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INTERNATIONAL SMALL COMPUTER SYSTEM

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, 1977 pp 3-5

[Article by general designer of SM EVM, Director of InEUM, Corresponding Member of the USSR Academy of Sciences B. N. Naumov]

[Text] A class of computers which are now called small, mini- and micro-computers and which have rapidly conquered extensive areas of application due to a number of characteristic features inherent to them have recently achieved vigorous development in computer technology. The production of machines of this class will increase continuously worldwide and the rates of this growth will surpass the development of computers of other classes. As is known, the structure of the computer stock is changing toward an increase toward mini-computers, which now comprise 60-80 percent of the total number of computers. It is expected that by 1985 hundreds of thousands of installations utilizing mini-computers will be operating throughout the world and the number of micro-computers built into the equipment will reach 12 million by 1985. Thus, the considered class of computers, which we will subsequently call small computers, will become the main, most massive type and will be used in different branches of industry, fields of science, education and in everyday life.

The main distinguishing feature of this class of computer is the minimum cost with maximum (optimum) satisfaction of the user's functional requirements. The range of these requirements is very broad and productivity with a cost of a set of computer equipment from 1,000 to 200,000-300,000 rubles will be provided from 5,000-10,000 to 1 million operations per second (in the near future this will reach several million operations per second), while the internal storage has a capacity from 2-4 to 256 kilowords.

The rapid development of small computers was primarily determined by the appearance of a new component base which makes it possible to achieve sufficiently high technical characteristics at comparatively low cost. On the other hand, the development of small computers was caused by the persistent needs to provide development of efficient control systems of different classes which operate in real time.

Significant results in the field of development and use of small computers have been achieved in the socialist countries. Production of ASVT-M, M-6000, M-7000, M-400 and M-40 control computer complexes, which became the main technical base of the ASU TP [automated control system of production processes] and systems for automation of scientific experiments, was organized in the USSR during the period 1971-1975. The small computers "Robotron-4000" and "Robotron-4200," developed in East Germany, the MERA-300 and others, produced in Poland, are known by their high technical characteristics and developed software. The following small computers have been developed and are being manufactured serially: the IZOT-310 in Bulgaria, the YeS-1010, TRA/70 and TRA-11/40 in Hungary, the SID-1000 and SID-2000 in the Republic of Cuba, the "Felix-32" in Rumania and the RPP-16 in Czechoslovakia. However, this work was carried out during the previous five-year plan without the appropriate coordination, which did not permit mutual use of many results achieved due to the incompatibility of machines in the apparatus and program sense.

Taking into account the importance of this direction of computer technology for the national economy, Hungary, Bulgaria, East Germany, the Republic of Cuba, Poland, Rumania, the USSR and Czechoslovakia decided in mid-1974 to organize joint work to develop a small computer system. The purpose of this cooperation is to develop a complex of computer facilities in the small computer class and to organize large-scale production of them on the basis of the specialization and cooperation of the socialist countries.

The international small computer system (SM EVM) is being created as a unit system of hardware and software of computer technology, normative, methodical and operational support and standards, linked by rational compatibility and standardization of systems, architectural and design solutions intended for construction of control computer complexes used in control systems of production processes and units, in systems for automation of scientific investigations, in systems for design automation, in control systems of objects of the nonindustrial sphere and also to make small commercial and engineering calculations.

The international small computer system is being developed on a modern technical level which also permits transition to a new level and to expansion of systems applications of computer technology in the national economy. The two international systems -- YeS EVM and SM EVM -- in combination, by supplementing each other, will essentially become the technical base for automation of data control and processing in all spheres of the national economy of the socialist countries.

Improving the effectiveness of using systems constructed on the basis of the SM EVM should be provided by the following main factors:

complex use of the scientific-technical and production potential of the participating countries of the agreement to develop the SM EVM for creation and extensive introduction of a unified joint family of small computers which satisfy the leading international systems of standards for software and hardware;

a high level of adaptation of hardware-software of SM EVM to the class of problems solved and to the operating modes of control objects;

provision of the possibilities of systems development during operation when new problems appear;

significant reduction of the deadlines and reduction of expenditures for development and introduction of systems based on the SM EVM;

the possibility of constructing efficient multiprocessor computer systems and networks with a common and separate memory field and with generalized peripherals;

configuration of computer technology facilities in the ASU [automated control system] by the design method;

improvement of the maintainability and serial production of hardware and software, reduction of the periods of serial development, extensive use of integrated circuits of improved degree of integration (with conversion to large integrated circuits -- BIS -- and to microprocessors in the near future), reduction of the cost of computer complexes and an increase of dependability compared to the small computers now produced.

