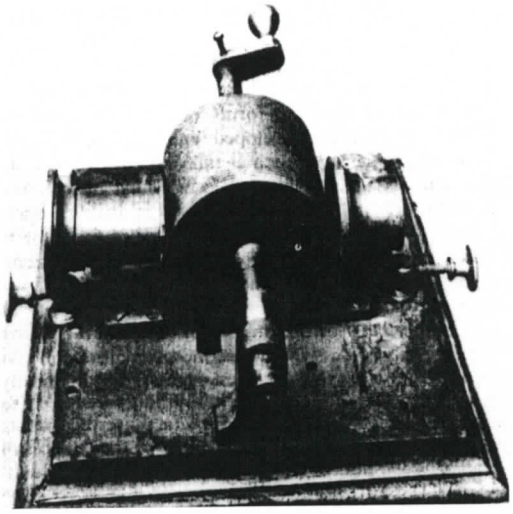

Fig. 22. Edison's phonograph, 1877.

Fig. 23. Berliner's gramophone, 1888.

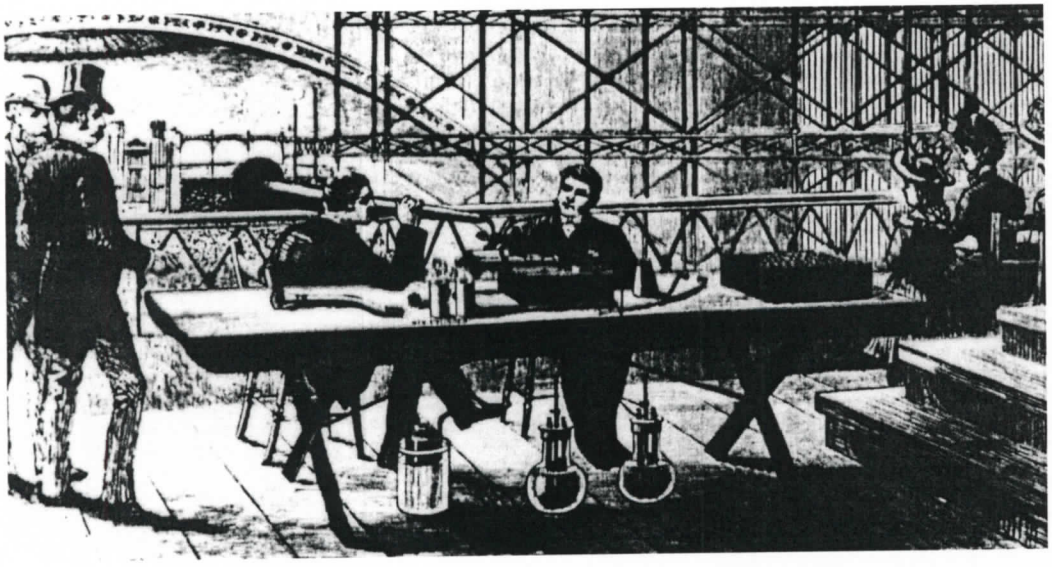

Fig. 24. Edison recording of Handel's *Israel in Egypt,* 1888.

Fig. 25. Advertisement for player piano, 1922.

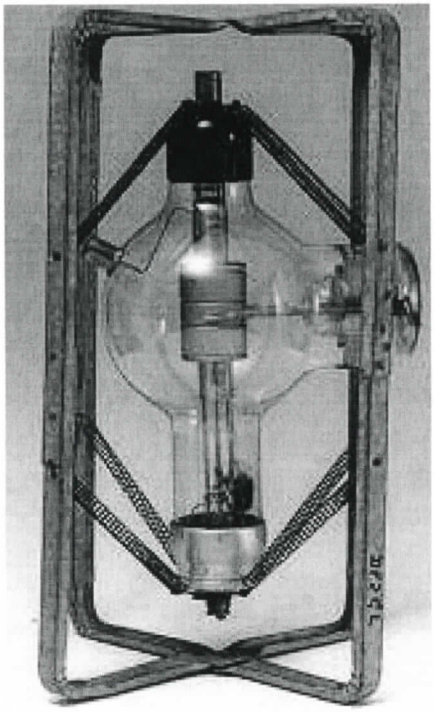

Fig. 32. First vacuum tube, invented by Lee de Forest, 1906.

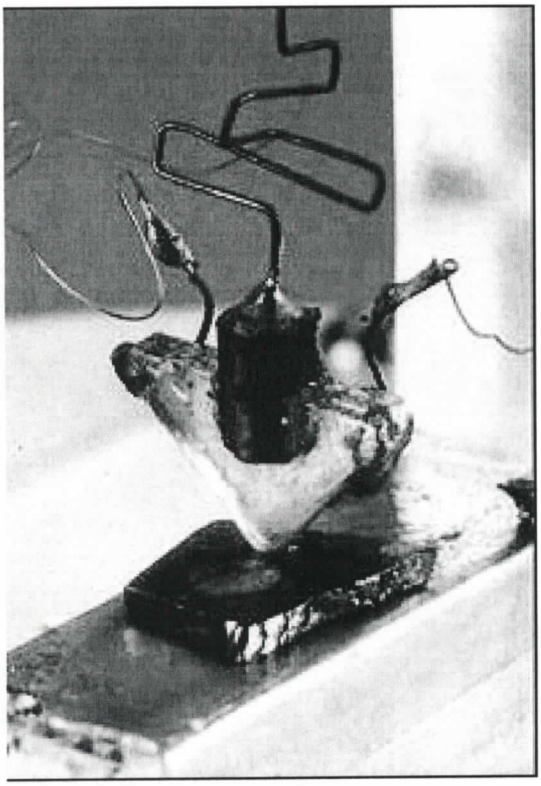

Fig. 33. First transistor, invented by William Shockley, 1947.

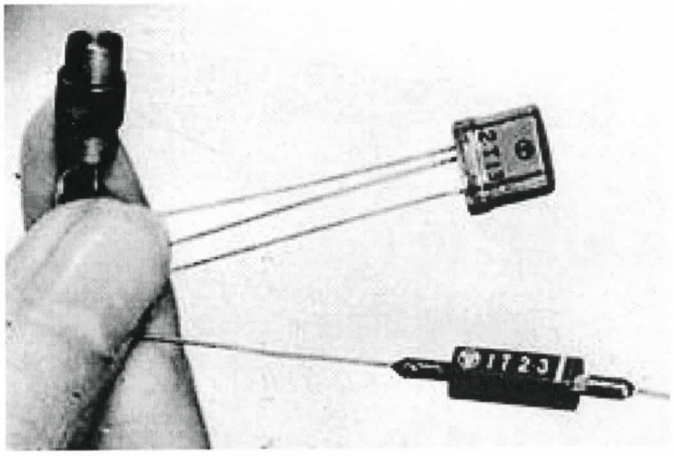

Fig. 34. Transistors in the 1960s.

Fig. 35. Futurists Marinetti, Piatti, Russolo.

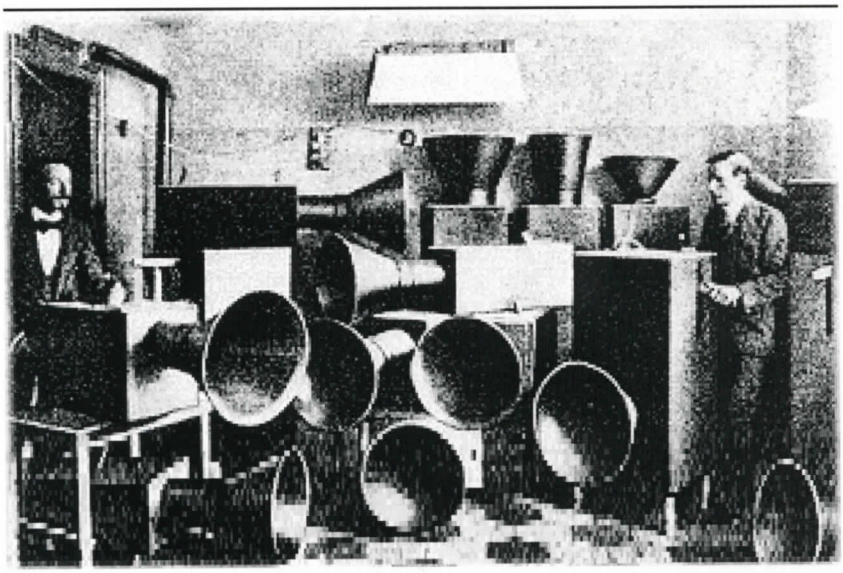

Fig. 36. Russolo and Piatti with intonarumori.

