

The Electronic Century

PART I:

BEGINNINGS

BY
JOEL CHADABE

*The
early years
of electronic
musical
instruments
set the tone
for a century.*

▶ As we enter the 21st century, electronic music is fast approaching its 100th anniversary. This is a good time to look at our roots and get to know how we came to be where we are. This is the first in a series of four articles in which *EM* explores the instruments, artistic ideas, business concepts, musicians and entrepreneurs, and technical breakthroughs of the century—from the first technological achievements to the synthesizers of tomorrow.

The focus throughout the series is on the technologies that have been used by musicians to expand on the resources available in traditional, acoustic instruments. Where appropriate, each article will also document important musical compositions that have employed these technologies. There's a rich and deep tradition to uncover, so let's begin our journey!

When did electronic music start? It's a question often asked. Was it in 1759, in France, when Jean-Baptiste de La Borde built the Clavecin Electrique, a keyboard instrument that employed static electrical charges to cause small metal clappers to hit bells? Was it in 1874, in the United States, when Elisha Gray invented the Musical Telegraph? In my view, these one-of-a-kind experimental devices, and many others that were built during the 19th century, were merely setting the stage for instruments to come.

The answer, then, it is widely agreed, is that electronic music began at the turn of the 20th century.



The Telharmonium

06

1920



Leon
Theremin

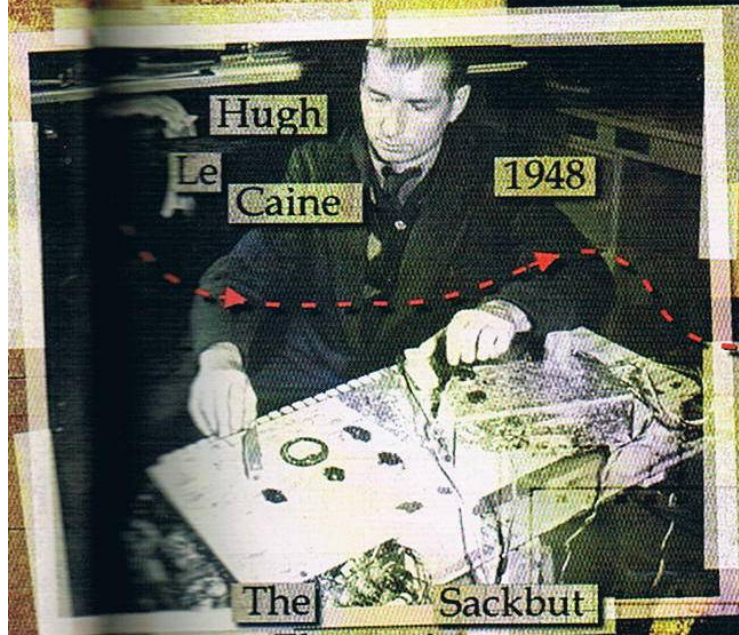


1928

The Martenot



1928 The
Trautonium



Hugh
Le
Caine

1948

The Sackbut
Electronic



RCA
Mark II

1957

Milton
Babbitt

ILLUSTRATION BY TERRY MIERA

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THADDEUS CAHILL

As the 19th century came to a close, electricity was not yet widely available. Automobiles were rare. Telephone companies were just beginning to lay their cables up and down city streets, and Thaddeus Cahill, a lawyer and entrepreneur in Washington, D.C., had an idea.

Cahill's idea was to build an electronic musical instrument and use it to broadcast music through telephone lines into homes, restaurants, and hotels. In an age when mass musical media such as tapes and discs did not exist, Cahill's Telharmonium was viewed by many as a major innovation in the distribution of music. (See the sidebar "For Your Reading and Viewing Pleasure.")