International cooperation in the field of developing the new family of computers -- SM EVM -- opens up extensive possibilities for effective solution of the postulated goals and contributes to combining the efforts of countries in a significant improvement of the efficiency of production, scientific investigations and design by developing a system on a unified hardware-software base.

Development of the SM EVM is oriented toward significant development of the technical level of ASU in the following directions.

1. Efficient combination of decentralization and centralization of the functions of monitoring production processes and scientific experiments during construction of systems: process control by integral indicators and unmeasurable (calculated) parameters.

Decomposition of a complex ASU TP into a number of subsystems which utilize joint, freely-programmable small computers and programmed automats yields the following advantages in many cases: debugging of the entire system and putting it into operation are simplified since independently allocated subsystems are being developed with restrictions clearly defined by the problems; development of the software and debugging of individual programs are simplified; a basis is created for the use of direct numerical control and gradual rejection of the use of rigid specialized local automated systems and cumbersome panels with display instruments at the low level of ASU TP.

2. Development of adaptive control systems based on improving the accuracy and reliability of information and coordination of monitoring process parameters with monitoring the state of the equipment.

3. Development of dispatching functions and operative correction of tasks and redistribution of functions between the ASU TP and ASUP [automated control system for enterprises] with easing the load of the former of record-keeping information.

Based on the facilities of the SM EVM, it is proposed that operative production control systems be developed significantly in machine-building with provision of solving such problems as automatic data gathering on production of articles and on the state of equipment, adaptive control of the conveyor and feed mechanisms and unloading of finished articles, numerical program control of equipment (sections and groups of machine tools of the processing center type) and communication with an upper-level computer at the shop and section level. These capabilities of the SM EVM should provide the required prerequisites for development of integrated production control systems.

4. Orientation of the systems applications of the SM EVM toward technical test stations and diagnosis of complex objects. Test systems using the SM EVM can be constructed as single-level -- at the section level of input monitoring or postoperational checks -- and as multilevel -- product quality control systems within the framework of the enterprise with a specific nature of production. The characteristic feature of using computers in this field is that the computer should solve optimized problems and real-time and time-sharing modes should be provided.

5. Improving the level of redundancy and the functional survivability of the facilities and complexes of the SM EVM.

6. Development of the methods and forms of human operator-system interaction, data "compression," and analysis of the consequences of errors introduced by operators (similar to monitoring equipment breakdowns). This is important for improving dispatcher control systems (for example, in power engineering), simulator complexes and so on.

7. Provision of the capability to control complex measuring systems or production equipment using "built-in" facilities of the SM EVM due to the small dimensions, high productivity and sufficiently large information storage of the SM EVM.

8. Development of modular programming systems for typical monitoring and control problems and of specialized instruction languages.

Technical and information joining of control systems into integrated ASU which provide coordination of the problem solved at different levels of control becomes possible as a result of improving the level of control automation and improvement of the hardware and software during development of the SM EVM.

A wide range of hardware and software is required to construct control computer complexes in the indicated spheres of application.

The international small computer system includes the following groups of devices: a baseline series of processes of different productivity (up to 1 million operations per second) -- SM-1, SM-2, SM-3 and SM-4 (the first unit), a wide range of input-output devices, external stores, display devices, object communications devices, remote communications devices and intramachine and extramachine communications devices.

The total nomenclature of devices of the first unit of the SM EVM comprises approximately 70 items. By the anniversary of the Great October Socialist Revolution, the scientific and production collectives of a number of socialist countries had completed a large complex of developments of devices of the first unit of the SM EVM and carried out intergovernmental trials of them. Production of the baseline processors SM-1 and SM-3 of the first unit of the SM EVM was begun in 1977, while production of SM-2 and SM-4 processors will begin in 1978. The production of peripheral devices of the first unit of the SM EVM will also be begun and carried out in the USSR and in other socialist countries participating in development of the SM EVM.

The nomenclature of the hardware of the second unit of the SM EVM is based on the use of BIS and microprocessors for construction of programmable controllers of peripherals and microprocessor realization of the smallest models of the SM EVM. The component base of this nomenclature is comprised by three microprocessor series (sets) of BIS, distinguished by their speed and consumed power. These sets are standardized by design version and will have the required signal-level matching components. The use of modern modules of semiconductor of internal and prominent storage devices will be extensively felt in improving the parameters of the devices and complexes of the SM EVM.