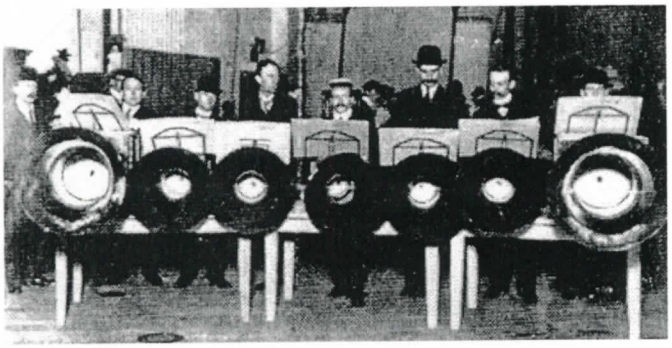

Fig. 37. Concert of intonarumori.

Fig. 38. Intonarumori and orchestra.

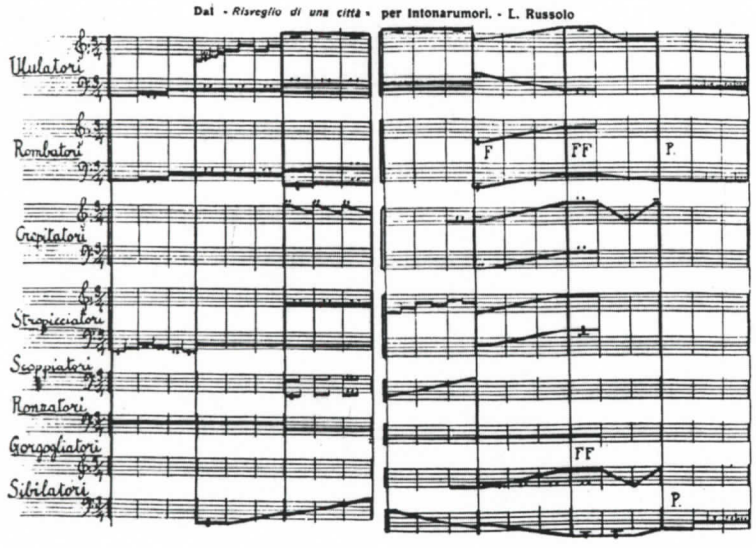

Fig. 39. Score for *Awakening of a City.*

So far, I and Piatti have invented and constructed 21 noise instruments. Studies and tests have already been made for many more, so that the orchestra of noise instruments will soon be enriched with new timbres and new families.

Here is a list of those already constructed:

3 HOWLERS (*Ululatori*)	1st: low	2nd: medium	3rd: high	
3 ROARERS (*Rombatori*)	1st: low	2nd: medium	3rd: high	
4 CRACKLERS (*Crepitatori*)	1st: low	2nd: medium	3rd: high	4th: very high
3 RUBBERS (*Stropicciatori*)	1st: low	2nd: medium	3rd: high	
2 BURSTERS (*Scoppiatori*)	1st: low	2nd: medium		
2 BURSTERS	Different from each other and from the preceding two			
2 GURGLERS (*Gorgoliatori*)	1st: low	2nd: medium		
1 LOW HUMMER (*Ronzatore*)				
1 LOW WHISTLER (*Sibilatore*)				

Externally, the noise instruments take the form of boxes of various sizes, usually constructed on a rectangular base. At the front end, a trumpet serves to collect and reinforce the noise-sound.

Fig. 40. Description of intonarumori.

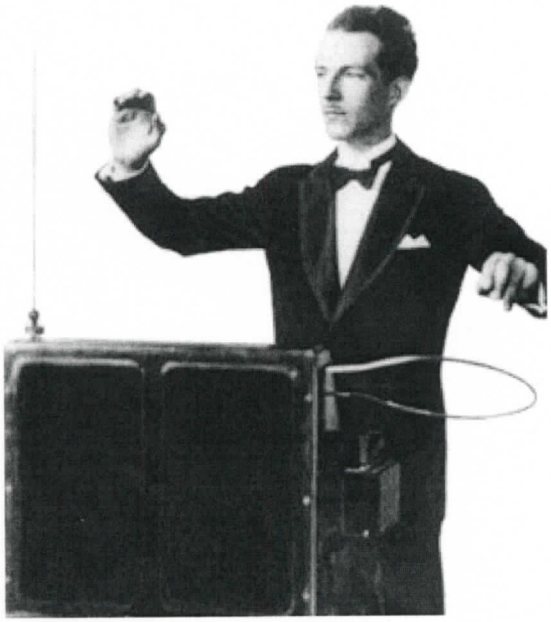

Fig. 41. Lev Termin and the Theremin.

Fig. 42. Clara Rockmore, ca. 1945.

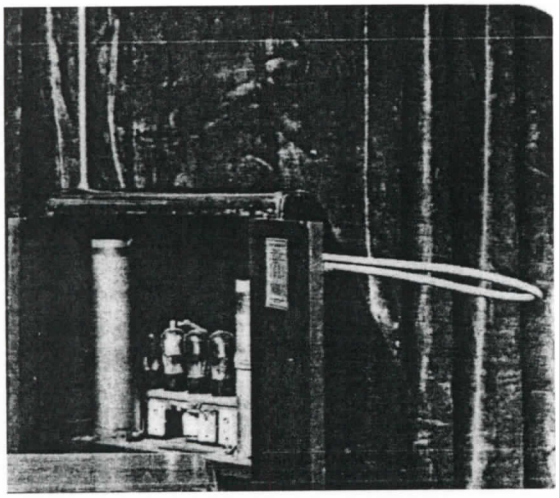

Fig. 43. Vacuum tubes in the Theremin.

Fig. 44. Termin and Paul Lansky, 1991.

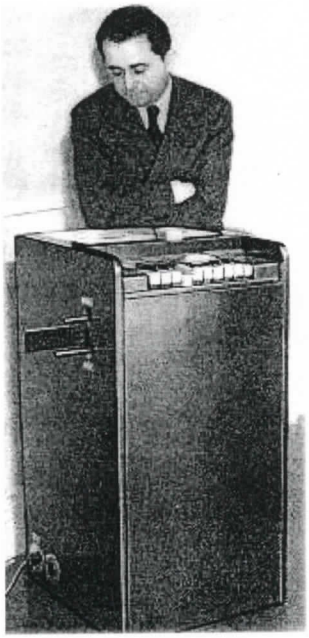

Fig. 45. Henry Cowell and Termin's Rhythmicon.

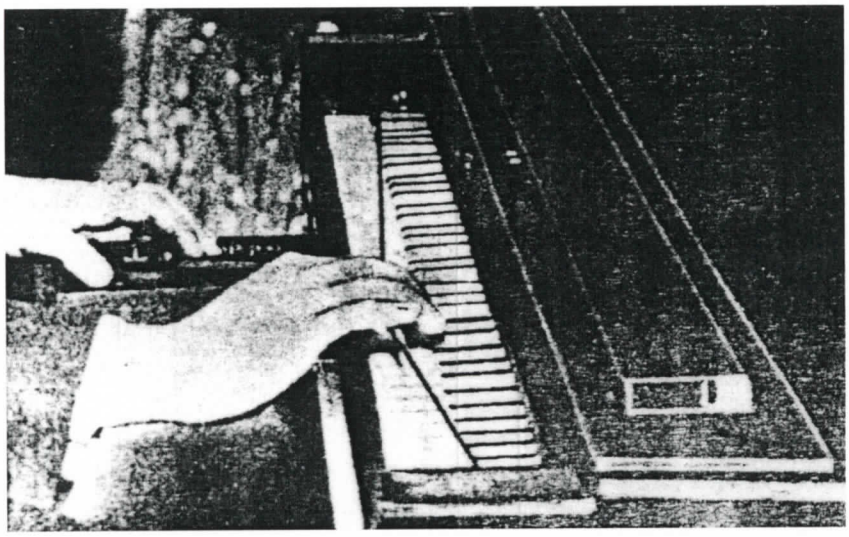

Fig. 46. Ondes Martenot with ribbon controller and painted keyboard.

