European Electronic Music Instrument Design*

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This paper is a survey of European electronic musical instruments. Some of the more interesting or well-known examples are described in greater detail.

THE basic European thinking with regard to electronic music instrument concept and design, as compared to the most successful way of creating instruments of this kind in the U. S., is dictated by the different tastes of the people, the different size and type of market, the different buying power and the different ratio of labor *vs* component costs.

Due to the effects of World War II on the European economy, the continuous industrial manufacturing of electronic music instruments started only as late as around 1948. Prior to this time, only pilot runs of a few instruments such as the Telefunken Trautonium and the Siemens Nernst Bechstein Grand were manufactured.

But, as in this country, starting as early as after World War I a remarkable variety of electronic music instruments had been conceived, a few of which were built and shown in public merely as novelties; some of them, however, deserve to be mentioned because of unique design or performance details.

Among these, the Theremin might be the best known one, because it has been shown in many countries. Its deficiencies of tuning instability, due to the heterodyning of radio frequencies, have been very cleverly disguised by the psychological effect of the "magic touch" type of playing upon the viewer.

Evidently, the Theremin stimulated the design of many melody instruments which did not rely upon the "magic touch" but which incorporated more tangible playing means, like the French Onde Martenot, which also has been used in many public performances. The Onde Martenot still provides a gliding scale, rather than playing members with fixed intervals; this also is the case with the German Trautonium, the German-Austrian Hellertion and an earlier version of the Sphaerophon by the German Jorg Mager.

The tone generating system of the Hellertion of Helberger and Lertes comprised a vacuum tube blocking oscillator circuit, the frequency of which was changed by a variable grid bias voltage derived from a ribbon-type potentiometer representing a gliding scale keyboard. By depressing the ribbon at selected points to make it touch a common electrode, the player was able to tune the generator to the desired note.

The Hellertion has been built with a total of four tone generators and correlated manuals, in order to facilitate the playing of harmonies. Naturally, the playing technique, requiring simultaneous proper tuning of four independent pitches was extremely difficult.

The Trautonium, based upon the ideas of the German Trautwein, has essentially been built in two versions, one of them as a very simple single manual instrument with a few formant filters by Telefunken, and the other as a very elaborate dual manual model by the performer O. Sala. The Sala Trautonium comprises two sets of complex tone shaping circuits as well as frequency dividers also capable of creating sub-harmonics other than in octave relationship to the generated note; furthermore, it comprises means to continuously change the timbre by foot controls from one filter to another, and a very good pressure-sensitive loudness control at the manuals. Only single specimens of the Sala Trautonium have been built.

Prior to the time when the Trautonium became famous, the German Mager conceived and obtained a large number of patents on a variety of instruments, including models

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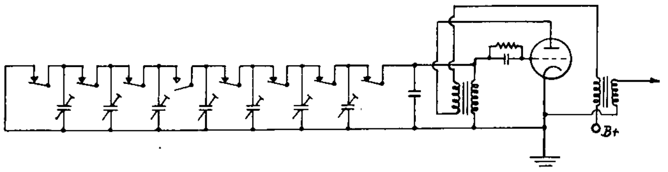

FIG. 1. Tuning circuit for melody-type audio generator of the Mager organ.

with a gliding scale and others with keyboards. The best known Mager instrument, which has been built as a sample, is a three-manual and pedal keyboard organ, with each of the keyboards representing a melody instrument, so that a maximum of four voices could be played. Fig. 1 shows a typical tuning circuit for the type of audio frequency generator employed in this Mager instrument. For achieving various tone colors, Mager did not use audio filters but a variety of loudspeakers with different shapes of diaphragms, horns, and other resonators.

Whereas most inventors were reluctant to propose and build instruments with a large number of tubes, and therefore limited themselves to melody instruments, the French Givelet and Coupleaux built a large organ with hundreds of keyed tube oscillators, the basic design concept of which could be considered to be in the category of the Conn and Allen organs. But for the European market more economic approaches had to be found.

