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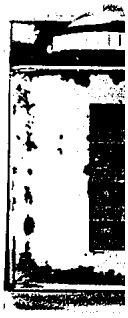

# CONSTRUCTION PRINCIPLES OF INDUSTRIAL INSTRUMENTS FOR AUTOMATIC CONTROL AND REGULATIONS

Elektrichestvo, No 2,
Moscow, Feb 1951, pp 88, 89

[The following is the full text of a summary by an unidentified author of a paper read by V. A. Trapeznikov at a general meeting of the Department of Technical Sciences, Academy of Sciences USSR. The paper was originally published in "Izvestiya Akademii Nauk SSSR, Otdeleniye Tekhnicheskikh Nauk," No 10, 1950.]

The basic problems currently encountered in the field of automatic control are the development of methods for complex automatization of production and, no less important, the development of equipment for automatic control and regulation.

Preliminary estimates have shown that more than 100,000 automatic control and regulation instruments of all types and sizes will be needed to meet the requirements of our expanding industry. Obviously, we must seek new principles of constructing and designing automatic systems.

A number of conflicting requirements arise in attempting to solve this problem. On the one hand, the huge demand in our industry for automatic units requires that their costs be reduced by mass production; on the other hand, the diversity of manufactured products and the peculiarities of technological processes requires an increase in the types of equipment. The inconsistency can be eliminated by means of the block-unit (aggregatnyy) system widely used in various branches of industry but insufficiently adopted in instrument building. The block-unit principle is based on the similar functions performed by individual elements which compose the various systems, particularly systems of automatic control and regulation. The study of different automatic devices reveals that, notwithstanding their apparent dissimilarity, they perform very similar operations. Consequently, an automatic device can be broken up into a number of independent units with the restriction, however, that the input and output characteristics of the individual elements must permit their combination into a single common system. The similar nature of the operations performed by the elements makes it possible to assign these functions to similar, structurally independent units which can be combined into a single over-all system (block-unit). The block-unit system makes it possible to obtain the greatest number of modifications with the least number of initial elements. At the same time, the block-unit system can be rapidly modified; because of the structural independence of the individual units, any of them can be replaced by a new device without disturbing the other elements of the system.

Automatic equipment designed on the block-unit principle must meet a number of requirements. The instruments must be designed for the control of the most diverse parameters. They must be highly accurate, fast-acting, very reliable in operation, and, finally, must allow for remote control.

These requirements indicate that automatization of industry eliminates the distinction between laboratory and industrial instruments. In addition, these requirements dictate specific engineering methods for the development of automatic control instruments.

Extreme accuracy requires the use of compensation methods of measurement. The variety of parameters and the remote-control provisions make necessary the extensive utilization of electrical measuring methods for both electrical and nonelectrical quantities. The need for dependability combined with fast action

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requires that the device be constructed as a sturdy mechanism without resorting to precision methods in the production of its parts. Accuracy of control must be secured by means of effective amplifiers of the error signals in compensated measuring circuits.

The operating conditions of regulators are even more varied than those of control devices. Hence, the basic requirements for regulators is wide versatility of elements, including control elements. The regulator must permit various forms of regulation, i.e., different dependencies between a change of the regulated parameter and the action of the final control element. The regulator must be suitable for remote control. Finally, the regulator must, if necessary, provide "dependent" regulation permitting different combinations of separate regulators and connection into a common system for various operational manipulations of the controlled quantities.

Analysis shows that indirect-acting equipment for automatic control and regulation designed on the block-unit principle can be conveniently divided into four structurally independent elements. The first of these is the sensitive element with the primary transducer. The second element is the panel installation comprising the compensating unit and the balancing electric motor. The third is the control element. The fourth element is the performance or final control mechanism (electric, hydraulic, or pneumatic). A system of automatic control and regulation devices for general industrial use must be considered as a single complex. The object of scientific research is no longer a single device but, instead, a system of devices interconnected by specific conditions. From this viewpoint, the most pressing scientific problems pertaining to this field may be divided into two groups: first, the construction of complex automatic control and regulation devices on the basis of the block-unit principle; and second, the complex automatization of industrial installations using devices built on this principle.

The first group has the following problems: (1) determination of efficient designs of automatic devices for various conditions of control and regulation, (2) methods of increasing accuracy, (3) methods of increasing speed of action, (4) means of increasing reliability, and (5) means of reducing equipment costs.

The second group of problems require: (1) a study of the feasibility of complex automatization of technological processes; (2) classification of industrial installations to be regulated, determination of expedient rules for their regulation, and installation of the most advantageous regulators afforded by the block-unit system; (3) a series of investigations of the engineering-economics type to determine the most effective method for automatization of industrial installations; and (4) development of methods for theoretical and experimental analysis of transients in systems utilizing automatic devices, including simulation methods.

The following persons participated in the discussion of the report: Academician I. P. Bardin, Academician V. N. Yur'yev, M. P. Kostenko, Corresponding Member, Academy of Sciences USSR, and others.

In summarizing the discussion, the chairman, Academician B. A. Vvedenskiy, pointed out that the paper and ensuing discussion indicate the great significance of the subject reported upon and the importance of the problem of constructing instruments for automatic control and regulation in the form of a single complex, meeting the requirements of all branches of the industry.

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