Progress in surgery is increasingly associated with the development of engineering products for use in operations and in management of the postoperative period.

Complex surgical apparatus and various types of instruments for use in operations are developed in specialized research institutes and experimental designing offices. Among the many measures adopted during the last few years by the Party and Government to strengthen the medical industry, an important event was the creation in 1951 of the Research Institute of Experimental Surgical Apparatus and Instruments (abbreviated since 1966 to VNIIKhAD), devoted to the theoretical study, development, and introduction into medical practice of new surgical apparatuses and instruments and techniques for using them.

On the occasion of the 50th Anniversary of the Great October Socialist Revolution, it is timely to review the work of the Institute in supplying Soviet surgeons with equipment and to outline a number of prospects of its future development. During the period since its creation, as a result of work carried out at the Institute aimed at providing surgery and related specialities with new apparatus and instruments, the technical resources of surgery as a whole have been greatly widened and improved. This has been helped by putting into practice the Party program adopted at the 22nd Congress of the CPSU, in which, in particular, the further improvement of the medical service was mentioned.

Throughout the years of existence of the Institute, more than 900 articles for different purposes have been issued, most of them for the benefit of the health service. The Institute was created in accordance with a new principle of combined effort for the solution of problems, and it is now a creative fraternity of engineers, designers, medical researchers, and workers at the experimental factory. A close link with the leading clinics ensures not only that the newly developed apparatuses and instruments will be tested and used by highly qualified specialists, but also means that the scientific thinking of the Institute is nourished by new ideas and suggestions, thus aiding the progress of surgical technique.

A shining example is the development of Soviet heart surgery. Its progress is directly related to the practical application of the technique and apparatus of the artificial circulation, enabling congenital defects of the heart to be corrected by open operation, the heart valves repaired or replaced, and diseases of the thoracic aorta treated operatively. Scientific investigations by workers at the Institute (S. S. Bryukhonenko, E. A. Vainrib, S. A. Mushegyan, and others) have contributed to the development of the method, the experimental study of its variants, and the clinical adaptation of several new techniques, and they have given an original impetus to the creation of Soviet artificial circulation apparatuses. In all models (and 11 have been produced in different years, including apparatuses for regional perfusion), an oxygenator of foam-film type is used as the gas exchanger (the idea and the first design were suggested by S. S. Bryukhonenko and V. D. Yankovskii; the foundations for the explanation of the physico-technical principles of saturating the blood with oxygen and eliminating carbon dioxide from it in oxygenators of this class were laid by E. A. Vainrib). In the opinion of the leading surgeons of the country (B. V. Petrovskii, A. A. Vishnevskii, etc.), and also of a number of foreign surgeons (Galletti, Britseher, etc.), this Soviet oxygenator is highly efficient and physiological and compares with other types of artificial gas-exchange devices.

In all models pumps of membrane type are used as "artificial hearts." In contrast to the roller and key-operated pumps most widely used in Western apparatuses (for example, the finger-operated pumps made by the firm of "Sigmamotor" in the United States), which are satisfactory for short-term perfusions, membrane pumps give rise to much less hemolysis, so that they can be used for surgical operations on the heart of any duration.

The physiological nature of the pumping system has been greatly increased in recent years (for example, the AIK–63M model), by the use of two arterial pumps working in opposition.

All-Union Research Institute of Surgical Apparatus and Instruments, Moscow. Translated from Meditsinskaya Tekhnika, No. 5, pp. 12–17, September–October, 1967.
In the latest models of the apparatus, membrane pumps with leaf-shaped valves made of silicone rubber are connected to an electromechanical device enabling their output to be regulated according to plan by a change in the stroke volume and pulse rate, so that physiological parameters may be maintained close to normal during perfusion.

Clinical trials of the VNIKhAI artificial circulation apparatus in more than 1000 operations in the cardiac surgical centers of the country (B. V. Petrovskii, A. A. Vishnevskii, S. A. Kolesnikov, V. I. Burakovskii, G. M. Solov’ev, V. S. Savel’ev, E. N. Meshalkin, A. S. Kharnas, etc.) have shown that it possesses good functional qualities.

Concurrently with continued research to improve apparatus for cardiac surgery (including an apparatus for operations on newborn infants and young children, in course of design at the present time), the specific conditions of chemotherapy in isolated organs have demanded the creation of a special apparatus whose power could be adapted to the conditions of regional perfusion. The AIK-RP-62, AIK-RP-64, and AIK-RP-3 apparatuses were created in the Institute (E. A. Vainrib, S. A. Mushegyan, B. S. Bobrov, N. A. Super, and others), retaining the fundamental features of the apparatuses used in heart surgery, but adapted in their output to the conditions of circulation in isolated organs and regions of the body. These apparatuses have been widely used in clinical practice as shown by experience in more than 1000 operations (combined data from the proceedings of a conference on regional perfusion held in Tyumen, in February, 1967). Regional chemotherapy by the perfusion method has been tested not only in malignant diseases, but also in a number of conditions of an inflammatory and destructive character.

Future problems are concerned not only with improving traditional artificial circulation apparatus, but also in developing apparatuses and techniques for use in resuscitation and for therapeutic purposes. This problem may be solved by the development of biologically controlled apparatuses, and work along these lines is being undertaken by a newly created special laboratory of the Institute.

An important place in the research and designing work of the Institute is occupied by the development of apparatus for extrarenal blood purification (M. G. Anan’ev, E. B. Gorbovitskii, A. S. Tkachenko, and others).

No such apparatus has been available in the USSR until recently. The "artificial kidney" apparatus produced by the Institute is now recognized as one of the best of its type in the world. Among the undoubted and considerable advantages of the Soviet model is the very small priming volume, only 220 ml. With this volume, the apparatus can be used without donors’ blood; the blood carrying system is filled with one of the blood substitutes. This advantage of the Soviet apparatus is shown to an even greater degree if it is used for chronic dialysis, during which the same patient may undergo hemodialysis regularly once or twice a week for a long time. The economic effect of this will be clear: with its low requirement of donors’ blood (at least 4-5 times less than in the case of most Western apparatuses) the cost of this complex and expensive form of treatment is considerably reduced.

A no less important advantage of the apparatus is the purifying power. This is shown clearly by the clearance index of the apparatus (with a blood flow of 200 ml/min the urea clearance is 130-140 ml/min, corresponding to the best Western model). This means that the time required to obtain the desired effect during operations is reduced.

It must also be pointed out that the Soviet "artificial kidney" possesses yet another virtue—it can be used for ultrafiltration, i.e., to remove an excess of water from the body (as much as 3-4 liters at one time), which is extremely important for the treatment of hyperhydration, often complicating the course of acute renal failure.

Recently the possibilities of this apparatus have been extended still further as the result of the development of a device for "regional heparinization," use of which enables artificial hemophilia to be produced only in the extracorporeal circulation. As a result of this the hemodialysis apparatus and method can be used with patients with a bleeding tendency.

Bearing in mind the importance of the use of hemodialysis in conjunction with other methods, besides an "artificial kidney" the Institute has developed a number of accessories for use in the rational conduct of operations: a weighing bed, a demineralizer, a set of catheters for connecting the apparatus to the patient’s vascular system, and so on. The creation of arteriovenous shunts for chronic hemodialysis in the current year deserves special mention. This development is an important forerunner to the introduction of