

L. S. Termen: Faustus of the Twentieth Century

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he index to the collected works of V.I. Lenin, founder of the Soviet Republic, contains about 8,000 names. Among these names is that of a celebrity who is still living today: Lev Sergeyevich Termen [1]. At one time, this Soviet inventor was also mentioned in *Who's Who* as an American millionaire.

Termen, who lives today in the epoch of computer synthesizers, projection television and laser shows, belongs to the pleiad of pioneer-inventors of electronic musical instruments, television and light-musical equipment. This is without taking into account some of the 'trifles' he has dealt with in a life that has spanned almost a century, for example, transmitting the sense of touch, working on the remote control of aircraft and investigating such phenomena as gravitational waves, the structure of time and longevity.

I am grateful to fate that we have been friends for nearly 25 years. When I first met him, it was as if I were seeing someone from the next world. Prior to that moment I knew him only through foreign reference books, where, next to his name, were the inevitable bracketed dates (1896–1938). I am glad to be able to share with others the following information about my famous colleague, a truly legendary man (Fig. 1).

Fig. 1. Portrait of L. S. Termen by N. Almeyev, 1980 (Kazan, USSR).



In 1927 an international music show was staged in Frankfurt am Main. It seemed there was nothing new with which the Russian delegation could surprise the satiated European public. This is what the newspaper *Pravda* wrote at the time: "The concerts were a success only during reports held by the Soviet inventor, Professor L. Termen." "Music of the spheres", "an angel's voice", "music of ether"—the German press and that of other countries were full of such rapturous exclamations. The tour of Termen, inventor of 'ether-wave music', was a prolonged one.

And there was indeed cause for surprise. The stage was absolutely empty but for a small box from which a short, glittering aerial protruded. A musician approached the box and started conducting—conducting not the orchestra but the music itself, music born of his hand out of nothing, out of the air! The sound itself was also singular—something in between a human voice and a cello.

The Termenvox (the voice of Termen) is the name by which this astonishing instrument became known (in the United States it was called the Thereminvox and its inventor, Theremin). It is an instrument without keys, without strings. The link between the instrument and the musician's hands is obvious. But this link is nonmaterial, ephemeral, established at a distance. Concert-goers in Dresden, Nuremberg, Hamburg and Munich, and at the Philharmonic in Berlin, Albert Hall in London and the Grand Opera in Paris, were enthusiastically applauding. This is what E. Zozulya, a Soviet writer who witnessed this triumph, wrote:

I had learned from three-column newspaper headlines that the great invention of the engineer Termen was to be demonstrated at the Grand Opera. Such epithets as 'of genius' alternated with the words 'miracle of nature'. What I heard at the Grand Opera is unforgettable. There were moments when the entire huge hall with all its circles uttered exclamations of amazement and delight.

And so it was at every concert in each city. A Berlin newspaper carried the following: "In the three months of

ABSTRACT

The author narrates the story of L. S. Termen, the Soviet inventor who created the world's first electronic musical instrument. Details about Termen's life are given, and his inventions in various fields of technology, primarily in electronic music, are discussed. The author touches briefly on Termen's life in the United States and offers readers less well known material about the inventor's later life, many aspects of which have remained inaccessible until recently.



Fig. 2. Termen (on far right) in 1917.

his guest performances here, Lev Termen outshone even Lev Trotsky by making 'world revolution' in music." Among the numerous wonders of our electronic age, this was one of the most beautiful. Up to the present day, even if Termen performs on a stage that has the most powerful modern synthesizers, the public regards with reverence the emergence of 'Termen's voice'. This is how it all started.

CHRONOLOGY

1910

The gymnasium pupil Lev Termen, who had already astonished his classmates with his self-made observatory (he sub-

sequently even discovered an asteroid), spoke to them about the properties of high-frequency currents. He illustrated his talk with experiments involving an apparatus of his own making. By that time he had already noticed that this apparatus occasionally produced sounds and that by changing its parameters, it was possible to alter the pitch. This inspired him—after all he was raised in a family of musicians.