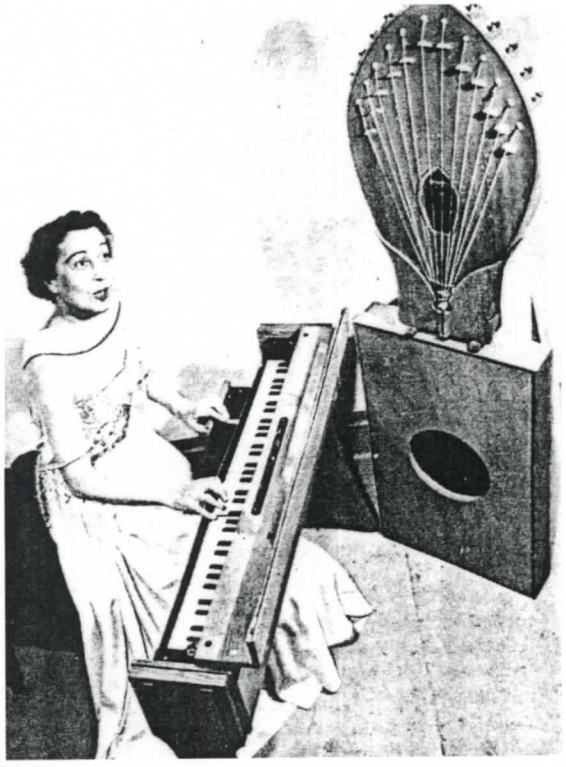

Fig. 47. Ondes with "palme" resonator.

Fig. 48. Ondes without left-hand controller.

Fig. 49. Trautonium.

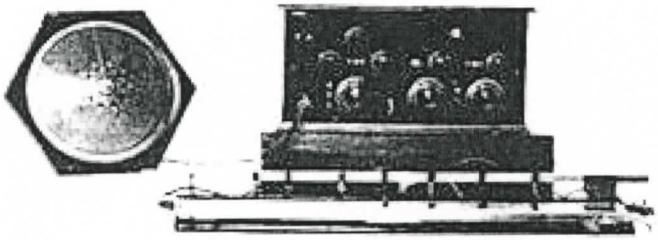

Fig. 50. Trautonium with speaker.

Fig. 51. Paul Hindemith, Oskar Sala, Friedrich Trauwein.

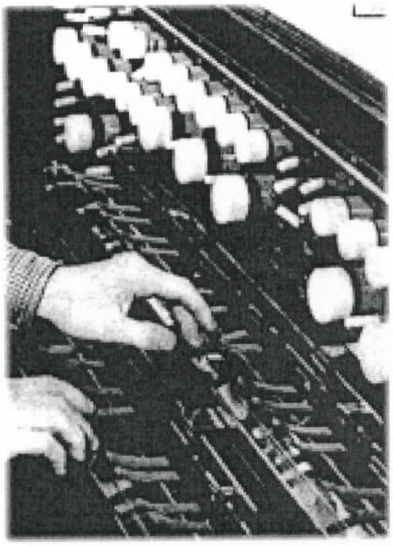

Fig. 52. Close-up of ribbon controllers.

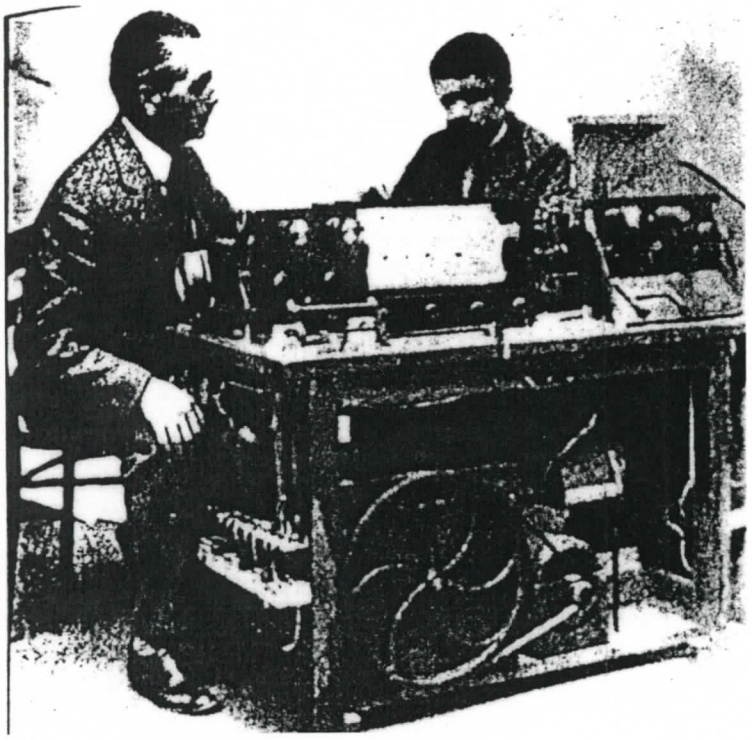

Fig. 53. Armand Givelet demonstrating the Givelet, ca. 1929.

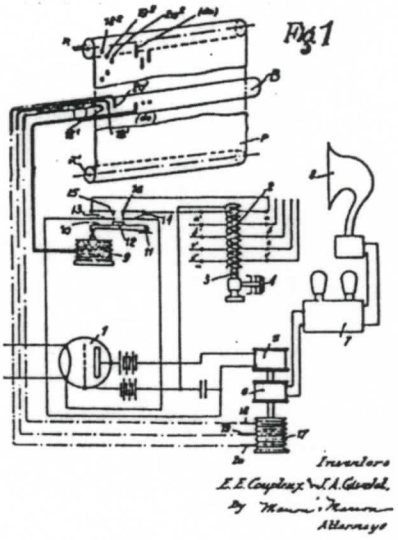

Fig. 54. Schematic of the Givelet.

Fig. 55. Givelet playing L'Orgue des Ondes.

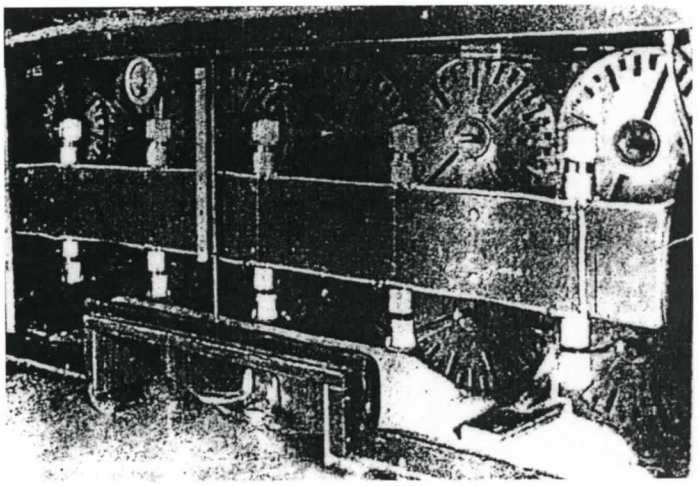

Fig. 56. Organ tone wheels, ca. 1930.

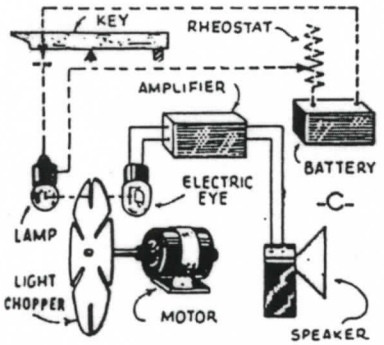

Fig. 57. Schematic for tone wheel organ.

Fig. 58. Dudley's Vocoder, 1939.

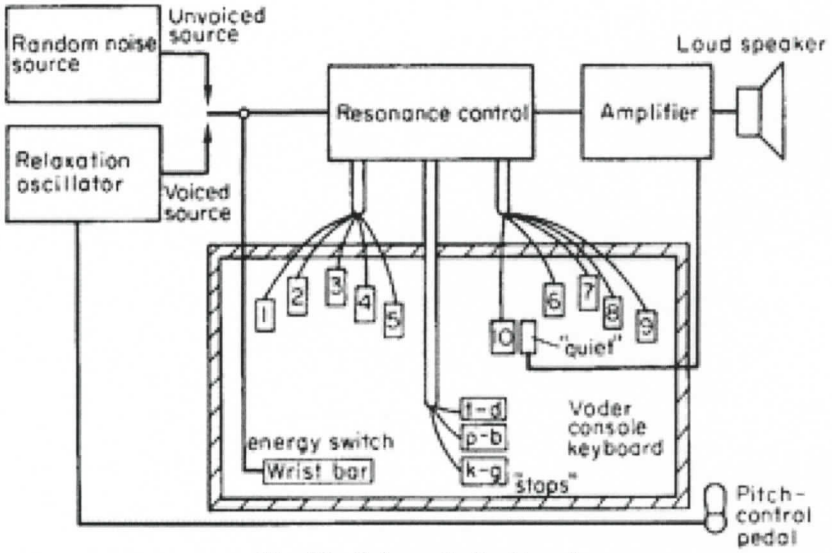

Fig. 59. Schematic for Vocoder.