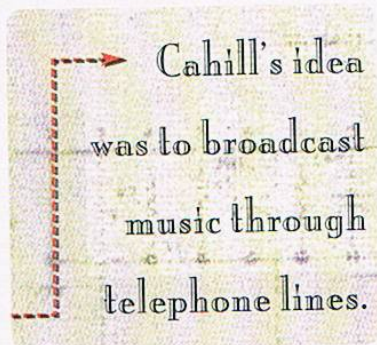
Events unfolded quickly. In 1897, Cahill was granted his first patent for "The Art of and Apparatus for Generating and Distributing Music Electronically." In 1898, he began to build the first version of the instrument that would later be called the Telharmonium. Cahill found financial backers in 1901, and the New England Electric Music Company was formed. In 1902, the company leased factory space in Holyoke, Massachusetts, and Cahill began to build an improved version of the Telharmonium. In 1905, the New England Electric Music Company signed an agreement with the New York Telephone Company to lay special cables for the transmission of Telharmonium music throughout New York City.

OPENING NIGHT

In 1906, the Telharmonium was dismantled and transported to New York City, where it was reassembled in the newly established Telharmonic Hall at 39th Street and Broadway (see Fig. 1). The instrument weighed approximately 200 tons and had to be transported from Holyoke in more than 12 railway boxcars.

The Telharmonium was played by two performers seated at a two-keyboard console that was installed on the ground floor. The sound-generating

method was additive synthesis, accomplished by alternating-current dynamos, which were installed in the basement along with the switching system, transformers, and other electrical devices. Sine waves were generated by toothed wheels rotating near inductor coils. As a tooth on the turning wheel came closer to the coil, the voltage in the coil would rise, and then the voltage would dip as a gap between teeth passed the coil. Different wheels produced different harmonics, as the number of teeth on a wheel determined the frequency of the resulting waveform.



Telharmonic Hall was opened to the public and press on September 26, 1906. The first broadcast to a restaurant was on November 9, 1906, to the Cafe Martin, on 26th Street between Fifth Avenue and Broadway. At the restaurant, romantic couples seated at tables were treated to Telharmonic sounds through special loudspeakers peering through plants on their tables. It was a festive moment.

But then the troubles began. The broadcasts of Telharmonically generated Rossini overtures, through the cables laid by the New York Telephone Company, interfered with telephone conversations. This led the telephone company to terminate its agreement to lay cables, and a crisis ensued. Cahill's business colleagues reacted by forming the New York Cahill Telharmonic Company and seeking a franchise from New York City to

lay its own cables. But in the meantime, there were no cables. And without cables, no sounds were broadcast. Without sounds, there were no subscribers to the service. Without subscribers, there was no business. The doors at Telharmonic Hall were soon closed.

Cahill remained undaunted and determined and would not admit defeat. He shipped the Telharmonium back to Holyoke, took control of the company, and made a valiant attempt at a comeback with a third and improved model. Finally, in 1911, the franchise to lay cables was granted. Unfortunately, by then it was too late. The time for the Telharmonium had passed. Other instruments and technologies were capturing the public's attention, and the Telharmonium was no longer newsworthy. In 1914, the New York Cahill Telharmonic Company declared bankruptcy.