1914

Termen became a student at the Petersburg University, entering two faculties at the same time: physics and astronomy. However, he did not abandon his music interests, for he simultaneously studied cello at the conservatory. But

the war dragged on, and Termen had to take a shortened course at the school of military engineers. Next followed the officers' electrotechnical school. As far as the conservatory was concerned, he received a freelance artist's diploma and served in the electrotechnical battalion. Thus art and technology, and war and peace constantly would intermingle in Termen's life.

1917

The year of the Russian Revolution: it was not the right time for music. He worked at the most powerful radio station in the country, *Deitskoye selo*, then at the military radio-technical laboratory in Moscow (Fig. 2). He underwent many severe trials, including an explosion at the radio station and an escape from the White Guard troops.

1920s

In Petrograd, the former capital of Russia, a new Physico-Technical Institute was being organized, headed by A. F. Ioffe, who brought together the best scientists and engineers of the country—his institute would become a kind of nursery for would-be academicians [2]. Termen was assigned to use radio methods to measure the density and dielectric constant of gases at different pressures and temperatures. Now his work at the radio station and his 'musical' wit came in handy.

Gas was placed between the plates of a condenser. A change in temperature led to the expansion of the gas and to a change in the condenser's capacity. Having increased the sensitivity of the instrument by means of a 'cathode relay' (frequency converter), the inventor connected the instrument output, not with the usual dial indicator, but with headphones. As a result, the instrument began to emit sound, changing frequency with the state of the gas. Termen noticed that the capacity also changed when his hand approached the instrument. And his hand, as we know, was that of a conservatory graduate. After a few exercises, the instrument was made to sing Massenet's "Elegy" and Saint-Saëns's "The Swan". Astounded talk could be heard all over the institute: "Termen performs Gluck on the voltmeter!" In 1921 Termen registered Patent No. 780, for a 'musical apparatus with cathode tubes'—the world's first electronic musical instrument (Fig. 3) [3,4].

The idea of using electricity for musical purposes was not new. One exotic invention that appeared at the begin-



Fig. 3. External view of the Termentvok.

ning of the century, before the advent of electronics, made use of the 'singing arc'. Here sounds were generated resulting from the charges on the tip of an electrode connected to the second winding of the Tesla transformer. In 1897 T. Cahill had created an instrument out of a set of electromagnetic generators, each of which excited its own frequency. Their combined weight amounted to 200 tons, and they occupied an entire building. They produced sounds in carphones, though the number of carphones was enormous, as this monster instrument was linked to the New York telephone network. As for Termen, he worked with carphones only at the beginning, for loudspeakers soon appeared. Besides, it was already possible to use radio valves.

The design of the Termenvox (Fig. 4) [5] is similar to heterodyne radio reception, which is based on obtaining audible frequency beats formed by the interaction (interference) of high-frequency oscillations. The Termenvox consists of two generators of electrical oscillations. One of them (1) has a strictly fixed frequency and is referred to symbolically as 'closed'. The other generator (2) has a variable frequency and is referred to as 'open', since one of the plates of its condenser is on the outside and connected to the aerial (3). One can change the capacity with precision by moving one's hand closer to the aerial (for the hand and the aerial make up the air condenser). Signals from both these generators are fed to the detector (4), which detects audible frequency beats. The subsequent chain is simple: the intermediate amplifier (5), the amplifier (6) and the loudspeaker (7). The circuit is adjusted so that a motion of one's hand close to the aerial corresponds to a change in sound within three to four octaves (the closer one's hand is to the aerial, the higher the pitch). With the other hand, the performer controls the volume in a similar fashion. An additional generator (8), to which a nooselike electrode (9) is connected, is provided for this purpose. Its energy is used to heat the electronic tube filament in the intermediate amplifier (5). As one's hand approaches the nooselike electrode, the generator frequency detunes relative to the frequency of the resonant circuit, which is part of the tube filament power circuit (hence the closer one's hand is to the noose, the lower the volume).