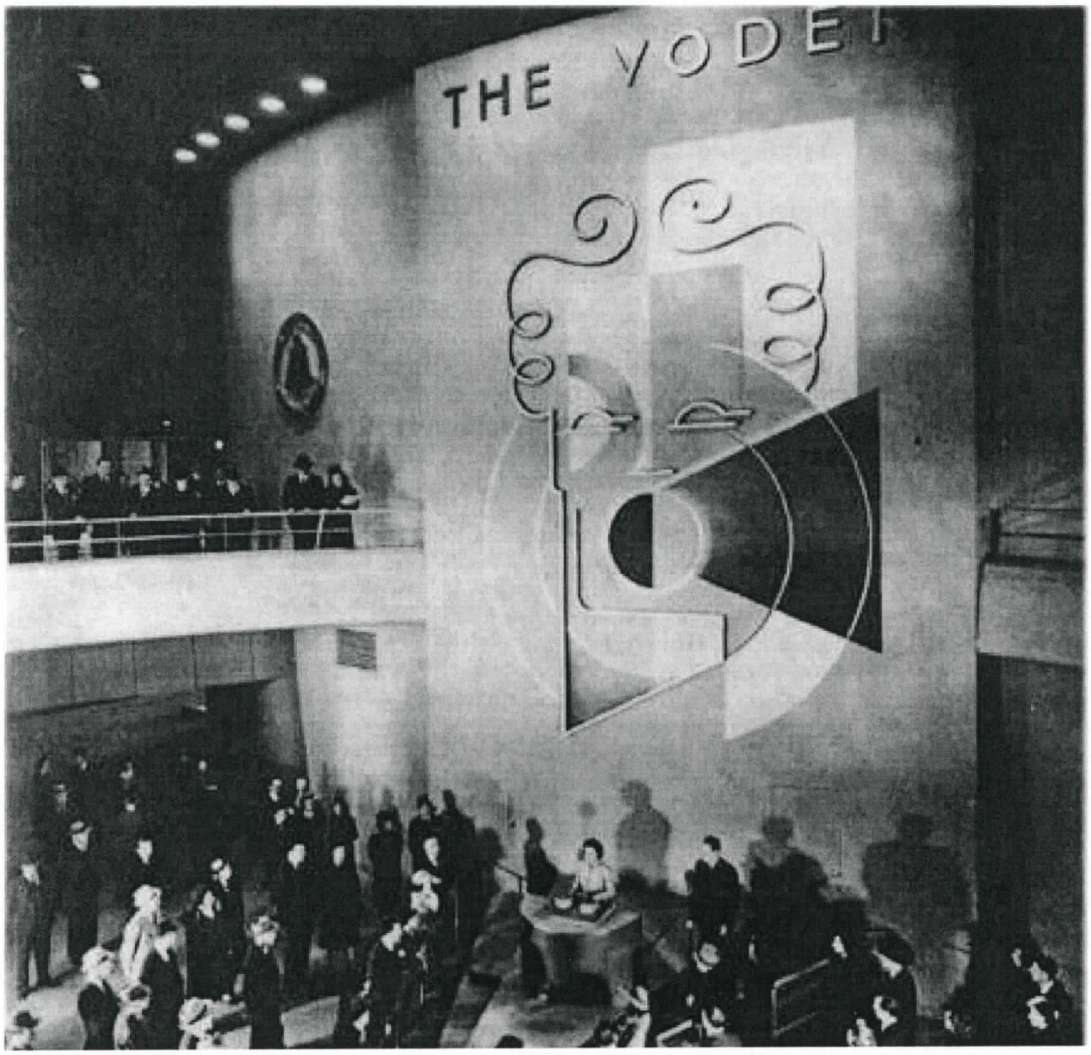

Fig. 60. Public demonstration of Vocoder.

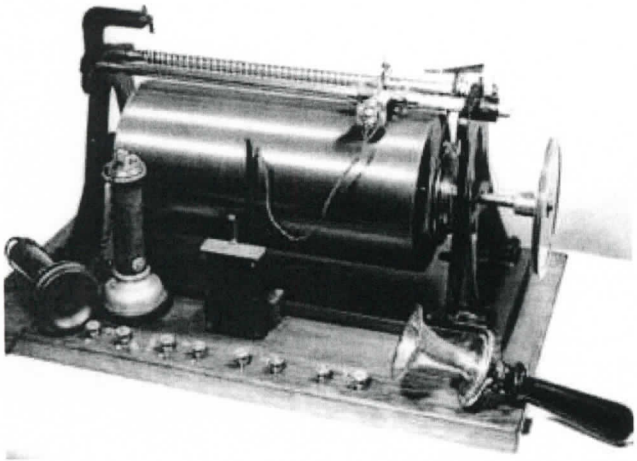

Fig. 61. Vladimer Poulsen's original Telegraphone, 1898.

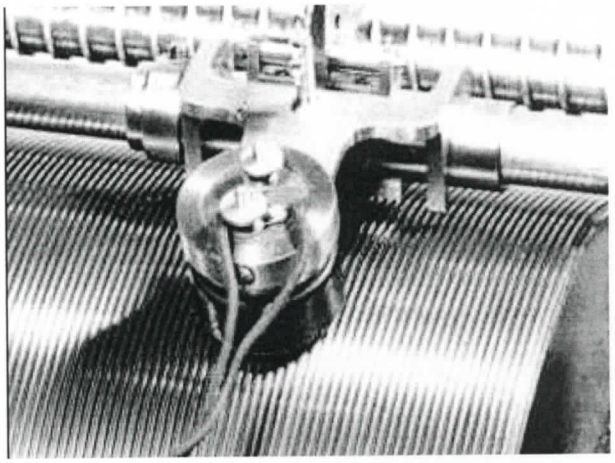

Fig. 62. Recording mechanism of Telegraphone.

Fig. 63. Telegraphone in 1900.

Fig. 64. AEG magnetic tape recorder, ca. 1935.

Fig. 65. Studer 4-track recorder used for Beatles Sgt. Peppers Lonely Hearts Club Band, 1967.

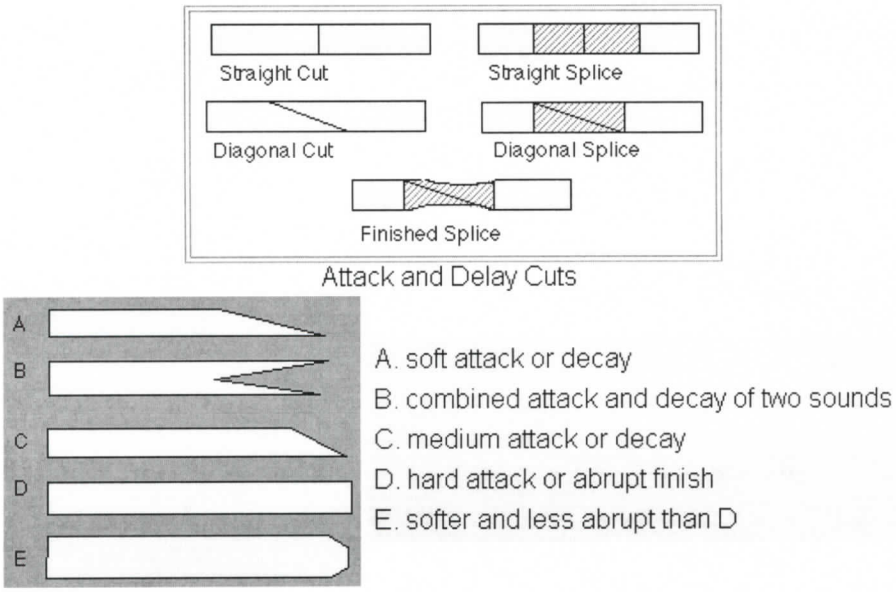

Fig. 66. Tape splicing examples.