The configurations of the control computer complexes which expand the capabilities of models of the first unit of the SM EVM using microprocessors will mainly have a number of computer systems with expander-processors. The compatibility of central computer devices with the processors of the first unit will be retained in these systems and the possibility of realizing some software functions by the apparatus method and easing the load of the central processor by performing a number of functions by the expander-processors (input-output processors, file control processors, communications processors in multimachine systems, specialized processors for Fourier transformation and other processors -- "identifiers" and "optimizers" of the dynamic properties of control processors) will be provided.

The use of specialized processors in combination with models of the first unit of the SM EVM will make it possible to develop computer and control complexes with average productivity in solving problems of a given class which exceed several tens of times the productivity of the central processor.

A significant part of the control devices (controllers) of the peripheral equipment will also be realized on the basis of microprocessors. In this case the same functional modules for performing given functions will be

programmed at the level of microinstructions or ordinary instructions of microprocessors. This will permit extensive standardization of the apparatus, reduction of apparatus expenditures for realization of devices with fixed logic (due to representation of the logic in the form of some sequence of instructions rather than a combination of logic conditions), improvement of flexibility in design and introduction of systems and improvement of dependability.

Microprocessor realization will primarily be concerned with functionally complex peripherals whose characteristics are now being reflected extensively in the cost and dependability of systems. These devices include controllers of external storage devices (magnetic disk and magnetic tape storage devices), control blocks for gathering and transmission of signals in devices for communicating with the object, controllers of peripheral systems combined with a central computer (for example, KAMAK controllers), data transmission multiplexers and adapters which implement specific error-protection algorithms, data gathering and information printout devices for communicating with several terminals and interpolation blocks in numerical program equipment control systems.

Moreover, as microprocessor sets of BIS are used, it will become possible to develop inexpensive models of micro-computers of the second unit of the SM EVM with relatively low productivity (less than in the first unit), compatible with the main models of the family. Specifically, these models will permit one to develop "office-computers," logic control devices (for example, for units of the oil and gas industry, in power engineering and so on), devices for program control of machine tools and equipment of the CNC type and centralized monitoring machines with significantly higher technical-economic indicators.

It should be noted that transition to the new component base will significantly alter the nature of developments of the new nomenclature of hardware. Besides the named trends of expanding the nomenclature of equipment of the SM EVM by reducing the cost and improving the dependability of the component base, development of old models which have significantly higher productivity (several million operations per second with an internal storage capacity up to 1-2 Mbytes) than models of the first unit of the SM EVM, but having similar economic indicators, is provided in the second unit of the SM EVM.

Old models of the SM EVM are designed for the other circuits of systems operating in real time where gathering and processing of large information flows or solution of complex problems must be provided for which the productivity of ordinary mini-computers is inadequate and the use of large universal computers is inefficient. These systems include, for example, systems for complex scientific investigations, testing of complex objects and optimum control of rapidly occurring processes.

The old models of the SM EVM will have flexible features by providing program compatibility with several of the most widely used families of small computers. Their configuration is also oriented toward efficient realization

of high-level programming languages to sharply reduce labor and machine-time expenditures for development and debugging of complex applied programs, toward efficient combination of small and old models of the SM EVM in multi-machine complexes, toward development of the principles of constructing multi-processor complexes designed for given dependability (survivability) and productivity and toward development of computer networks and time-sharing systems where the facilities of the SM EVM will play the role of commutation devices and computer terminals.

Development of the second unit of the SM EVM will provide creation of peripheral equipment of the SM EVM with high technical-economic indicators, including devices based on new principles: external storage on cylindrical magnetic domains, laser printers, solid-state display devices, adaptive text reading devices (including manuscript), speech input-output devices and so on.

The software systems of small computers are being developed with regard to the restrictions which are imposed by the technical characteristics of the apparatus and primarily with regard to the need to use the smallest possible storage capacity. The desire to simplify the software of modern small computers compared to large computers is now being noted. This is determined not only by economic concepts but also by the requirements of the accessibility of the machine to the nonprofessional programmer.

The operational systems in large computers occupy up to 70 percent of the machine time for dispatcher type operations, which makes it difficult to use them in real-time problems. The operational systems of small computers are now much simpler -- universality is not required of them and many service and control functions are carried out by the apparatus. At the same time these systems are effectively solving the main problem jointly with the apparatus -- they provide multiprogram operation in real time.

On the other hand, the need to provide operation of small computers in systems and in the required modes (real time, packet, data gathering, dialogue and time-sharing) determines the feasibility of developing a set of operational systems which effectively realize any one of the modes. These systems are simpler than universal systems of large computers.

