Vladimir Aleksandrovich Kotel'nikov (on his seventieth birthday)

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Usp. Fiz. Nauk 126, 165–168 (September 1978)

PACS numbers: 01.60. + q

Academician V. A. Kotel'nikov celebrated his seventieth birthday on September 6, 1978. He is one of a number of prominent Soviet scientists who have contributed significantly to the development of radiophysics, radioengineering, and electronics.

Kotel'nikov was born at Kazan' into the family of a Kazan' University professor. After graduation from the Moscow Power Engineering Institute (MÉI), he was employed by the Red Army Scientific Research Institute on Communications in 1930, and from 1931 on he taught at the MÉI, an activity that he combined with scientific work at the Central Scientific Research Institute of the USSR People's Commissariat of Communications. Kotel'nikov worked on the design of special communications apparatus during the war years (1941–1945). He was twice awarded a USSR State Prize (in 1943 and 1946) for developments in this area.

In the period from 1948 through 1953, Kotel'nikov gave a great deal of energy to the organization and development of the MÉI Special Design Office, in which he held the post of Chief Designer.

Kotel'nikov defended his doctorate dissertation in 1946. He was made a professor in 1947 and was elected an active member of the USSR Academy of Sciences in 1953. In 1954 he became Director of the USSR Academy of Sciences Order of the Red Banner of Labor Institute of Radioengineering and Electronics (IRÉ AN SSSR).

Kotel'nikov is Chairman of the USSR Academy of Sciences Scientific Council on the problem "Radio Astronomy," Editor-in-Chief of the journals "Radiotekhnika i Élektronika" and "Vestnik AN SSSR," and a member of the Committee of Lenin and USSR State Prizes in Science and Technology in the USSR Council of Ministers.

Since 1971, he has been a Deputy of the RSFSR Supreme Soviet, and since 1973 its Chairman.

Kotel'nikov's early studies were concerned with analysis of phenomena that take place in various radio devices. Their aim was to improve the operating efficiency of devices used in communications during the 1930s.

One of Kotel'nikov's outstanding works was his paper "On the Transmission Capacity of the "Ether" and Wires in Electrical Communications," which he published in 1933. It formulated the theorem of samples (which is known as Kotel'nikov's theorem in communications theory). It states essentially that a function with a limited spectrum can be represented accurately by a set of readings of this function that have been taken at specific points. Kotel'nikov was the first to point out the enormous technical significance of this theorem, although it had been known earlier to mathematicians. Its importance goes far beyond the limits of communications theory. It is used in radiophysics and optics, in the theory of digital signal processing, and in various other areas of science and technology.

VLADIMIR ALEKSANDROVICH KOTEL'NIKOV

Kotel'nikov's "Theory of Potential Noise Immunity" won wide recognition. It is concerned essentially with the limits on radio reception in the presence of noise. Herein lies its fundamental importance, since it established the fundamental limitations imposed by noise on the sensitivity of radio receivers. Limits of this kind are highly important in physics and engineering practice, since they caution the designer against attempting to solve problems whose fundamental insolubility is dictated by the laws of nature.

The concept of potential noise immunity was formulated for the first time in this study; the structure of optimum receivers was found for several cases, and various other problems of noise immunity in various communications systems were analyzed.

Although more than 30 years have passed since the

 0038-5670/78/090798-03$01.10

appearance of potential noise immunity theory, it is just as important now as it was then.

Close coupling of theory with practice was characteristic of Kotel'nikov's work. During the prewar years, he supervised the development of equipment for single-band radio communications between Moscow and Khabarovsk, a system that was, in its time, the crowning achievement of Soviet radio engineering. The group led by him developed new communications systems during the Second World War. He was later involved in development of the first models of control and monitoring apparatus for space vehicles.