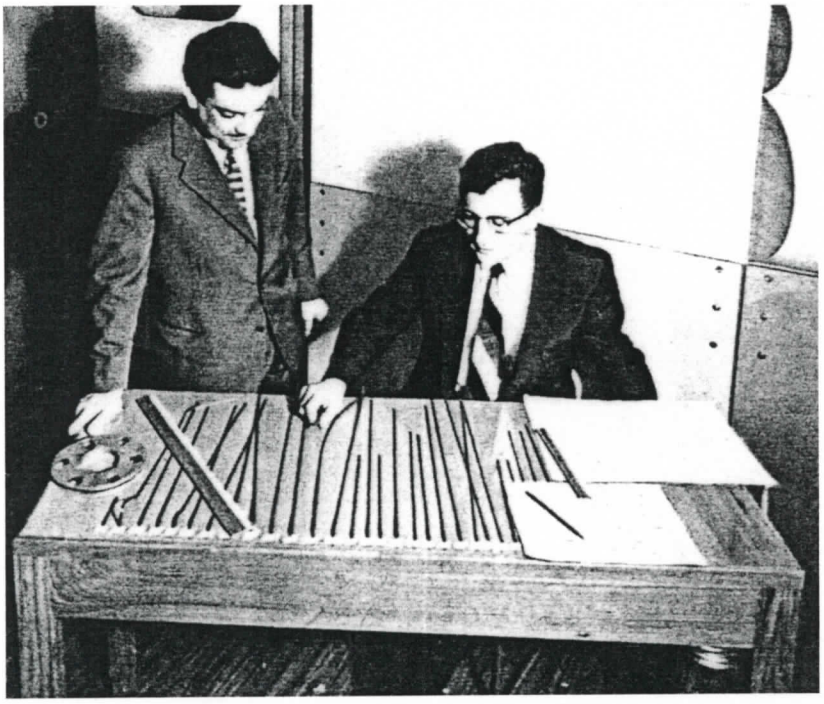

Fig. 67. Bruno Maderna and Luciano Berio.

Fig. 68. Pierre Schaeffer.

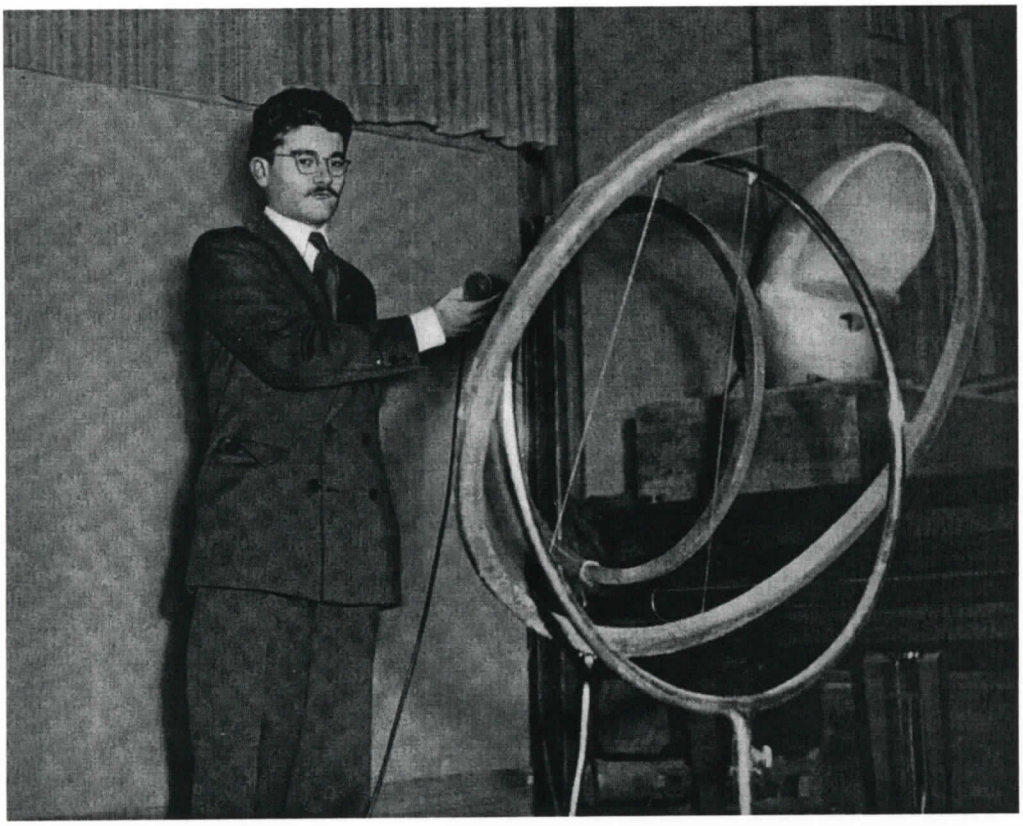

Fig. 69. Pierre Henry.

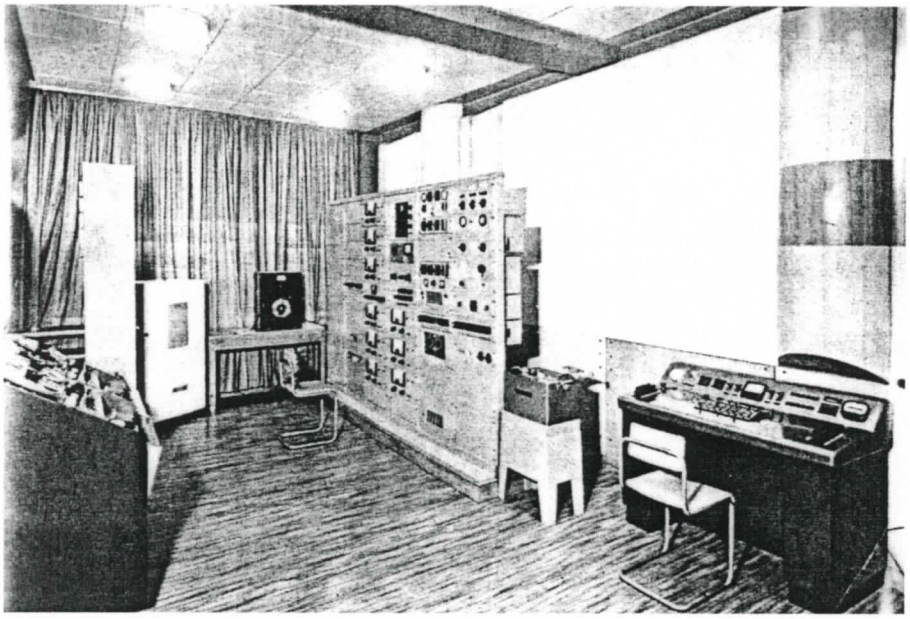

Fig. 70. RAI Studios, Milan.

Fig. 71. WDR Studio, Cologne.

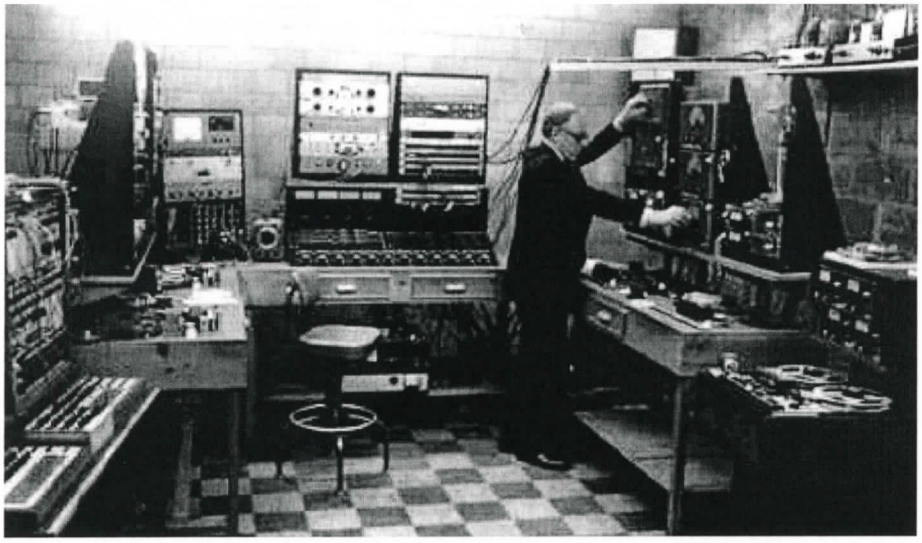

Fig. 72. Columbia-Princeton Studios, New York, with Otto Luening.