A very important trend is making it easier for the user to program various applied problems. It is desirable in this plan to provide those programming systems and libraries of finished program modules which would require instruction from the user of only the required functions (which the system should do), freeing him of concerns of how it will be carried out. Development of questionnaire programming systems for the SM EVM (of the "fill-in-the-blank" type), oriented toward the larger and more important classes of systems applications, is being carried out in this direction.

At the same time investigations are being developed to create more efficient problem-oriented programming languages and to realize the corresponding translators. For example, realization of a specialized control language in real time in the SM EVM should be regarded as urgent.

Software systems for working with data files of complex structure, which will provide development and introduction of local data banks and information retrieval systems, will play an important role in development of the applications of small computers. It is suggested that significant attention be devoted to software of improved dependability and survivability of systems based on the SM EVM with redundancy of the most crucial devices and functions.

As already noted, there is sufficiently extensive experience in the socialist countries in development of small computers and their systems application. In this regard the problem of the continuity of the software and the experience of developing control systems arises. It is suggested that special software (cross-compilers, converters and so on), which facilitate the process of transferring the corresponding programs to the SM EVM, be developed in the software of the SM EVM to solve this problem.

The latitude of the spheres of application of the SM EVM provides the requirement of the "universality" of the software structure of the SM EVM, while keeping a record of the characteristics of use of small computers, i.e., maximum orientation toward the user, determines the requirement of specialization. New requirements are also being advanced on organization of software production. Very promising is the conversion to industrial methods of producing software and documentation from specialized program components.

The following types of program components (units) may be distinguished: programs which provide logic-mathematical data processing regardless of the sphere of application, programs which provide efficient functioning of different hardware, programs which realize the functions of user interaction with the system with regard to specific characteristics (occupational and national) of spheres of application (for example, data output in a form used in a given branch, printout of commentaries in the language of the user country and so on), programs which realize different methods of organizing the computing process (the packet mode, time-sharing mode and so on). Efficient systems of specific designation will be developed from the set of program components of each type by using an automated software production system according to customer orders.

The development of the SM EVM is a joint project of countries of SEV [Council of Mutual Economic Assistance], by which the efforts of the participating countries are combined in development of the software, primarily applied program packets. Organization of a unified software stock for the SM EVM (similar to the software stock for the YeS EVM) is being provided.

The scientific, design and production collectives of the socialist countries -- participants in cooperation in the field of computer technology -- are dedicating the results of their labor and their first successes in creation of the SM EVM to the anniversary of the Great October Socialist Revolution.

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CONTROL COMPUTER COMPLEXES SM-1 AND SM-2

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, 1977 pp 6-9

[Article by deputy general designer of SM EVM, Deputy Director of the NII UVM for Scientific Work, Candidate of Technical Sciences V. V. Rezanov and Candidate of Technical Sciences V. M. Kostelyanskiy]

[Text] The SM-1 (Figure 1) and SM-2 control computer complexes (UVK) are designed for use in ASU [automated control system] of units, production processes and plants, in experimental research complexes, for preliminary processing of complex equipment test results, geological prospecting data, medical-biological research, in information retrieval systems and so on.

The SM-1 and SM-2 complexes are configured according to the specifications of the customer on the basis of the SM-1P and SM-2P processors from unit modules of the small computer system (SM EVM) with use of peripherals from the nomenclature of the M-6000/M-7000 system of the ASVTM if necessary. These complexes have complete program compatibility with the M-7000 system and one-way compatibility at the level of transportable programs with the M-6000 system and also total compatibility with the given systems by the input-output interface.

Multiprocessor computer systems with a common storage field and common or separate peripherals can be configured on the basis of the SM-2P processors. The SM-1 and SM-2 complexes completely replace the M-6000 and M-7000 complexes, respectively, by typical parameters and structural capabilities.

A new method of design configuration is used in the SM-1 and SM-2 UVK. Any unit module is made either in the form of a so-called "self-contained complete block" -- structurally complete, with self-contained power supply, built-in ventilation system or as an incomplete design (a block of components realized on a printed circuit card or a partial insert block), installed in the design of the self-contained complete block (another unit module), where a location, power supply and ventilation are provided for it. The self-contained complete block may be moved in a standard rack (without requiring any additional design work, calculation and installation of power supply and so on in this case), on a desk, support rack, in a cabinet and so on.