In the autumn of 1921, Termen de-

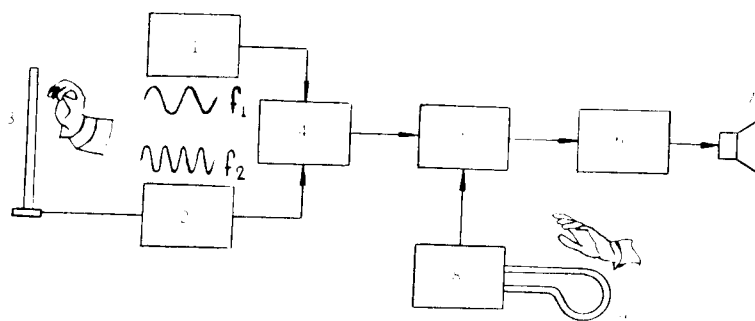


Fig. 4. The basic components of the Termenvox: The 'closed' generator (1) has a fixed frequency, while the 'open' generator (2) has a variable frequency and is connected to the aerial (3). Capacity is controlled by the distance between the performer's hand and the aerial. Signals from both generators are fed to the detector (4), which is linked to an intermediate amplifier (5), an amplifier (6) and loudspeaker (7). An additional generator (8), to which a nooselike electrode (9) is connected, aids the performer in controlling the volume: the closer the performer's hand is to the noose, the lower the volume.

monstrated his device at the Eighth All-Russia Electrotechnical Congress, at which the famous plan for the electrification of Russia was adopted. (This struck the science fiction writer H. G. Wells at the time, if one recalls his book *Russia in Gloom*.) The performance of music by Massenet, Saint-Saëns and Minkus on the Termenvox aroused interest not only among engineers. Following an enthusiastic review in *Pravda*, special concerts of ether-wave music had to be arranged for the general public.

In March 1928, Termen was invited to the Kremlin to demonstrate his achievement to V. I. Lenin [6,7]. The principal idea, it is true, was to demonstrate the instrument in the mode of a wireless 'radio watchman'. But what Lenin liked most was the way this multipurpose radio watchman 'sang' one of Chopin's nocturnes and "Skylark" by the Russian composer Glinka. Lenin even tried his own hand on the Termenvox, which led him to conclude, "Well, didn't I say electricity could work miracles? I am glad it is in our country that such an instrument appeared." A few days later, Lenin wrote the following to L. Trotsky: "Consider whether it is possible to cut the number of Kremlin cadets on guard duty by introducing an electrical alarm system. (The engineer Termen showed us his experiments in the Kremlin . . .)" [8]. The radio watchman ultimately did find an application—at the State Treasury, the Hermitage and the State Bank. However, only specialists knew about this when the Termenvox began its triumphant procession across the country, with Lenin's blessing. The composers

Glazunov, Shostakovich and Gnesin were present at the ether-wave music concerts.

Termen began to broaden the scope of his experiments. By combining the Termenvox with dynamic color (Fig. 5), he attempted to achieve the synthesis of ether-wave music with variable sensory effects (using specially designed arm-chair elbow-rests). Concerts were held in a number of cities, the hundreds of performances serving to advertise electrification, which proved able to subject even art! The press reviews bore the imprint of the epoch: "Termen's invention is a musical tractor coming to replace the wooden plough." "Termen's invention has done almost what the automobile has done for the means of transportation. This invention has the brightest prospects." "The problem of producing the ideal instrument is solved. Sounds are liberated from 'admixtures' of matter. The age of 'ether-wave music' has arrived."

Thus, the press reacted in the same fashion to Termen's Russian tour as it was to react during his subsequent concert tours in Europe. The same thing was to happen later in America. But before discussing Termen's years in America, I feel obliged to tell about another Termen, one not known to foreign readers.

A. E. Ioffe, director of the Physico-Technical Institute, would charge the talented inventor with lots of 'impractical' tasks. His motto was "Try to accomplish something nobody has done before". Along with his radio watchman, the Termenvox and his concerts, Termen took up one of the most difficult tasks of that time, namely, the trans-

mitting of images. He resolved it brilliantly, developing and constructing between 1921 and 1926 several versions of a working wireless 'distant vision' device (Fig. 6). Simultaneously, he was studying at the Polytechnic Institute, for the war had prevented him from getting his diploma in physics. "The Mechanism of Electric Distant Vision" was the title of his graduation thesis.