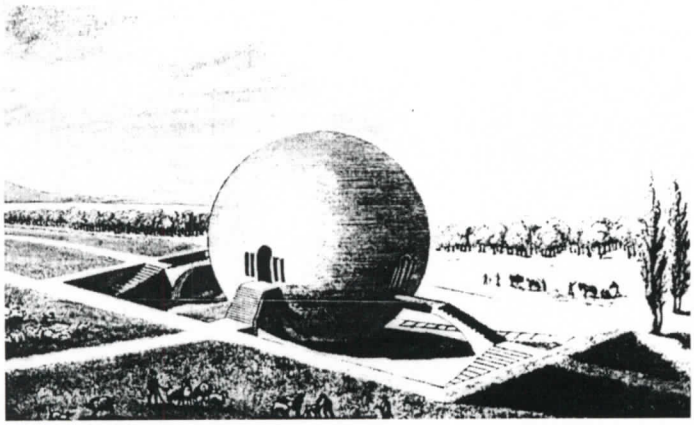

Fig. 73. Architect C.N. Ledoux's building, ca. 1770.

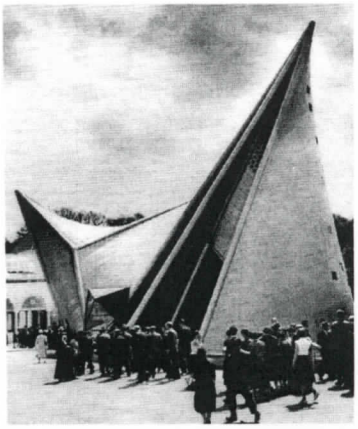

Fig. 74. Architect Le Corbusier's Philips Pavillion, 1958.

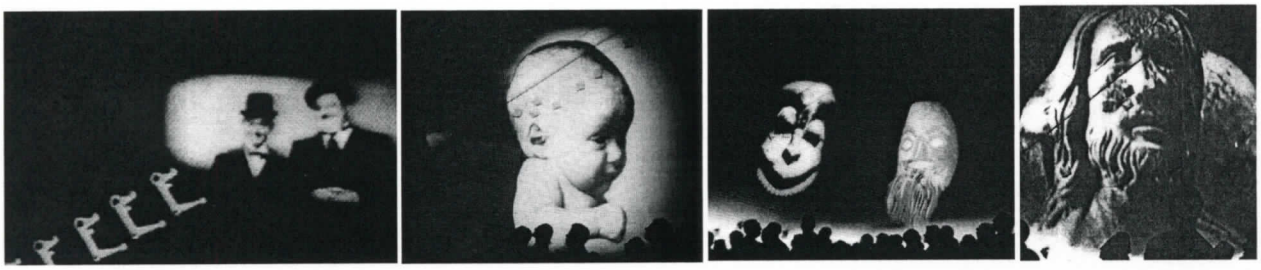

Fig. 75. Projected images in Poeme Electronique.

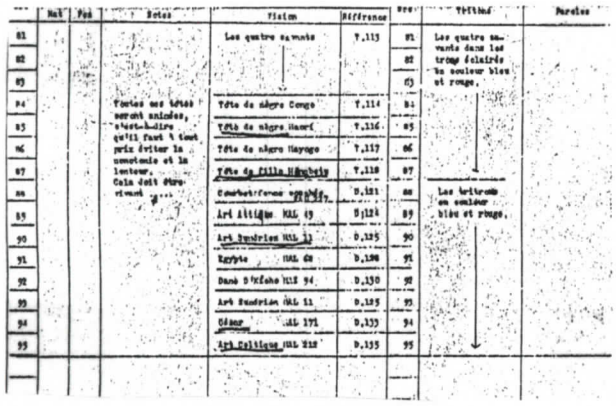

Fig. 76. Control track score.

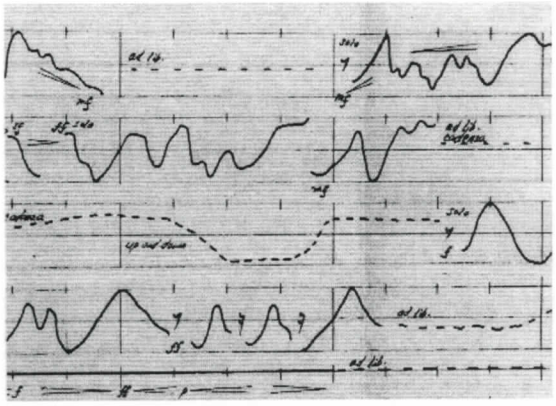

Fig. 77. Musical score.

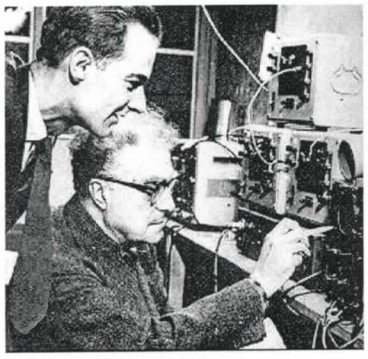

Fig. 78. Varese demonstrating equipment.

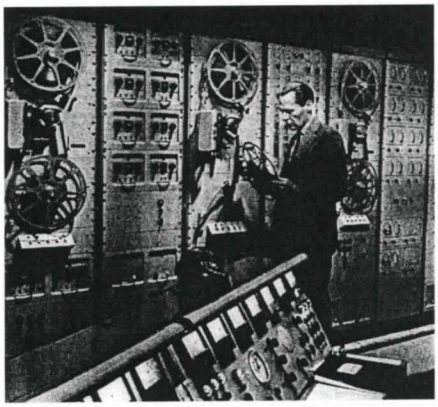

Fig. 79. Philips Pavillion control room.

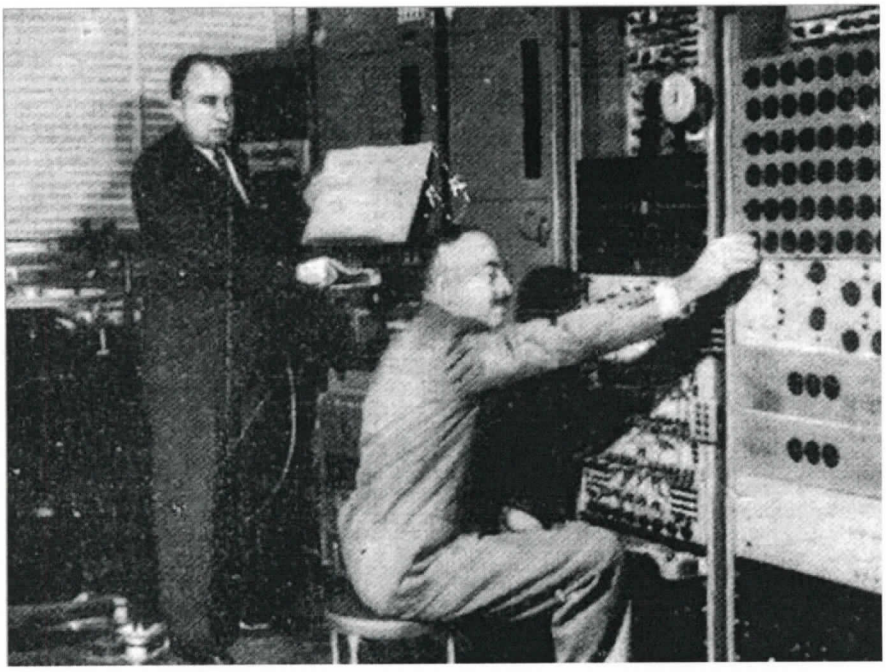

Fig. 80. Harry Olsen and Herbert Belar.

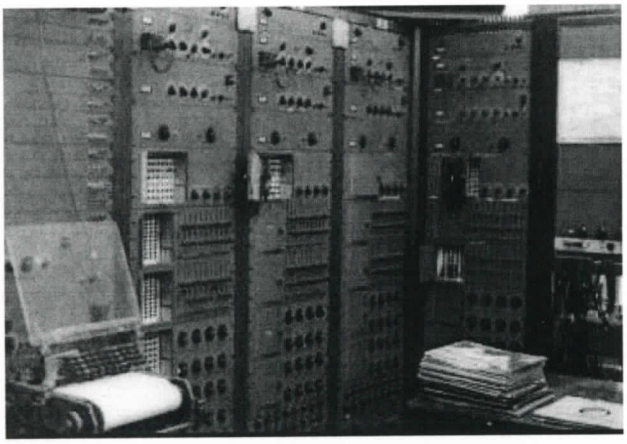

Fig. 81. RCA Mark II Synthesizer.