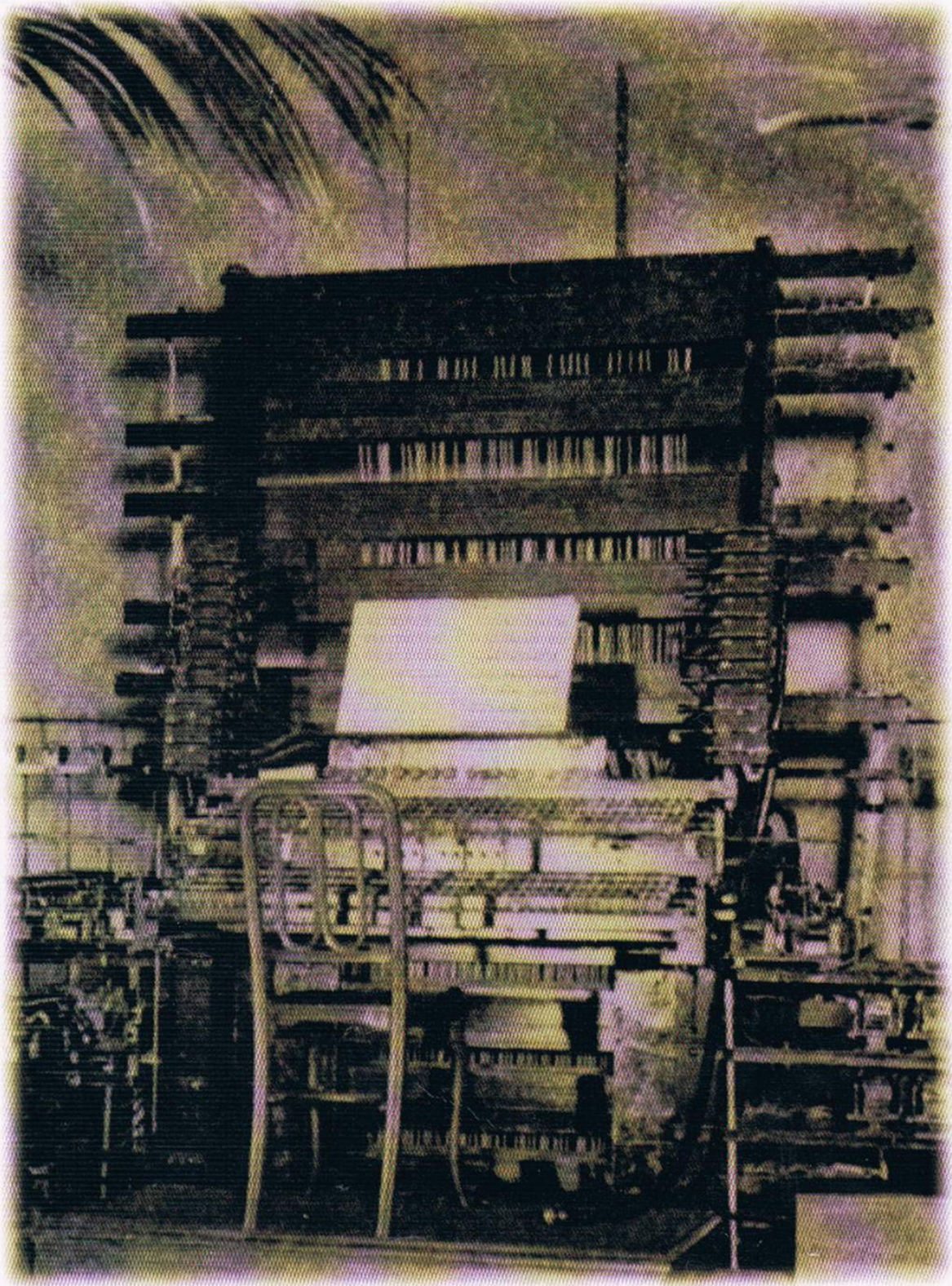
It was a sad ending. As both engineer and businessman, Cahill had taken a visionary idea to its limit. He failed because his idea required a technology that was simply not available at the time. The technology did exist, however, for the next major electronic musical instrument, invented just a few years later.

THE MAGICAL INSTRUMENT

Although the theremin has never sold in huge numbers to a mass market, it was by all other measures a resounding success. The story of the theremin and its inventor, Leon Theremin, is a tale of political intrigue as well as musical invention.

In 1920, while still an engineering student in Moscow, Theremin built a very unusual instrument and demonstrated it to his fellow students. It was a box with two antennas, one extending vertically from the top, the other projecting horizontally from the side (see Fig. 2). Theremin played his instrument by moving his hands in the air. He moved one hand relative to the vertical antenna to control pitch, and the other hand relative to the horizontal antenna to control volume.

At that time, the Russian government was making a major effort to introduce electricity throughout Russia. Since Theremin's instrument was electronic, it attracted attention. After presenting his instrument before a group of Soviet scientists in Moscow in 1921, Theremin was invited to demonstrate it



COURTESY ELECTRONIC MUSIC FOUNDATION

FIG. 1: Thaddeus Cahill's Telharmonium was installed in New York in 1906. It was transported from its home in Massachusetts in more than a dozen railway boxcars.

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for Lenin. He carried his instrument to Communist leader Vladimir Lenin's office and performed. Lenin then played it himself. As Theremin later recalled, Lenin had a musical ear.