I have seen the materialization of his ideas and I wish every student could boast of such results: the first functioning television set in the country, with a screen measuring 150 × 150 cm. It should be pointed out that similar experiments conducted in other countries involved very small screens, the size of a postcard or a matchbox. Moreover, while his colleagues worked at the time primarily with the Nipkow disk, employing the system with a 'scanning beam', Termen was one of the first to make use of the original mirror sweep (a rotating disk with mirrors placed at different locations and whose light fell on the photocell). This made it possible to telecast, not from some dark location where the control object was normally placed, but directly from the street under natural light. Besides, this object could be mobile, which at

the beginning proved a stumbling block for many. Of course, the resolution of this television set was small, only 16 lines; but in his latest version, Termen succeeded in bringing this figure up to 100. That was not at all bad for 1926.

Ioffe was pleased with the result: "Termen's discovery is grand and on the all-European scale!" he wrote in *Pravda*. The device was shown to Stalin, Ordzhonikidze, and to the Red Army marshals-to-be Voroshilov, Budënyv and Tukhachevsky. Termen's invention struck members of both the government and the military. Was this not yet another triumph? Of course it was. But herein lies the reason for Termen's name being dropped from the list of those generally recognized as the pioneers of television: his invention was immediately classified as top secret because it was to be used to assist border-guard patrols. It would seem that after so many years all this could be made known and declassified. But, as we will see, the subsequent years of Termen's life were full of zigzags and ups and downs. For a long time there was no trace of his diploma work, which has been recovered only quite recently, finally making public Termen's priority,

along with the necessary proofs [9]. This contribution to science was alone sufficient for Termen's name to go down in history. However, this was but an episode in his life, which continued in America, where he was sent on a prolonged business trip in 1928.

Termen in America (1928–1938)

Termen performed concerts at the Metropolitan Opera and Carnegie Hall in New York. Imagine an ensemble of 12 Termenvoxes performing the overture to Wagner's *Lohengrin*! I will not quote from the enthusiastic press reviews, of which there were many, including several dozen in the *New York Times* over a period of years.

Termen was completely carried away by the spirit of enterprise found in the business world of America. Several firms—General Electric, Westinghouse Electric and Radio Corporation of America—started production of the Termenvox, manufacturing several thousand of them. The musicians' trade union registered 700 representatives of the new profession 'Termenist'. Termen organized a studio of music and dancing; and later, by agreement with the Soviet government, he also organized the Teletouch Corporation, which was housed in a six-story building on East 54th Street in New York. (I wonder what is in this house now. It would be a good idea to establish a museum dedicated to Termen there.)

Besides developing sensory transmission equipment (10), Termen continued to perfect his electronic musical equipment, creating another new instrument, the Terpston (Terpstone) (Fig. 7). This instrument makes use of a broad metal platform that is placed under the floor and serves as a sensitive aerial. One produces music not by waving one's hand but by moving one's whole body—music born of dance! Variations by Franck and fugues by Bach were performed.

During his European tour, and particularly while he was in America, Termen was associated with many famous people. His concerts and studio attracted the musicians G. Gershwin, M. Ravel, O. Respighi, B. Walter, J. Szigeti, J. Heifetz and Y. Menuhin; the writers G. Hauptmann and G. B. Shaw; and the film directors S. Eisenstein and C. Chaplin, who ordered Termenvoxes for his cinema equipment. The well-known American conductor T. Stokowski collaborated closely with