Kotel'nikov's ideas in the area of weak-signal reception served as a basis for a new scientific trend that he initiated—planetary radar. The practical stimulus to this development was the need to determine distances in the solar system more accurately in support of flights of space vehicles to the planets. The basic scale factor is the astronomical unit (the mean distance from the earth to the sun), which is estimated at 150 million kilometers. Before the radar studies began, this quantity, which was obtained basically from planetary parallax observations, was known with a possible error of several tens of thousands of kilometers. This accuracy was clearly inadequate for reliable control of space-vehicle flights. For example, if the old value of the astronomical unit had been used in the flight of Venera 4, which was the first probe to descend into the atmosphere of Venus, it would have missed by three radii of the planet.

The very first experiments in which radar signals were returned from the planets Venus, Mars, and Mercury made it possible to establish the value of the astronomical unit with an error of only a few thousand kilometers. Modern planetary radar enables us to determine the astronomical unit with a relative error of the order of 10^{-8}.

Radar observations made it possible to establish with high accuracy the period and direction of rotation of Venus, something beyond the capabilities of optical astronomy owing to the fact that Venus is completely covered by clouds. According to recent radar data, the period of rotation of Venus is about 243.16 days, a value at which Venus should turn the same side toward the earth at each inferior conjunction.

Radar observations of the planets also stimulated several other directions of research and development. For example, radar data made it possible to improve the theory of the motion of Venus. Planetary radar accelerated work on the design of quantum paramagnetic amplifiers (QPA), with which high sensitivity can be obtained in radio equipment. One of the first QPA used in practice was used in a planetary radar.

Kotel'nikov has had a major part in the development of new trends in radioengineering and electronics. As Director of the USSR Academy of Sciences Institute of Radioengineering and Electronics, he initiated research in the area of long-range millimeter-band communications lines using large-section round waveguides. On his suggestion, the Institute began work in the field of integrated circuits and the study and mastery of new wavelength bands: millimetric, submillimetric, and infralow-frequency. Often, out of the desire to make certain that the research has the necessary scope, Kotel'nikov has taken initial supervision of a new problem on himself. In 1959, for example, he headed the country's research effort to develop scientific background and designs for low-noise ultrahigh-frequency parametric amplifiers using semiconductor diodes.

At the IRÉ AN SSSR, he organized and at first supervised the activity of the Paramagnetic Amplifiers Laboratory; an All-Union Seminar on the problem was set up under his supervision and coordinated the work being done in the country on paramagnetic amplifiers. He himself did the theoretical research that marked the way to attainment of extremely high noise characteristics in parametric amplifiers. Kotel'nikov's drive to know everything "down to the last nut and bolt" came to the fore in this effort.

Kotel'nikov committed himself with vigor to the task of automating scientific research. In 1967, at the direction of the Presidium of the USSR Academy of Sciences, he headed the newly created Council on the Automation of Scientific Research. A corresponding department was set up in the Institute that he headed, and the Special Design Office (SKB) of the IRÉ AN SSSR began development of systems that would make it possible to interface experimental apparatus with computers and to control experiments automatically. The Council on the Automation of Scientific Research organized collaboration between the Institutes of the USSR Academy of Sciences and the organizations of the Ministry of Instrumentation and Automatic and Control Systems of the USSR on the development of measurement and computing complexes and systems for automation of scientific research. A standard scientific-research automation system was developed on the basis of this study and recommended for use in the institutes of the Academy of Sciences. Kotel'nikov directed the work of the Council until 1974. But even now, as Vice President of the USSR Academy of Sciences, he takes a very active part in the guidance of its work.

Kotel'nikov's unflagging interest in problems in communications was revived when it became known that several foreign laboratories had succeeded in making low-loss fiberoptic light-guides. His immediate appraisal was that massive use of fiber optics could bring about a technical revolution comparable in significance, in his words, to the conversion from electron tubes to solid-state devices. At his instruction, intensive research was begun in this area in the USSR Academy of Sciences Institute of Radioengineering and Electronics that he directed. The necessary equipment was built and the technological processes making possible the stable production of fiber lightguides with losses of less than 10 dB/km were developed over a short period of time. Simultaneously, the Institute began work on the development of a fiberoptic component base and built models of fiber communications lines capable of transmitting information at a speed of 50 megabits/sec and models of television, teletype, and video-telephone

lines based on the use of fiber optics. Kotel'nikov's interest in and attention to this problem have not slackened over these many years. He himself regularly proposes various devices, performs difficult calculations, and holds Author's Certificates for inventions in the field of fiber optics. Thanks to the enormous amount of organizational work that Kotel'nikov has done, all these areas have advanced not only at his institute, but also in the scientific-research and design organizations of several Ministries. The results of these scientific investigations are being used successfully in the country's economy.