It is reasonable to assume that the meeting in Lenin's office was the beginning of Theremin's involvement as an ancillary contact for the NKVD, the precursor of the KGB. Theremin was given a travel grant to demonstrate his instrument throughout Russia. In 1927, he received support in a very suc-

cessful concert tour throughout Europe. When he arrived in New York in December, Theremin was welcomed as a celebrity.

Theremin stayed in New York for ten eventful years. He met Clara Rockmore, who became the first and best-known theremin performer. RCA produced theremins for a short time. Leon Theremin found patrons, built instruments himself, performed, worked with others in performance, and married. But he carried out un-

satisfactorily his tasks for the NKVD.

In 1938, probably judging that he would be of more use in Moscow than in New York, the NKVD kidnapped Theremin and returned him to Russia. During World War II, Theremin worked on radar. In 1947, after the war, he developed a bugging device for what had become the KGB and, as a reward for his work, received the Stalin prize of 100,000 rubles. In 1991, at the age of 95, he returned to the United States for a brief visit, during which he played a concert at Stanford University and met with old friends. Leon Theremin died in 1993.

SLIDING PITCHES

Theremin wasn't alone in having the idea of a keyboardless device that could play pitches between the normal notes of a scale. If the theremin had been invented in the MIDI era, it would have been called an alternate controller. And although many keyboard instruments were built during Theremin's early years (including organs of many different types, shapes, and sizes), some of the most interesting instruments, among them the Trautonium and Ondes Martenot, were conceived without a keyboard in mind.

The Trautonium, developed in 1928 by Friedrich Trautwein in Berlin, was something like a horizontal metal violin, played by pressing a wire against a metal bar much as a violin string is pressed against a fingerboard. A second metal bar was used to control the volume and articulation of each note, and timbre was chosen by manipulating an independent bank of switches. Oskar Sala, who studied with Trautwein in Berlin, developed a two-manual version of the original instrument and called it the *Mixturtrautonium*. Sala was particularly interested in film music and used the device to compose music and sound effects for films, including some sound effects for Alfred Hitchcock's *The Birds*.

Maurice Martenot developed the Ondes Martenot in 1928 in Paris. In the first version of the instrument, Martenot played it by pulling a ribbon that was attached to a ring placed on his finger, so that as he pulled the ribbon, the pitch changed in a continuous glissando. While he pulled the ribbon, he used his left hand to vary volume and choose timbre settings from a bank of switches. Responding

FOR YOUR READING AND VIEWING PLEASURE

There are several excellent resources that you should consider if you'd like more information on the first era of electronic music technology. Here are some book recommendations:

Electric Sound (Prentice Hall, 1996), by Joel Chadabe, discusses developments throughout the 20th century, with excellent coverage of the first 50 years.

Magic Music from the Telharmonium (Scarecrow Press, 1995), by Reynold Weidenaar, is the most thorough book ever published on this amazing instrument; check out the video as well.

Sackbut Blues (Canadian National Museum of Science and Technology, 1989), by Gayle Young, chronicles the life and work of Hugh Le Caine, a fascinating innovator.

To supplement your reading, here are a few recommended recordings:

The Art of the Theremin (Delos) features Clara Rockmore playing transcriptions of music by Rachmaninoff, Saint-Saëns, Stravinsky, and others.

Oskar Sala: Synthetische Mixturen (Erdenklang) includes compositions for the Trautonium by several composers, including Paul Hindemith.