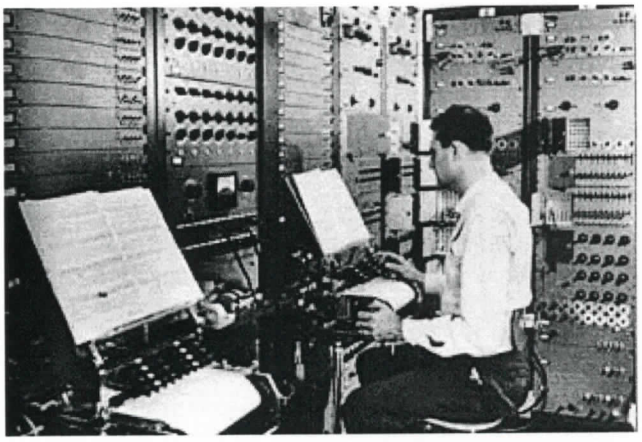

Fig. 82. Unidentified composer working on synthesizer.

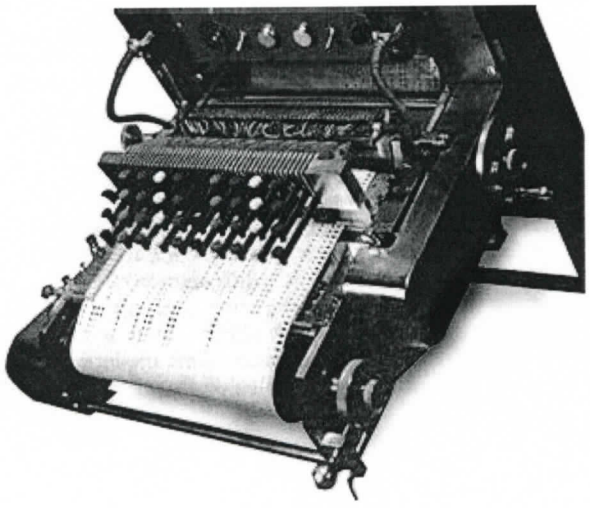

Fig. 83. Paper-roll mechanism.

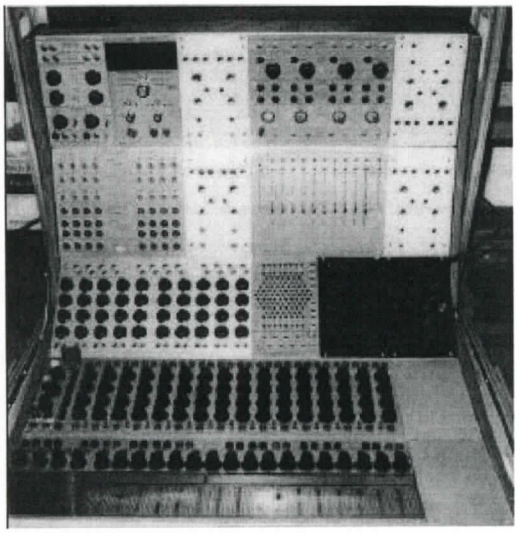

Fig. 84. Buchla 100.

Fig. 85. Buchla 200.

Fig. 86. Unveiling of Buchla 200 in Buchla's studio.

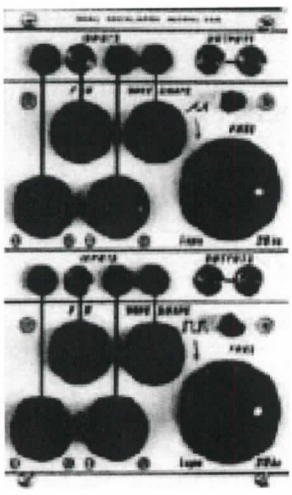

Fig. 87. Dual voltage-controlled oscillator.

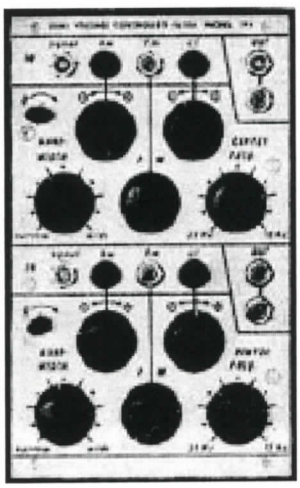

Fig. 88. Dual voltage-controlled filter.

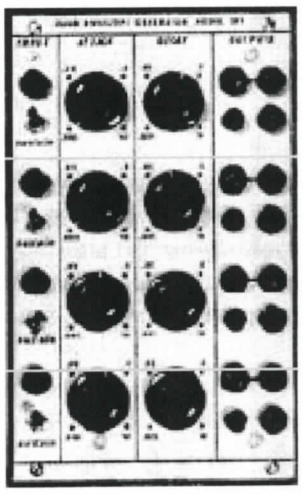

Fig. 89. Quad voltage-controlled oscillator.

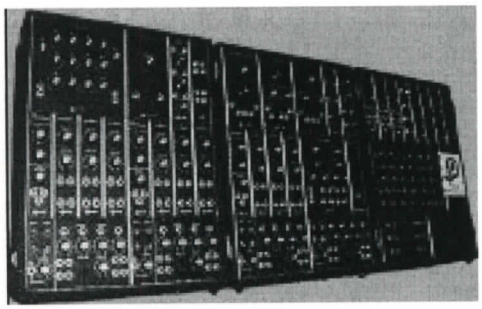

Fig. 90. Moog IIIP.

Fig. 91. Moog IIIC.

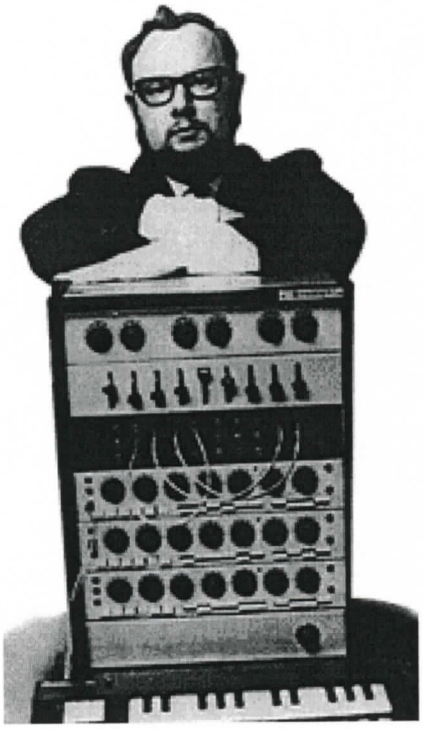

Fig. 92. John Eaton with Synket.

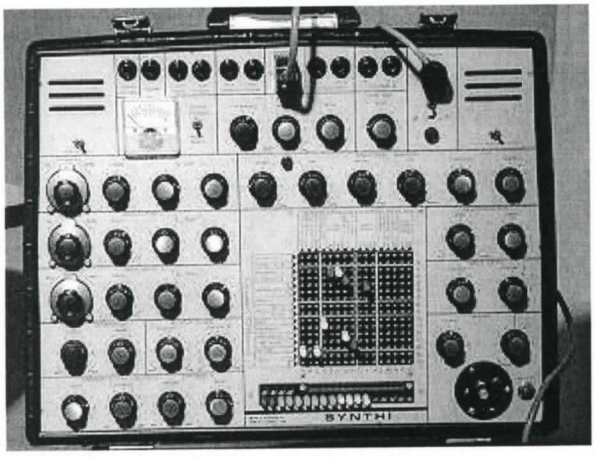

Fig. 93. EMS Synthi.