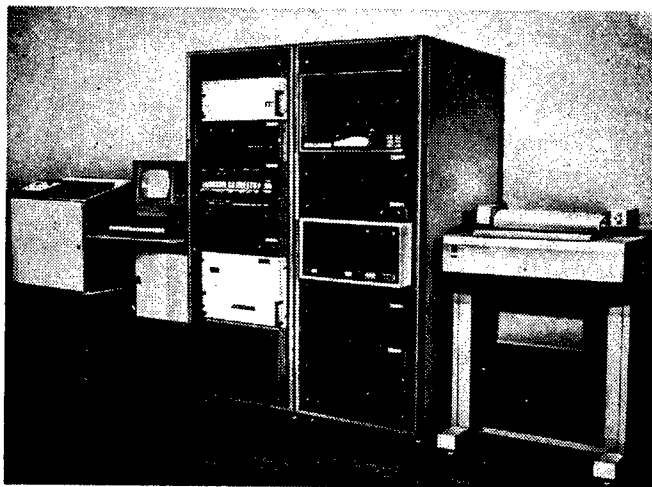


Figure 1. SM-1 Control Computer Complex

This realization considerably simplifies the design configuration, installation, reconfiguration and maintenance of the complexes compared to the ASVT-M and other previously produced computer equipment systems.

The SM-1 and SM-2 complexes with their small overall dimensions and comparatively low cost provide high productivity, high operational characteristics (developed capabilities in monitoring and diagnosis, automation of system recovery during breakdowns, automation of the initial program load and starting of the system) and problem orientation of the configuration (the possibility of expanding the instruction system both by standard sets of additional instructions and by special instructions of the user).

One can configure local and territorially dispersed multimachine complexes on the basis of the SM-1 and SM-2 UVK. Data can be transmitted in dispersed complexes and also between complexes and terminals by telephone, telegraph and special communications lines. Integration with the YeS EVM, the KAMAK system, the domestic unit systems ASET, ASKR, ASPI, KTS LIUS and so on is provided. The comparative characteristics of the M-6000, SM-1, M-7000 and SM-2 UVK are presented in Table 1.

The Central Processing Devices of the SM-1 UVK

A block diagram of the nucleus of the SM-1 UVK is presented in Figure 2.

In design the SM-1P processor is made in the form of a self-contained complete block which may be installed on a desk (the instrument version) or placed in a typical rack of the SM EVM together with other complete blocks. The processor P, including the microprogram memory of the processor and channel and the engineering panel, the internal storage control block which provides connection of up to 16K words of memory, up to 4 internal storage

Table 1

(1) Параметр	(2) Тип УВК			
	M-6000	CM-1	M-7000	CM-2
Максимальный объем оперативной памяти в кбайт (3)	64	64	256	256
Объем микропрограммной памяти в кбайт (4)	—	8	8	16
Число рабочих регистров, адресуемых: (5)				
в программе, без учета регистра номера команды, регистров баз, защиты и т. д. (6)	2	4	4	4
в микропрограмме (7)	—	30	7	17
Время выполнения основных операций в мкс (8)				
сложения с фиксированной запятой (9)	5	2,5	2,5	2,2
умножения с фиксированной запятой (10)	43	36,6	11	10
сложения с плавающей запятой (11)	—	—	35	18-40
умножения с плавающей запятой (12)	—	—	35	23
передачи управления (13)	2,5	2,5	1,6	1,8
Максимальная скорость КППД* в К слов в секунду (14)	400	250	340	700
Возможность проблемной ориентации системы команд (15)	Нет	Есть	Есть	Есть
Автоматический рестарт (16)	—	—	Нет	—
Совместимость: (17)				
по потребительским программам (18)	—	—	—	—
по интерфейсу ввода-вывода (19)	—	—	—	—
Возможность встраивания в установки, приборы (20)	Нет	Есть	Нет	Нет
Агрегатность конструктивного исполнения (21)	—	—	—	Есть

*Direct memory-access channel.

KEY:

- | | |
|--|---|
| 1. Parameter | 11. addition with floating decimal |
| 2. Type of UVK | 12. multiplication with floating decimal |
| 3. Maximum internal storage capacity in kbytes | 13. control transfer |
| 4. Microprogram storage capacity in kbytes | 14. Maximum speed of KPDP, K words per second |
| 5. Number of working registers, addressed | 15. Possibility of problem orientation of instructions system |
| 6. in the program without regard to the register of the number of the instruction, base and protective registers and so on | 16. Automatic restart |
| 7. in the microprogram | 17. Compatibility |
| 8. Time to complete main operations, microseconds | 18. by user programs |
| 9. addition with fixed decimal | 19. by input-output interface |
| 10. multiplication with fixed decimal | 20. Possibility of building into installations or devices |
| | 21. Completeness of design version |
| | 22. No |
| | 23. Yes |

devices (OZU) with total capacity of 16K words and up to 10 peripheral interface blocks (IBPU) which yield a power supply source and blowers for the 2K (I 2K) interface are located in the self-contained complete block.