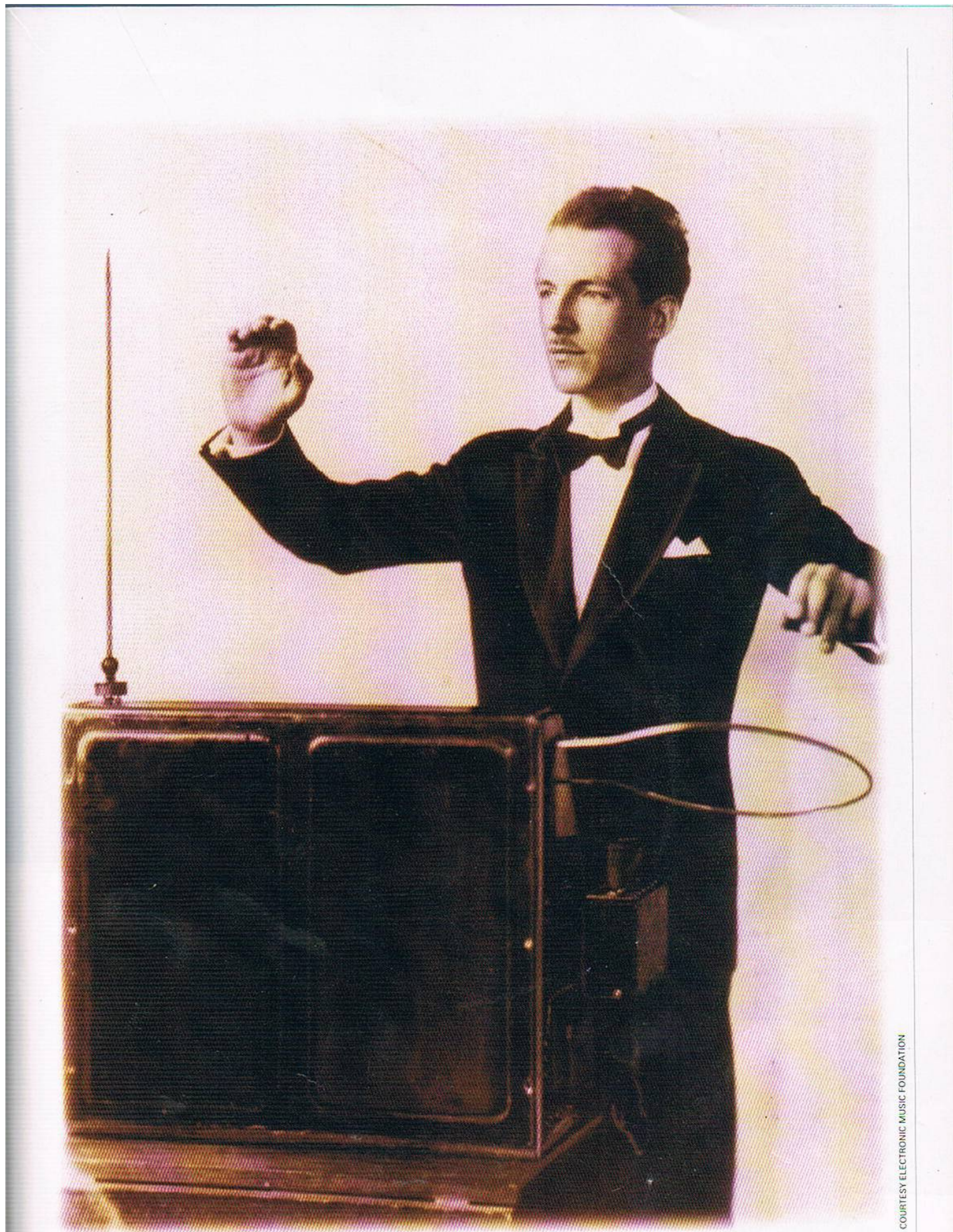
Les Ondes Musicales (SNE) features Genevieve Grenier performing Debussy, Ravel, Fauré, Gaubert, and Satie on the Ondes Martenot.

Milton Babbitt (CRI) includes the seminal work "Vision and Prayer," featuring Bethany Bevelacqua, soprano, and electronic sounds from the RCA Mark II Electronic Music Synthesizer.

We also recommend this videotape:

Clara Rockmore: The Greatest Theremin Virtuosa (Big Briar), produced by Robert Moog and Big Briar, features theremin performances and demonstrations by Clara Rockmore in an informal conversational environment with Robert Moog and Tom Rhea.

These and other interesting items are available from CDeMUSIC at www.cdemusic.org.



COURTESY ELECTRONIC MUSIC FOUNDATION

FIG. 2: The electronic instrument invented by Leon Theremin can be heard on various recordings even today.