Two interesting approaches to the design of multitone instruments which are not in the organ category are shown by the Siemens Nernst Bechstein Grand, also known as the Neo Bechstein, and the Electrochord by Vierling. The Neo Bechstein was a miniature Grand (also with a built-in radio receiver) with relatively short strings, one for every note, ending at electromagnetic pickups, with a pneumatic action and "micro hammers," and without a sounding board, so that the energy dissipation from the strings was extremely low, which made a very long and organ-like tone sustain possible. Except for the long sustaining tone, the color of which could not be changed, this instrument offered nothing new in contrast to the Electrochord by Vierling (which, incidentally, resembles a Miessner electronic string piano). The Electrochord comprises capacitive pickups at various locations relative to the strings. This is shown in Fig. 2. Depending upon the location of the pickup, some harmonic frequencies of the string will be detected and others not, as demonstrated by the graphs (Figs. 1b, d and f) adjacent to the simplified pictures of the strings with the pickups (Figs. 1a, c and d). By combining and proper phasing of various pickups, including others than presented in Fig. 1, a surprising variety of tone colors may be obtained.

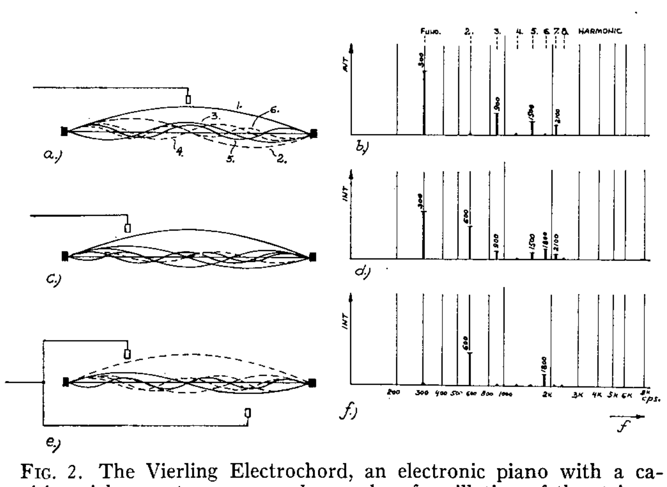

FIG. 2. The Vierling Electrochord, an electronic piano with a capacitive pickup system; a, c, and e, modes of oscillation of the strings; b, d, and f, harmonic analysis with the corresponding pickups.

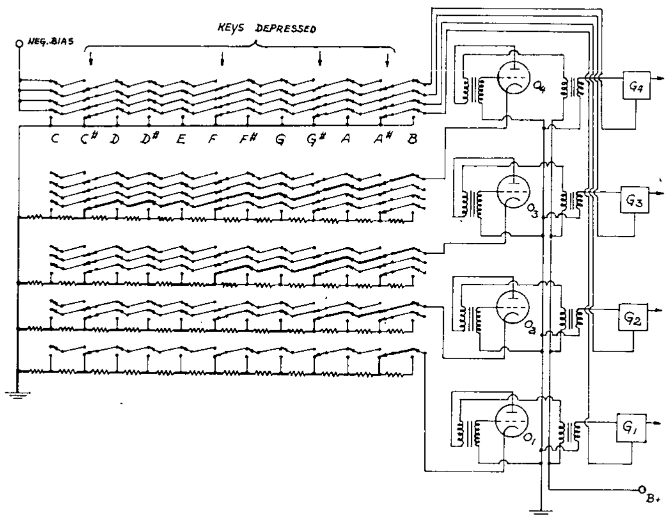

FIG. 3. The oscillators, keying switches and tuning means of the Warbo Formant Organ.

Other approaches for creating multitone instruments include the Welte photoelectric organ and many French patents on photoelectric instruments.

