Automation of the diagnosis and treatment of diseases is finding increasing use in clinical medicine. Of great practical importance in this case is the development of a multichannel apparatus for comprehensive evaluation of the condition of an organism.

In this article we describe an automatic device, a digital analyzer and regulator of physiological functions (DARPF), for bringing patients out of terminal states under experimental conditions. Terminal states were induced by acute blood loss, intravenous injection of peptone, or overdosage of an inhalation anesthesia (ether). Four basic indexes were observed: respiration, arterial pressure, ECG, and encephalogram. On the basis of the investigation results and in accord with the literature data we isolated the critical parameters of each of the investigated functions. We incorporated an appropriate treatment apparatus for a certain combination of these parameters. All the necessary combinations were reduced to a verity table on the basis of which we compiled the operating program of the automatic device. As actuating units acting on the organism we used a system for intraarterial injection of liquid at a pressure of 120 and 180 mm Hg, an apparatus for electrical stimulation of heart, and apparatus for artificial respiration, and a defibrillator.

Taking into account the large volume of incoming information, the duration of the cycles of its processing, and the need for logic and storage units, we decided to construct an automatic device on the basis of a digital computer which would permit (if necessary) an appreciable expansion of the volume of information processed. The functional diagram of the DARPF is shown in Fig. 1. At the input are voltage amplifiers (A1–A4) with an adjustable amplification factor which match the operating conditions of the machine with the input signals of the pickups and reduce the maximum input voltages to a normalized level. The instrument uses time selection of the input signals, which is accomplished by a channel switch (CS2) beyond which is the voltage-to-binary-code converter (VC). The time of one conversion is 800 μsec. The frequency of the input signals is different, therefore, the frequency of switching the converter to different channels is: 500 MHz to the EEG channel and ECG channel, 10 Hz to the respiration channel, and 2 Hz to the arterial pressure channel. The maximum error of the VC is 5%.

From the converter discrete signals are sent to the comparison circuit (CC), storage registers (SR), and amplitude decoder (AD). In the comparison circuit the sign of the derivative of the signal is elicited, which is then compared with the sign of the preceding derivative stored in the storage register. As a result of comparison an extremum signal is generated and sent to the counter unit (CU). Simultaneously a binary code corresponding to the extremum value of the function stored in the register is sent from the comparison circuit to the amplitude decoder. The decoded magnitude is sent to the amplitude-level deducer (ALD).

For selection of the QRS peaks of the ECG there is an oscillation-duration meter (ODM). To it are sent the effective values of the voltages of the peaks, the sign of the derivative, and the "zero level" of the voltage. When the amplitude and duration of the electrical oscillation are within prescribed limits, the system generates a signal of the presence of a QRS peak. This signal goes to the counter unit for counting the frequency of heart contractions (here the number of maxima during the averaging time for a given channel is automatically counted). The averaged frequency is sent through the frequency decoder to the frequency-level deducer (FLD). The amplitude-level and frequency-level deducers are built alike and refer the arriving amplitude or frequency to one of the programmed discrete levels. The same value can be referred to different levels (this permits a rather wide variation of the operating program of the device).
The signals on the levels of amplitude and frequency are sent to the decision elements (DE) of each channel through channel switches CS2 and CS3 and the DE perform logic operations on the analysis of each function separately and interrelatedly. The principal operating algorithm of DE1–DE3 was constructed on the basis of the verity table. We set up logical equations for channels DE1 and DE3. Thus for channel DE3, after minimization the logical equation took the following form:

\[
C = A_1 \overline{A}_2 \overline{A}_3 \overline{A}_4 vF_1 \overline{F}_2 \overline{F}_3 \overline{F}_4 vA_1 \overline{A}_2 \overline{A}_3 \overline{A}_4 F_1 \overline{F}_2 \overline{F}_3 \overline{F}_4 (BVC_1)
\]

\[
vA_1 A_2 A_3 A_4 \overline{F}_1 F_2 F_3 F_4 vA_1 A_2 A_3 A_4 \overline{F}_1 F_2 F_3 \overline{F}_4 (BVC_1).
\]