Besides the main variant of the SM-1P processor described above, a variant with the M-6000 UVK instruction system, which provides complete program

Main Specifications of the SM-1P (A131-10) Processor

Control principle	Microprogram
Control memory:	
digit capacity in bits	18
storage capacity (number of words)	4,096
access cycle, microseconds	0.3
Number of working registers, addressable:	
in programs	5
in microprograms	30
Digit capacity of registers in bits	16
Cut-off system	Multilevel
Time to complete addition type operation (register-storage), microseconds	2.5
Direct storage access channel (built into processor):	
control principle	Microprogram
maximum rate of data exchange in monopole mode, thousand words per second	250
rate of data exchange with simultaneous operation of processor and channel, thousand words per second	100
Internal storage:	
digit capacity, bits	18 (16 informa- tion and 2 moni- toring)
Maximum storage capacity, K words	32
Access cycle, microseconds	1.2
Maximum number:	
of connected peripherals with one-level addressing	55
of peripherals with use of RIM A714-5 expansion module with two degrees of addressing	1,728
Overall dimensions, mm	482 x 310 x 690*

compatibility with the M-6000 processor not only in transportable but also in absolute programs, can be delivered to users upon request.

Main Specifications of the A211-15 Internal Storage

Storage capacity (number of words)	4,096
Digit capacity, bits	18
Access cycle, microseconds	1.2
Sampling time, microseconds	0.55
Overall dimensions, mm	355 x 350 x 18.5

*Here and further the overall dimensions of the devices are presented in the order of width x height x depth.

In design, the devices are made in the form of self-contained complete blocks in which are located the storage blocks, control blocks, interface blocks for connection to the SM-1P processor, blowers and secondary power supply sources.

The A151-6 input-output matcher (SVV) is designed to increase the number of peripherals connected to the SM-1P processor. Up to three input-output matchers may work with the processor. There are 16 outputs for the I 2K in each SVV, but one of the outputs for the I 2K in the processor is occupied to connect each SVV. Thus, the maximum number of outputs for the I 2K in the SM-1 UVK (at the first level) is 55 ($16 \times 3 + 10 - 3$). The input-output matcher is made in the form of a self-contained complete block which can be installed on a desk or located in the standard rack of the SM EVM together with the other complete blocks. The dimensions of the SVV are 482 x 278 x 690 mm.

The SVV control device, up to 16 IBPU which emerge to the I 2K, a power supply source and blowers are located in the SVV.

The nominal power supply voltages of the interface blocks provides by the SVV power supply source are presented in Table 2.

Table 2

(1) Напря- жение в В	(2) Макси- мальный ток в А	(3) Нестабиль- ность в %
+5	12	2,5
-5	1,5	2,5
+12,6	1	2,5
-12,6	1	2,5
+24	0,5	1
-24	0,5	1

KEY:

1. Voltage, V

2. Maximum current, A

3. Instability, percent

A block diagram of the nucleus of the SM-2 UVK is presented in Figure 3.

The SM-2P processor is made in the form of a self-contained complete block with engineering panel where a processor, control memory, power supply sources and blowers are located and where a location is also provided for installing the KMR-8 eight-channel switchboard, by use of which the processor communicates with the UOP and SVV. The delivery set of the processor contains a single monitoring block designed for mutual monitoring of the processors. The SM-2P processor is installed in a standard rack of the SM EVM jointly with the other unit modules.

The A211-18 internal storage device is a self-contained complete block consisting of internal storage blocks, power supply source and blowers where there is also a place for installation of the KMR-4 four-channel switchboard, used to communicate with the SM-2P processors and the A152-6 KPDP.

Main Specifications of the SM-2P (A131-11) Processor

Control principle	Microprogram
Control memory:	
digit capacity, bits	36
storage capacity (number of words)	4,096
access cycle, ns	300
Number of working registers, addressable:	
in programs	6
in microprograms	17
Digit capacity of registers, bits	16 and 32
Cut-off system	Multilevel
Time to complete register-memory operation, microseconds:	
with fixed decimal:	
addition	2.2
multiplication	10
division	17
with floating decimal:	
addition	18-40
multiplication	23
division	40
Internal storage capacity, K words:	
minimum	32
maximum	128
Maximum number of connected:	
peripherals with one-level addressing	56
peripherals with use of A714-5 RIM expansion module with two degrees of addressing	1,764
Overall dimensions, mm	482 x 310 x 770

Table 3

(1) Напря- жение в В	(2) Макси- мальный ток в А	(3) Нестабиль- ность в %
+5	10	2,5
-5	1,5	2,5
+12	1	2,5
-12	1	2,5
+24	1	3
-24	1	3