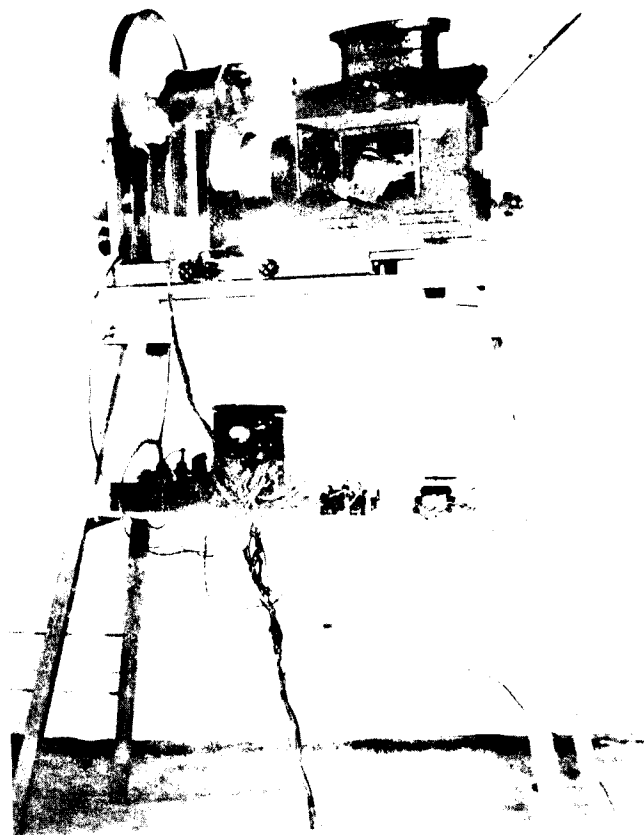


Fig. 5. Light-music projector in action with the Termenvox, 1920s. The sound contact is automatic; changing the pitch of a tone changes the color.

Termen. A special instrument with a superbass register was manufactured for Stokowski and his soloist Clara Rockmore. A. Einstein, a frequent visitor to Termen's New York studio, wrote that "the sound freely emerging from space is a new phenomenon". This must have been a splendid duet: the famous physicist's violin and the famous inventor's Termenvox. Together they played jazz pieces by Gershwin. But Einstein was carried away by yet another idea: the search for an analogy between music and spatial images and their synthesis. Termen told me that Einstein's whole studio was full of drawings of various geometrical figures that the young artist M. E. Bute had helped him to make. In the 1950s Bute would become famous for her color-musical films, which, as she has pointed out, were influenced by her work with Termen [11].

Future American celebrities also paid visits to Termen's studio: the young D. Eisenhower, as well as L. Groves, who later supervised the Manhattan Project. Termen met with Du Pont, Ford and Rockefeller; after all, he too was a millionaire. Yet he remembered his homeland—he was among those who welcomed the heroic Soviet pilots who had made a nonstop flight to the United States from the USSR. He followed the international situation with anxiety. As he said in his frank interview for the *Moscow News*:

My conversations with the military and with people dealing with the American military industry were not confined to music. I was well informed about the plans brewing on the American political Olympus. From what I knew, I concluded that the nazi-fascist axis would be our enemy in the next war—not the United States. Chief of the Red Army Intelligence Department Janis Berzins, whom I know as Peteris, was of the same opinion. In July 1938 Stalin made short work of him [12].

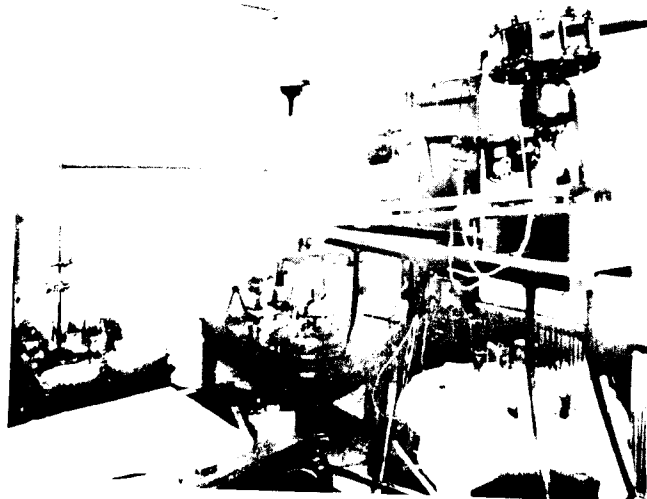
Later on, Termen himself was to suffer cruelly.

In 1938 he was at last permitted to return to Russia, which he barely recognized—the country had sunk into the gloom of the Middle Ages. He would later tell me about these hard years in snatches, but he has published his reminiscences only recently in the *Moscow News*, from which I have taken some brief information about his life in labor camp.