A different and unique approach for a multitone instrument with a minimum of tone generators has been tried by the author in the Warbo Formant Organ (Fig. 3). In this experimentally built instrument, four relaxation-type oscillators were correlated to a 44-note keyboard by a switching system which coordinates the first oscillator O_1 to the highest note, the second oscillator O_2, to the note next to the highest, and so forth. The oscillator outputs were connected to gates (G_1 through G_4), which were opened for the played notes only by an additional switching system. This instrument also comprised envelope control means for percussive tones and two sets of filters, one of which could be correlated at will to one group of voices (for instance, 1st and 3rd) and the other to the remaining ones (for instance, 2nd and 4th).

Although this instrument was capable of producing interesting effects, the stability with the employed tone generating system was not sufficient, and the switching device was too expensive.

At this time, which was in the late thirties, further component developments for reliable multitone instruments were required, and therefore the emphasis was still on melody

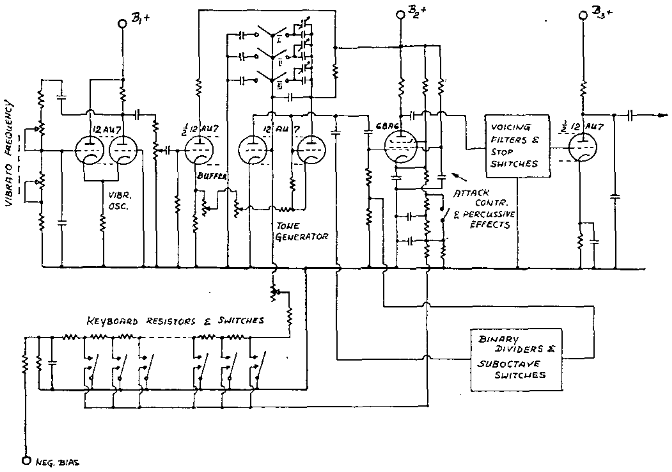

FIG. 4. Simplified schematic diagram of the German version of the Martin Clavioline.

instruments, one of which, the author's Melochord, (a keyboard instrument with a very complex tone and envelope shaping system) has been heard in many public performances and is still being used in the NWDR for creating new sound effects. Another, the Clavioline, which was developed after World War II by the French Constant Martin, is capable of imitating many orchestra instruments by its tone shaping circuits and univibrator tone generating system. It was and still is produced and sold in many countries, including the United States. A simplified schematic diagram of the German Clavioline is shown in Fig. 4.

One of the successful European concepts of multitone electronic instruments has been implemented by the Compton organ in England, which is an organ with rotating tone generators and capacitive pickups.

In Germany, the author created the first models of the AWB organ, which, in contrast to the Compton instrument, was an entirely electronic concept utilizing the principle of tone synthesis, first demonstrated by Cahill and then incorporated in the Hammond organ. In order to apply the principle used by Hammond to derive the various harmonics from the tempered scale, the tone generating system had to be sufficiently stable, the tones produced had to have a relatively low harmonic content and, for the switching concept

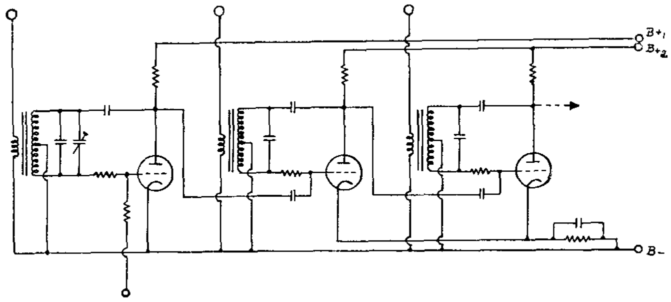

FIG. 5. Master oscillator and two divider stages of the synthesis organ with synchronized Hartley-type oscillators by Bode.

employed, the output impedance had to be low. In order to meet these requirements, a tone generator with synchronized Hartley-type oscillators was developed (Fig. 5).

The AWB organ represented the technical foundation for a line of instruments which is still being manufactured in Germany and sold to other countries in Europe. Some of the Ahlborn, Riegg and Lipp instruments employ the principles which are derived from the AWB instruments.