Kotel'nikov is an outstanding teacher and has invested much work in the preparation of scientific and engineering manpower. For more than 30 years he has directed the work of the Basic Radioengineering Department at the Moscow Power Engineering Institute, and for the last 10 years he has also headed the Electromagnetic Waves Department of the Moscow Physico-technical Institute (MFTI). He designed the course on "Fundamentals of Radioengineering," and, with A. M. Nikolaev, wrote an excellent textbook for it. Kotel'nikov also taught a course in electrodynamics at the MÉL His lectures, which were distinguished by extreme rigor and clarity of exposition, were eagerly attended not only by undergraduates, but also be teachers and graduate students. Kotel'nikov accomplished much as Dean of the MÉI Radioengineering Department.

Kotel'nikov combines his scientific and teaching activity with a great deal of scientific organization work in the USSR Academy of Sciences. For a number of years, he was Deputy Academician-Secretary of the Division of General Physics and Astronomy of the USSR Academy of Sciences. In 1963, he became a member of the Presidium of the Academy of Sciences, and from 1969 to the present he has been Vice President of the Academy. In 1975, when the Academy of Sciences was observing its 250th Anniversary, Kotel'nikov was the Acting President.

As Vice President of the Academy of Sciences, Kotel'nikov devotes much strength and energy and all his outstanding talent as an organizer to supervision of the Academy's activity, vital scientific-organizational work, and the solution of many problems that arise in connection with new objectives of the Academy and the steadily increasing importance of Soviet science. He works both on solutions to these major strategic problems and on everyday matters in the life of the Academy in his characteristic consistent and methodical fashion. This work began during a time of particularly rapid development of the Academy, which has now become the center for the country's fundamental research and the coordinator of all its scientific work.

For several years, Kotel'nikov has supervised the vital task of forecasting and long-term planning for the country's scientific and technical progress. In 1972–1973, the USSR Academy of Sciences and the USSR State Committee on Science and Technology, working under his direction, accomplished the monumental and extremely responsible task of preparing the Complex Program of Scientific and Technical Progress and Its Social and Economic Consequences for 1976–1990. This work was approved by the Twenty-Fifth Party Congress, which recognized the necessity to continue it in the future as an organic part of current and long-term planning. Since 1976, this has been the task of the USSR Academy of Sciences Scientific Council on Problems of Scientific-Technical and Social-Economic Forecasting and the State Committee on Science and Technology under Kotel'nikov's direction.

Kotel'nikov is a Hero of Socialist Labor and has been honored with five Orders of Lenin, the Order of the Red Banner of Labor, the "Badge of Honor" and a number of medals. In 1964, he won a Lenin Prize for his radar studies of the planets Venus, Mars, and Mercury. For fundamental research in communications theory and planetary radar, the Presidium of the USSR Academy of Sciences in 1974 awarded to Kotel'nikov the A. S. Popov Gold Medal. Kotel'nikov's election to membership in the Academies of Sciences of the German Democratic Republic, Poland, and Czechoslovakia is evidence of the international recognition accorded his scientific accomplishments. He has also been elected an honorary member of the American Institute of Electrical and Electronic Engineers.

Kotel'nikov is at the height of his creative powers. His profundity of thought, the energy that he devotes to the ongoing scientific quest, his effort to perform the maximum service to his country, his high honesty, and the discipline of a Communist scientist, which he applies to himself, his colleagues and his staff, guarantee that the Soviet nation and Soviet science will continue to benefit greatly from Kotel'nikov's all-round scientific teaching and government activities.

We wish the celebrant rugged good health, good spirits and new creative successes.

Translated by R. W. Bowers