Development of Anesthetic and Ventilation Equipment at VNIIMP-VITA, Ltd.

R. I. Burlakov and Yu. Sh. Gal’perin

Before World War II, local anesthesia was used for abating pain of surgical patients in the USSR, whereas artificial ventilation was considered by the majority of people as a part of physical exercise training. The first domestic apparatus for inhalation anesthesia (IA), A-1, was developed in 1937-1938 at Central Scientific-Research Laboratory for Medical Instrument Industry (TsNIL). This laboratory established the basis of the history of VNIIMP-VITA, Ltd. VNIIMP-VITA, Ltd. was organized on the basis of the All-Russia Scientific-Research Institute for Medical Instrument Engineering in 1992. The development of the A-1 IA apparatus was supervised by V. A. Mikhailov and performed by P. N. Kapkov (later to be researchers of VNIIMP). After World War II, the Ozhivitel’ apparatus for mechanical lung ventilation (MLV), a copy of the M&G oxygen cylinder-based apparatus (USA), and apparatus for gas anesthesia (1948) were developed.

In the mid-1950s, the Laboratory of Gas Devices and Apparatuses (Head, A. S. Perel’mutr) was established in the Institute. The laboratory was staffed with 15 engineers, constructors, technicians, etc. G. M. Freidin, a member of the laboratory, had both engineering and medical background. Several models of aerosol generators, water spirometers, apparatuses for submerged massage, drying cases, etc. were developed.

In the late 1950s IA and muscle relaxation agents were brought into use in MLV-assisted surgery in the USSR. Long-term MLV was also used in treatment of poliomyelitis and some other neurological diseases. An important role of MLV in resuscitation was also demonstrated. Academicians V. A. Negovsky, B. E. Votchal, B. V. Petrovsky, and Professors N. N. Elansky, I. S. Zhorov, L. M. Popova, and L. L. Shik substantiated the use of IA and MLV in surgery.

The first domestic MLV apparatuses DP-1 and DP-2 became commercially available from Respirator (Orekhovo-Zuevo) in the late 1950s. These simple pneumatic devices were copies of similar models of German manufacture.

Young researchers studied the medical bases of such equipment. For the first time in the USSR, technological parameters (e.g., resistance of tracheal tubes, theory of rotameters, etc.) of MLV apparatuses were tested instrumentally. The results of tests of IA, MLV, and aerosol generators were reviewed by the Laboratory researchers.

I. P. Smirnov, the Head of the Institute, and A. S. Perel’mutr promoted this promising approach. The Department of Equipment for Anesthesia and Resuscitation (DEAR) was organized and the number of staff members was increased to 60.

In the late 1950s, the first domestic models of apparatuses for IA were developed at DEAR: UNA-1, UNAP-2, and NA-3. For the first time the construction of the devices was based on theoretical calculations of evaporator, absorber, and respiratory and safety valves.

The first domestic MLV system for IA, RN-59, was developed by M. K. Soms. These devices pioneered a promising new area in domestic medical engineering of that time, equipment for respiratory inhalation anesthesia (RIA). These devices were manufactured at the Krasnogvardeets plant (St. Petersburg).

In 1962 a new model of the MLV apparatus RO-62 was developed at the Institute. It was the first model of the most popular series of domestic MLV devices. Some technological achievements implemented in this model (triggering of respiration cycle phases, built-in low-pressure compressor, etc.) are still in use in modern domestic MLV devices. A total of 15 new models of MLV apparatuses of this family were developed at VNIIMP in collaboration with leading pulmonologists and engineers.

Several devices for group aerosol therapy were developed at Tekhnolog, Ltd. (Moscow) and widely used in many domestic clinics.

An important stage in development of anesthetic and ventilation equipment at VNIIMP-VITA was the solution of complex theoretical and practical problems associated
with this process. Menshutin and Puzankov, Heads of the Krasnogvardeets plant (St. Petersburg), significantly contributed to production of IA apparatuses for intensive care and resuscitation and their introduction into medical practice and research.