Return to Russia

Siberia, the Kolyma, the ends of the

Fig. 6.
L. S. Termen's
'distant vision'
device, 1926.



earth; in 1939, the friend of Chaplin and Einstein was working in a stone quarry. He certainly would have perished had he not devised an easier way to transport a heavy load—a wheelbarrow with a wooden monorail.

The war was approaching and those 'on top' remembered worthy persons. The inventor was transferred to Omsk, and from there to Moscow. He worked in a secret design bureau together with the aircraft designer A. Tupolev and the future spaceship designer S. Korolyov. Termen, deprived of freedom, under guard, worked on radio beacons for aircraft and other problems. Many attempted to encroach on his talent. That his talent was highly valued is attested by the fact that he was awarded the Stalin Prize, Class I (the highest award at that time), in 1947 while he was still in custody. Why was he given this prize? According to unconfirmed reports, L. Beria, head of the secret police, used a bugging device developed by Termen—it was given the code name 'Buran'—to spy on his rivals in Stalin's inner circle. Termen apparently survived this period only because his keen brain was sorely sought after by the powerful. Is this not a plot for a new 'Faustus', a Faustus of the twentieth century?

Rehabilitation

The years 1938–1958 were lost for music, for new art. Yet life continued, and Termen was rehabilitated. In the early 1960s, he returned to normal life, resuming his work at the Moscow Conservatory and later becoming chair of the Department of Acoustics at Moscow University. On returning to normal life, he could see that the 'electrification of music' that he had started in the 1920s

had, and still continued to have, its ardent supporters. For a number of years the variety artist K. Kovalsky had been a convinced Termenvox propagandist in the USSR, as had been Clara Rockmore in the United States. At the same time, many of Termen's pupils and followers had gone their own ways. Even before the war, some original electronic musical instruments had been developed, among them N. Ananiev's 'sonar', V. Gurov's 'violena' and A. Rimsky-Korsakov's 'equodin'. E. Sholpo applied the original principle of artificially synthesizing an optical phonogram to his 'variophone' (even prior to the Revolution he had belonged to the Leonardo da Vinci Society, which had set itself the task of radically 'rearming' music). A similar method, but with a more complex design, was employed by the engineer E. Murzin in his 'ANS' sound photosynthesizer (named after the composer Alexander Nikolayevich Scriabin, the music reformer). Murzin laid claim to the idea as early as 1938, but he was not able to make his instrument until 20 years later. The ANS octave is divided into not 12 but 72 parts; therefore, it is possible to synthesize all known and unknown timbres with the ANS, the process of composition being reduced to drawing music graphically with the possibility of its instant reproduction [13–22].

Termen familiarized himself with all this equipment and began actively to perfect his own devices, continuing the experiments initiated in the United States. He constructed new Terpsitons and polyphonic Termenvoxes with which the performer can accompany the melody by chords in pure pitch obtained by means of electronic circuits of multiplication and division of the melody sound frequency. The additional

manipulations that are required are carried out by the performer with the help of a hand-held miniradio transmitter. Variants of the Termenvox were elaborated in which a change in timbre is controlled by the performer by means of glances (to be more precise, by means of a photocell tracking the pupil). In another model, the same result is achieved by means of biopotentials. Termen and his followers supplemented the Termenvox with a noise generator, created simplified Termenvoxes for children as well as more complex models that are activated by one's voice or a whisper, and utilized the principle of capacity control for light-musical equipment.

It is difficult to enumerate all the devices designed by Termen for use by musicians and teachers; they included a spectrograph for analyzing timbres, a decelerator of phonation without alteration in the pitch of sound and a

rhythm shaper. He conducted interesting research in the field of musical acoustics (e.g. his experiments on shaping timbres not only with overtone frequency values but also with the help of undertone harmonics corresponding to minor constructions) [23-28].

At the present time, Termen works at Moscow State University, where he deals with naval acoustics and noise suppression in automobiles. But he still makes Termenvoxes at home, chiefly for museums and sometimes for groups of performers. His daughter gives performances on the Termenvox (Fig. 8), and his granddaughter on the Terpsiton. If one were to remove the cover from the Termenvox, the entire history of radio engineering would be plainly visible in its interior. By some method known only to himself, Termen has combined old-fashioned valves with glimmering cathodes and plates with transistors, integrated circuits. There

have been arguments in the Soviet press on more than one occasion as to whether the Termenvox has become outdated or whether the past should be revived and the device produced in quantity. Some people say that the instrument is inconvenient to use because of its gliding sound and the difficulties involved in fixing pitch when one is playing it, while other people regard this as an advantage [29]. While people keep arguing, radio fanciers from different countries continue to build their own versions of the Termenvox [30-36].