KEY:

1. Voltage, V
2. Maximum current, A
3. Instability, percent

The A491-6 input-output matcher is designed to connect peripherals to the SM-2P processor. It is made in the form of a self-contained complete block where the matcher itself, power supply sources and blowers are located and where a place is also provided for installation of up to 16 IB interface

Main Specifications of A211-18 Device

Storage capacity, K words	32
Digit capacity, bits	18
Access cycle, microseconds	1
Sampling time, microseconds	0.5
Overall dimensions, mm	482 x 400 x 755

blocks (16 outputs per I 2K) and a four-channel switchboard by means of which the SVV is connected to the processors and the KPDP. The overall dimensions of the SVV are 482 x 355 x 755 mm.

The nominal power supply voltages of the interface blocks provided by the power supply source of the SVV are presented in Table 3.

The A152-6 direct memory-access channel is designed for rapid exchange of information between the internal storage and the peripherals. A maximum of 48 peripherals connected through the SVV and two peripherals directed to the KPDP through the I 2K are accessible to the channel. The channel can service up to four input-output devices connected through the SVV or one input-output device connected directed to the KPDP simultaneously. Control information is transmitted to the latter through the special Bif-77 block contained in the delivery set of the KPDP and the SVV (see Figure 2). The Bif-77 block can be connected to the output to the I 2K of one or another UVK. Two-way control of the KPDP is possible. Variants of organizing control of the KPDP are shown in Figure 4, a-c.

The channel is made in the form of a self-contained complete block where the KPDP itself, a power supply source and blowers are located and where there is also a place for installing the KMR-8 eight-channel switchboard by means of which the channel communicates with the UOP and SVV modules.

The channel provides the following maximum rates of data exchange: with word volume of 400,000 per second and with byte volume of 550,000 per second with servicing of the device connected through the SVV; with word volume of 700,000 words per second and with byte volume of 1,100,000 words per second during servicing of the device connected directly to the KPDP. The dimensions of the KPDP are 482.6 x 221.5 x 755 mm.

The KMR-8 eight-channel and the KMF-4 four-channel switchboards are designed to provide intrasystems communications between the SM-2 devices of the UVK. Complete matrix commutation (radial communications) of each processor and channel with each UOP and SVV is realized by using a distributed switchboard in the UVK.

An eight-channel commutator is installed in the processor or channel and a four-channel commutator is installed in the UOP or SVV. The commutators have no independent power sources and receive power from the modules in which they are located. The delivery set of the KMR-8 commutator contains