The high efficiency of IA equipment sharply increased the area of its application. This substantiated development of new models of such equipment. In the mid-1960s, a comprehensive systematic approach to the problem of RIA development was used. New MLV models RO-3, RO-5, and RO-6 for adults and Vita-1 system for children/neonates were developed at VNIIMP (R. I. Burlakov, Yu. Sh. Galperin, S. A. Glukhov, I. K. Gorlin, R. I. Gorokhovskaya, M. N. Katsuba, S. E. Ksandrova, I. B. Krishtul, G. P. Lyutov, M. K. Soms, A. I. Trushin, E. N. Reiderman, G. I. Ulyakov, A. A. Cherkasova, et al.) in collaboration with another group of researchers (Profs. A. A. Bunyatyan, N. E. Burov, V. L. Vanevsky, V. A. Gologorsky, E. A. Damir, T. M. Darbinyan, A. P. Zilber, V. L. Kassil, G. I. Lukomsky, V. A. Mikhelson, et al.). These devices were based on the RD-1, RD-2, RD-4, ADR-1, and ADR-2 MLV devices. A sharp increase in the level of production of MLV apparatuses was due to enlargement of the area of their medical application. In the 1970s new MLV models were used in many domestic clinics, urgent care hospitals, maternity hospitals, etc. Some special purpose models were also developed: RO-6R, RO-6N, RO-6-03. These models are convenient to use and provide good ergonomic and treatment characteristics. These three models are still commercially available.

At the same time, a new generation of IA devices was developed, including the following systems: Polinarkon, Polinarkon-P, Narkon, and NAPP, an intermittent-flow apparatus. More advanced models Polinarkon-2, Polinarkon-2P, Narkon-2, and NAPP-2 were developed later. For the first time these models employed original evaporators Anestezist-1 and Anestezist-2 adapted to liquid anesthetics. Simple UDS-2 air humidifiers were also used.

Aerosol inhalation generators and generators of negative ions were developed by A. V. Kitaev and L. A. Smirnova.

During this period of time standard methods of testing of IA and MLV equipment were introduced. The mechanical lung apparatus for testing gas devices was invented in TsNIL in 1939.

Second generation devices are based on new circuitry: transistors, integrated circuits, pneumatic systems, computers, microprocessors, etc. The first commercially available domestic MLV apparatus RO-3 based on integrated circuits was developed in 1966. Many efforts were taken to produce circuitry based on electroconductive polymers.

Pneumoautomatic systems were developed in collaboration with the Institute of Automation and Telemechanics (Technical Cybernetics), Russian Academy of Sciences. For the first time, jet systems (pneumonics) were used in MLV RD-1 apparatus. Hyperbaric medical systems were also developed.

More than 10 models of RIA apparatuses were manufactured at Krasnogvardeets plant (St. Petersburg) (total annual production, 4000 items) to meet the demands of domestic medicine in RIA apparatuses.

The apparatuses of the second generation implemented advantages of IA and MLV and have been used with millions of patients. The RIA systems developed at VNIIMP provided a basis for anesthesiological, intensive care, and resuscitation service in the USSR. A new medical specialty, Anesthesiologist–Resuscitologist, was introduced into urgent care, military medicine, and many other medical organizations.

A domestic school of anesthesiology was established in these years. Researchers of the Department of Equipment for Anesthesia and Resuscitation of VNIIMP defended 11 Candidate and 2 Doctoral dissertations. VNIIMP actively collaborates with KMLT (Germany), Chirana (Czechia), and Medicor (Hungary) in various aspects of standardization. However, collaboration with companies from USA, Great Britain, and France was hampered because of commercial controversy.

In 1975 R. I. Burlakov and A. V. Yushkin (VNIIMP) and Prof. T. M. Darbinyan (Vishnevsky Institute of Surgery) developed ROA-1 and ROA-2, new MLV apparatuses. These apparatuses implemented MLV control based on physiological mechanisms.

A number of former defense industry facilities have also contributed to development and production of MLV systems: NII Avrora (St. Petersburg), KB Khimavtomatica (Voronezh), and Kazakov MPZ (Moscow).

A number of accessory monitors (SM-1 and SM-3), artificial coughing apparatus IKAR-4, MLV bronchoscopic apparatus Eol, three UDS-1 air humidifiers, intravenous injector of anesthetics VEDA-2, bacterial and absorption filters, etc. were developed at VNIIMP at that time.

In the early 1980s the third generation of MLV systems was developed. The family of the systems was given a collective name Spiron. The following devices and systems developed in VNIIMP are other examples of this approach: Spiron-201 resuscitation system for adults, Spiron-402 resuscitation system for pediatric patients, Spiro-Vita-412 resuscitation system for neonates,