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to requests, he later incorporated a keyboard in the instrument. He also added a knee-operated lever, placed under the keyboard, by which a performer could control continuous timbre change.

Neither Trautwein nor Martenot were businessmen. They were inventors. They designed and built their instruments without market analysis, without plans for mass production, and without a business strategy for public success. The Ondes Martenot, more than the Trautonium, did have buyers, but it was manufactured and purchased on a one-by-one basis.

By 1930, the field of electronic musical instruments seemed to have promise, though yet unfulfilled. One major business had failed, one innovative instrument had become well known, a few instruments had small followings, and many others had come and gone without any general public awareness.

Was there a large market for electronic musical instruments? Yes. And it was about to break open.

COMMERCIAL SUCCESS

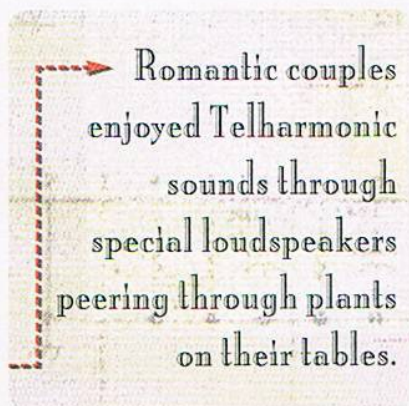
Inventor Laurens Hammond designed and manufactured a variety of instruments: clocks, an automatic shuffling bridge table, and eyeglasses for viewing 3-D film. Then, in 1933, he bought a used piano and began to design an electronic organ.

Unlike Theremin, Trautwein, and Martenot—and the other electronic-instrument inventors who were motivated by the adventure of invention and a fascination with discovering new ways to make music—Hammond was motivated by profit through sales. His goal was to sell organs to a mass market. Like most businesspeople with a similar goal, he approached the problems of design, manufacture, marketing, and sales with a cool-headed eye toward reducing expenses and increasing revenue.

The designs for his organs reflected economy in manufacture. For example, after analyzing concave pedal-

boards in other organs, Hammond leveled the pedalboard in his design and omitted the pedals that were played the least often. The sounds in his organ were generated by additive-synthesis tonewheels that were refinements of the mechanisms that Cahill had used in the Telharmonium.

The Model A organ appeared in June 1935. Hammond's marketing was pervasive and intense, initially aimed at



churches throughout the country. But his organ's distinctive sound was soon found to have just the right quality for jazz and blues—and eventually for rock. Many different models followed, with assorted variations and improvements, to satisfy customers' varied needs. The Hammond B-3, first introduced in 1936, has achieved legendary status in the music world. Especially when paired with a Leslie rotary speaker, the B-3 has brought tears of joy to the eyes of many musicians.

Hammond's organ was a major success. It was everywhere. And it demonstrated the existence of a mass market for electronic instruments. But it was limited in the variety of sounds it could produce. From the perspective of a musical-instrument inventor, there was a lot of work to be done.

THE ELECTRONIC SACKBUT

During World War II, Hugh Le Caine worked on microwave transmission at

the Canadian National Research Council in Ottawa. In a more relaxed period following the war, he pursued a secret life. Working at home in the evenings, he was building an electronic musical instrument.

In 1948, Le Caine finished a working prototype of what he called the "Electronic Sackbut," a precursor to the voltage-controlled synthesizers to come in the 1960s (see Fig. 3). The Sackbut was capable of great performance nuance, with keys that were sensitive to sideways pressure to change pitch. One note could slide into another, vibrato could be performed by wiggling a finger side to side, or notes could be bent as far as an octave away from the basic pitch. Vertical pressure on a key controlled volume such that gradual attacks could be made. Even more interesting, Le Caine added mechanisms that introduced irregularities into the tones, such as breath sounds, buzzing, or raspiness, to enhance what he called the "monotonous purity" of electronic tones.

Following a public presentation of the Sackbut and many lectures and demonstrations, Canada's National Research Council established a studio for Le Caine. The studio enabled him to develop electronic musical instruments for manufacture by Canadian companies. This was an affirmation that an electronic-music market truly existed and that this market was beginning to open up.