A portable electronic organ, the Tuttivox, created by the author in 1953, employs Hartley-type master oscillators with frequency dividers of the phase shift oscillator type, one version of which is shown in the schematic diagram of Fig. 6. Another version operates without the buffer stage between the master and the first divider. The outputs of the signal sources are connected with a switching system with normally closed switches (to save space) and through bus bars to the tone filters and other means of expression.

Basically, the Tuttivox offers nothing exciting and it was designed mainly to meet a special demand of the European

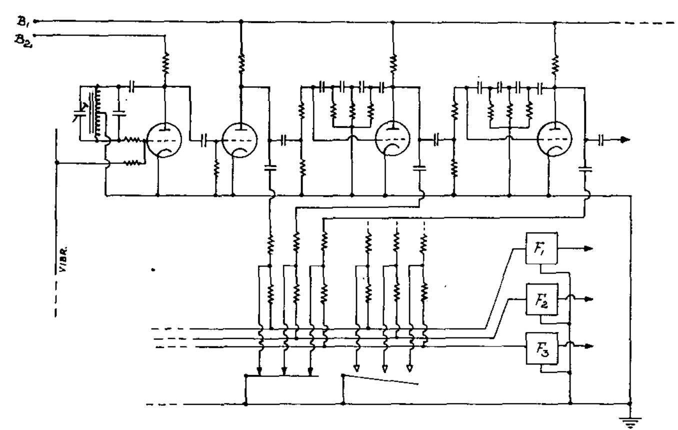

FIG. 6. Master oscillator, buffer and two frequency divider stages plus keying circuitry of the Tuttivox, a German suitcase organ.

market; its main consumers, for a long time, were small dance bands who had to carry their instruments in small cars.

A version of the Tuttivox with a built-in Clavioline is being manufactured and sold under the name Combichord. Also, a large organ utilizing the Tuttivox concept and with the footages and tones of a cathedral organ, the Basilika, is being built by the German Joergensen Company.

A complete line of purely electronic, reed electronic and amplified reed instruments is manufactured by the German Hohner Corporation. These include the Electronium, a melody instrument, created by Seybold, the Hohnerola, a single manual reed electronic organ, the Cembalet, a harpsichord-like instrument with percussive tones, and the Hohner-Vox and Bassophon, representing supplements for the Hohner accordeons.

Along with the tremendous recovery of the European economy in recent years, the electronic music instrument market has gone through considerable changes, and whereas

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just a few years ago only professionals could or had to afford an electronic organ, the home market now starts to open its doors. Thus it has been possible for one manufacturer to increase his output of various types of electronic organs to 200 a month, a fact that five years ago would have seemed impossible. Some of the best-selling instruments in the lower price class, incidentally, remind us very much of U. S. models with sharing oscillators. Generally speaking, no major surprises are being offered from a performance standpoint.

The manufacturing of electronic music instruments in Europe is still very inefficient as compared with U. S. standards, but this can be explained by the different labor *vs* material cost ratio, which justifies hand labor—especially at the comparatively low production output—where otherwise mechanization would be required.

It appears that in spite of the different musical tastes of the public in Europe and in the U. S. future design trends will not differ as drastically, and that the European public (aside from a few exceptions) will accept performance standards in the home and entertainment field which are close to those of domestic instrument design.

THE AUTHOR

Harald Bode was born in Hamburg, Germany and graduated from the University of Hamburg in 1934. He continued his education at the Heinrich Hertz Institute of the Technische Hochschule, Berlin.

After the Institute, Mr. Bode specialized in the field of electronic music and originated a variety of new instrument designs. He then spent six years in the field of military electronics at Loewe-Opta in Berlin where he was in charge of several research groups. After World War II he pioneered in the commercial production of electronic organs in Germany.

Mr. Bode came to the United States in 1954 and joined the Estey Organ Corporation in Brattleboro, Vermont as a chief engineer and later transferred to Torrance, California. Before joining the Wurlitzer Company in 1960, where he is currently employed, Mr. Bode conducted his own research activities in the field of special sound producing devices.

He has written in a variety of publications in the fields of audio and electronic music instrument design and holds a number of patents in the United States, Canada, and in several European countries.