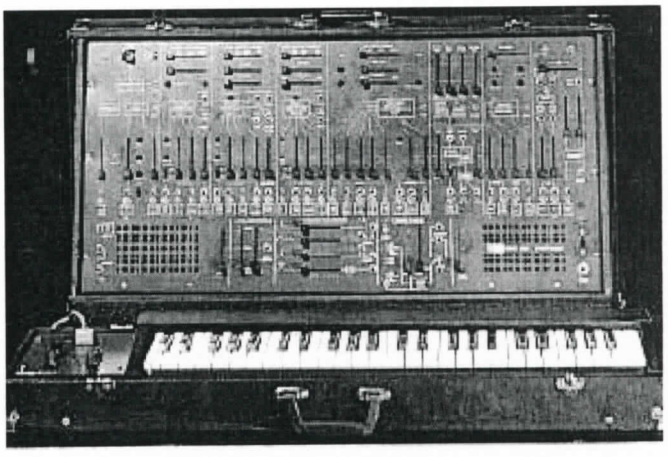

Fig. 94. Arp 2600.

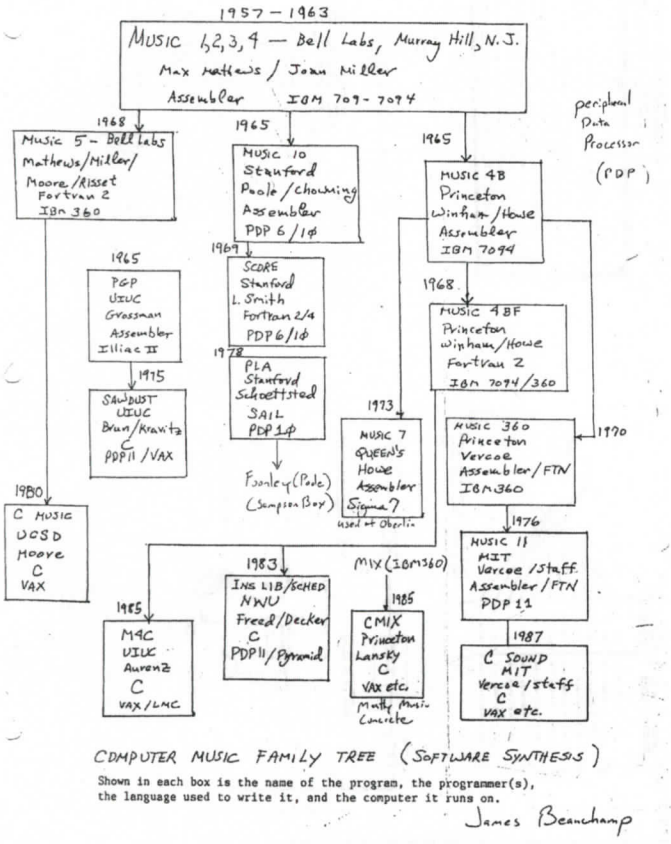

Fig. 95. Music-N Family Tree.

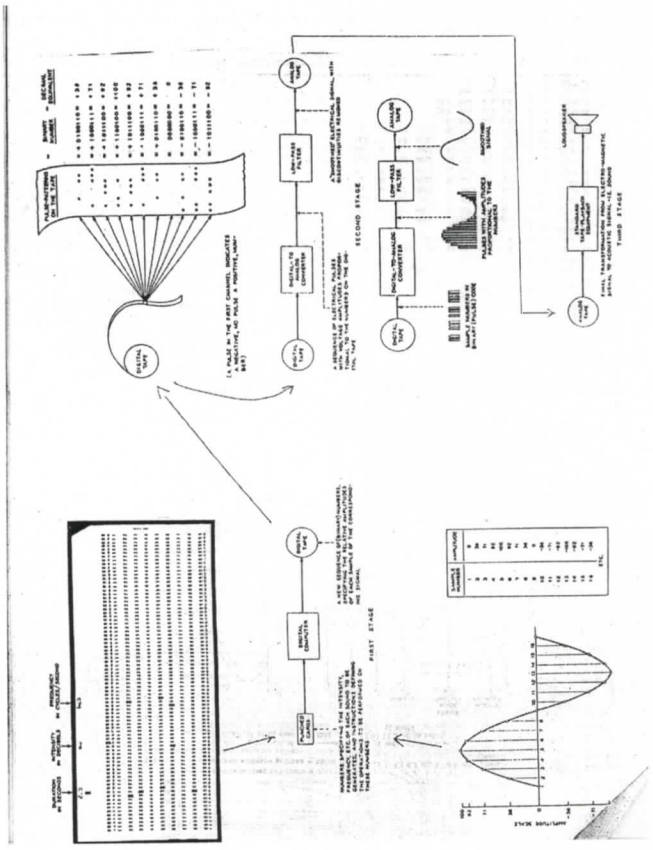

Fig. 96. Music-N work flowchart.

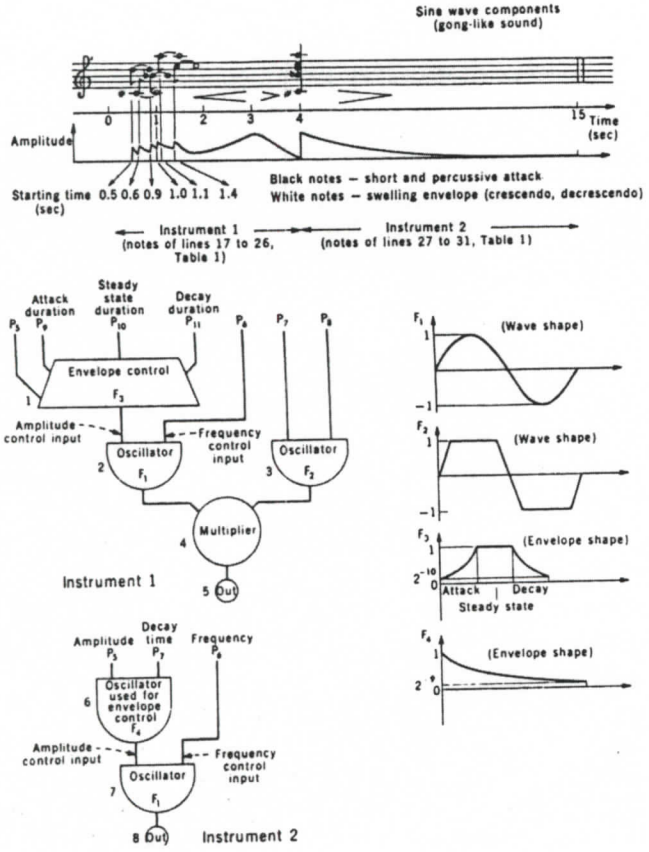

Fig. 97. Music-N "instrument."

```
 1 INS   0   1;
 2 ENV   P5   F3   B3   P9   P10   P11   P30;
 3 OSC   B3   P6   B3   F1   P29;
 4 OSC   P7   P8   B4   F2   P28;
 5 MLT   B3   B4   B3;
 6 OUT   B3   B1;
 7 END;
 8 INS   0   2;
 9 OSC   P5   P7   B3   F4   P30;
10 OSC   B3   P6   B3   F1   P29;
11 OUT   B3   B1;
12 END;
13 GEN   0   2   1    1    1;
14 GEN   0   3   2    0    10 10   10   10   10   0    -10 -10 -10 -10 -10
15 GEN   0   6   3   10    1  1   10;
16 GEN   0   7   4   -9;
17 NOT   .5  1    .6   18   424 18   1000   .01   0    .59;
18 NOT   .6  1    .6   18   727 18   1000   .01   0    .59;
19 NOT   .9  1   3.6   18   424 18   1000  2.3    .1  1.2;
20 NOT   .9  1    .6   18  1545 18   2000   .01   0    .59;
21 NOT  1    1   3.5   18   727 18   1000  2.7    0    .8;
22 NOT  1.1  1    .6   18  1136 18   2000   .01   0    .59;
23 NOT  1.3  1   3.2   18  1545 18   2000  1.9    .1  1.2;
24 NOT  1.4  1    .6   18  1352 18   2000   .01   0    .59;
25 NOT  1.5  1   3     18  1136 18   2000  1.9    0   1.1;
26 NOT  1.8  1   2.7   18  1352 18   2000  1.4    .1  1.2;
27 NOT  4    2  10    400   273 10;
28 NOT  4    2   7.5  200   455  7.5;
29 NOT  4    2   4.5  200   576  4.5;
30 NOT  4    2   6.5  150   648  6.5;
31 NOT  4    2   4    150   864  4;
32 TER  15;
```

NØT	Play note
INS	Define instrument
GEN	Generate function
TER	Terminate piece
ØUT	Monophonic output
ØSC	Oscillator
ENV	Envelope generator
MLT	Multiplier

Fig. 98. Music-N "score."