THE RCA SYNTHESIZER

The next major electronic musical device to come along focused on the ability to make any sound. RCA's concept was to develop an instrument that could substitute for a studio orchestra. The RCA Mark II Electronic Music Synthesizer was a step in that direction, built by Harry Olson and Herbert Belar at RCA's Sarnoff Laboratories in Princeton, New Jersey, and finished in 1957.

The Mark II contained 750 vacuum tubes. It covered an entire wall of a room, horizontally and vertically. It was, in fact, a punched-paper-tape reader that controlled an analog synthesizer. Information was input by using a typewriterlike device to punch holes in a paper roll. The paper roll was then passed through a reader and read by contacts between metal brushes that touched through the holes,



COURTESY ELECTRONIC MUSIC FOUNDATION

FIG. 3: Hugh Le Caine with his Electronic Sackbut in 1954. Despite its technological innovation, it never reached a mass market.



COURTESY ELECTRONIC MUSIC FOUNDATION

FIG. 4: Renowned classical composer Milton Babbitt mastered the complex workings of the RCA Mark II synthesizer to produce some of the most significant electro-acoustic works of this century.

1920 *The Electronic Century*

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thereby closing switches and causing the appropriate machine processes to start or stop.

Considering the time at which it was built, the Mark II was powerful. But its user interface was a nightmare. In fact, it was so difficult to operate that it had only one primary user. Acquired by the Columbia-Princeton Electronic Music Center in 1959, it was used almost exclusively by Milton Babbitt, composer and professor at Princeton University (see Fig. 4). (Babbitt later remarked, "I've got the patience of Job.") Although the Mark II was seriously damaged by thieves who broke into the studio in 1976, it still exists in the Columbia University Computer Music Center.

THE EARLY DAYS

In summary, the history of electronic music during the first part of the 20th century comprises the development of the early instruments more than the evolution of electronic musical art. These instruments, by and large, were not associated with innovative musical ideas. Rather, they were continuations of a long lineage of instrument invention, and they were generally intended for playing the same music that was played on traditional instruments. Cahill, for example, had set out to provide mass distribution of music that would include many musical styles, from Rossini overtures to popular music to church hymns.

Most of the early instruments, including the Telharmonium, did not offer composers a lot of new musical possibilities. They did offer some novel sounds, even if they were often difficult to play, and a few avant garde composers experimented with them. Paul Hindemith, for example, composed a few pieces for the Trautonium. Pierre Boulez and Olivier Messiaen, among other composers, had a passing interest in the Ondes Martenot—in fact, it's worth noting that the Ondes Martenot is still occasionally used by contemporary composers. Le Caine himself experimented with music for the Sackbut,

but his hit number was a performance of the opening to Gershwin's "Rhapsody in Blue." The sounds of the RCA Mark II were documented on a demo LP made by RCA engineers, but the selections, which included Irving Berlin's "Blue Skies," were not exactly musically innovative.

The RCA Mark II was exceptional in that it did offer new musical possibilities. It offered precision of control, the possibility for substantial complexity in rhythm and texture, and a large palette of electronic sounds. These were the qualities that Milton Babbitt found important, and Babbitt's "Philomel" (1963) and "Vision and Prayer" (1964), both for soprano and taped electronic sounds made with the RCA Mark II, are probably the only masterworks created with the early instruments.

In one way or another, all of the early instruments foreshadowed the future. Cahill's business plan for the Telharmonium presaged Muzak. The Trautonium and Ondes Martenot laid the foundations for pitch bending and microtonality. The Electronic Sackbut was the forerunner of the voltage-controlled synthesizer, and the RCA Mark II Synthesizer, with its punched-paper-tape reader, prefigured the software sequencers of the MIDI age.

There was one exception: the theremin. Among the entire first group of electronic musical instruments, the theremin alone remains viable today in its original form. It has been used in music by the Beach Boys, Led Zepelin, and many others, and its sound has provided an eerie background to films by the likes of Alfred Hitchcock. It is now lighter and less expensive than it was at the start, and its mechanisms have otherwise been improved by modern technology. But it does today exactly what it did when Theremin played it in New York in 1927.

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