The memory of this first electronic instrument is still alive, and not just in its home country. By now there are quite a number of artworks that provide for the use of the Termenvox: A. Pashchenko's "Symphonic Mystery" (1923), B. Martini's "Phantasy for the Termenvox and Other Instruments", E. Varese's cantata "Equatorial" (1934) and works by such composers as N. Berezovsky, J. Schillinger, A. Fuleihan, P. Grainger and A. Shnitke. In 1978 the American firm Delos released a record with music by Russian composers that was performed by Clara Rockmore on the Termenvox. The Japanese firm Yamaha held negotiations with the inventor on the subject of manufacturing, beginning in 1990, multitimbre Termenvoxes controlled by biopotentials. Presumably it will not be a mere restoration of the cathode relay. The revival of the Termenvox principle most likely will involve its combination with the newest computer technology. What is beyond doubt, however, is that the future belongs to that unity championed by Termen during the best years of his life: art - science - technology.

Meeting with Termen, I always keep thinking: Can it really be only one person, only one life, that has accommodated technology, music, war and peace, the Terpsiton and the "Buran", the paradisaic childhood of a nobleman's son and the purgatory of the Revolution, the applause of the whole planet and the Hades circles of Beria's concentration camps? His whole fate brought together in his life such personalities as Lenin and Stalin, Tukhachevsky and Rockefeller, Gershwin and Korolyov, Beria and Einstein. Almost all his friends from his younger days have become academicians, while he is employed at the Moscow University as a worker-mechanic. Could he have become an academician? He could have, undoubtedly; but as they say, the divine will is inscrutable. But he seems little

Fig. 7. Termen's new instrument, the Terpsiton (called the Terpsitone in English), as illustrated in *Radio-Craft* (December 1936).

THEREMIN "TERPSITONE" A NEW ELECTRONIC NOVELTY

By means of this new Termenvox, Termen has created a new electronic instrument, the Terpsiton, which is capable of producing a wide variety of sounds. A complete description of this new instrument is given in this article.

By L. S. TERMEN

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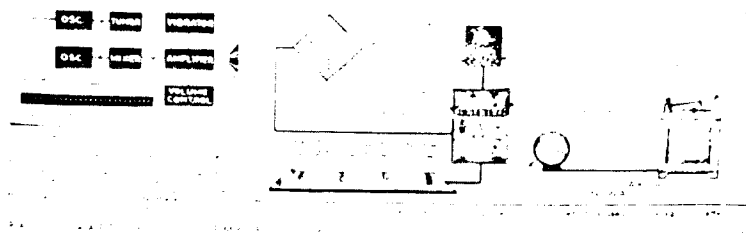




Fig. 8. Natasha, Termen's daughter, at the 1987 Light and Music All-Union Festival.

concerned with such things. He has seen everything, both the delights of worldwide triumph and the seamy side of life, remaining Termen, Faustus of the twentieth century. Observing his constant, cheerful smile and listening to his witty talk, one may think at times that perhaps he is Mephistopheles, only a kind one. Or perhaps the syncretism of the two? Aply, some old German sources present a reconstruction suggesting that these two names are derived from the same root.

Since we have touched upon the subject of old times, there is another reason to speak of times even more ancient. It turned out that Termen's ancestors had fled from France many centuries ago at the time of religious discords and later settled all over Europe. One branch of the genealogical tree in some strange way has sprouted in Russia. Termen showed me his family album with his genealogy and a sketch of his genealogical tree. On the first page, there is the ancient coat of arms of the Termen family with the mysterious motto "No more, no less". The branches of this tree have proved to be strong. If a competition could be held for the title of the genuine representative of the twentieth century, Lev Termen is in an excellent position to contest it. No more, no less.

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