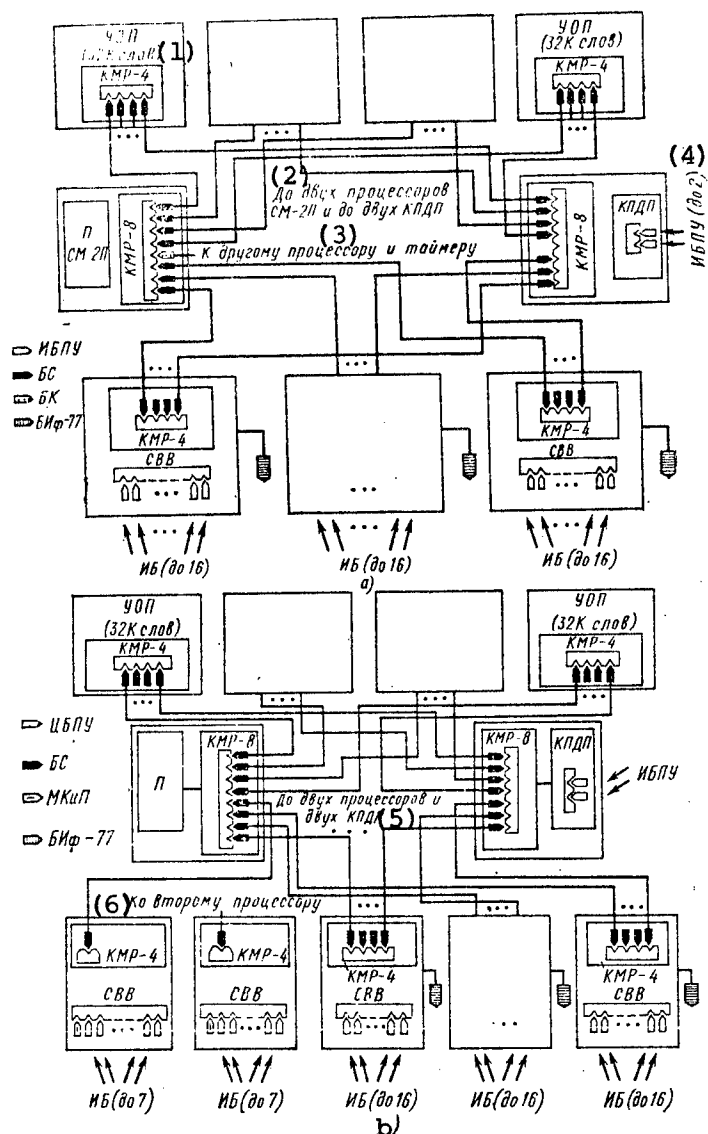


Figure 3. Block Diagram of SM-2 UVK: a -- first variant (BS -- communications block; BK -- monitoring block; BIF-77 -- interface block for assigning control information to the channel); b -- second variant (MKiP -- monitoring and restart module)

KEY:

- | | |
|--|--------------------------------------|
| 1. Words | 4. Up to |
| 2. Up to 2 SM-2P processors and up to 2 KPDP | 5. Up to two processors and two KPDP |
| 3. To the other processor and timer | 6. To the second processor |

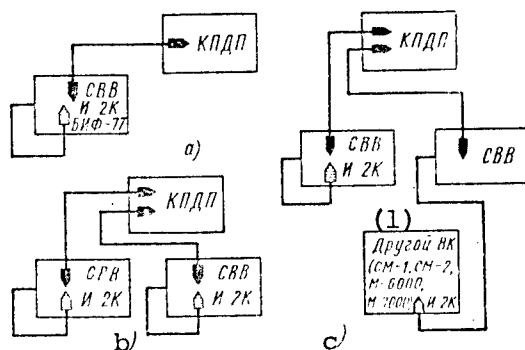


Figure 4. Variants of Direct Memory-Access Channel Control

KEY: 1. Another VK

four communications blocks and two bunches which provide the possibility of connecting one UOP and one SVV to the processor or channel (two communications blocks are installed in the KMR-8, one UOP is installed in the KMR-4 and one SVV is installed in the KMR-4). If a greater number of UOP and SVV must be connected, additional communications blocks and bunches must be acquired. The dimensions of the KMR-4 and KMR-8 commutators are 254 x 150 x 217 and 254 x 194.5 x 217 mm, respectively.

Input-Output Organization

Input-output operations provide data transmission from the internal storage or the processor registers to the peripheral or from the peripheral to the internal storage or processor registers. The peripherals are connected to the UVK through the I 2K.

The 2K interface. The 2K interface contains the following busses (some auxiliary busses are omitted):

a) busses which transmit signals from the processor or channel to the peripheral device (output busses) -- information ShIN0-K -- ShIN15-K (16 busses), check bits KR0-K and KR1-K (2 busses) and the signals "Issued" VD-K (1 bus), "Receive" PR-K (1 bus), "Execute" VP-K (1 bus), "Stop" OST-K (1 bus) and "Common dump" OSB-K (1 bus);

b) busses which transmit signals from the peripheral to the processor or channel (input busses) -- information ShIN0-T -- ShIN15-T (16 busses), check bits KR0-T and KR1-T (2 busses) and the signals "Absence of check" OK-T (1 bus), "Ready" GT0-T, GT1-T and GT2-T (3 busses), "Error" OSh-T (1 bus) and "End of operation" KOP-T (1 bus).

The information busses ShIN-K (part of the busses may not be used in the peripheral) are designed to transmit instructions or data to the peripheral. Data is transmitted to the bus ShIN-K by the processor program or by the

channel microprogram and is accompanied by a control signal of bus VD-K, transmitted through the main systems to all outputs of the 2K interface, and by the signal of bus VBR-K, which travels to one selected output. These control signals are used to form a data receiving gate to the buffer register of the interface block.

The busses of check bits KRO-K, KRI-K, KRO-T and KRI-T are used to transmit check bits for each byte of transmitted data. The processor generates data with check bits, while the peripheral generates data both with and without check bits. A special bus OK-T is used to delimit these two cases (the information issued by the peripheral is checked or not).

The information busses SHIN-T (similar to bus SHIN-K, part of the busses may not be used in the peripheral) are also designed to transmit information data on the state of the peripheral to the processor or channel. The peripheral transmits data to bus SHIN-T upon receipt of the signal of bus PR-K and a signal corresponding to the sampling code of bus VBR-K.

The signals of busses VP-K and OST-K, generated by the processor or channel, are used as control signals; their designation is determined by the type of peripheral. Similar to signals of busses VP-K and OST-K, upon designation of signals OSh-T and KOP-T, they are based on the type of peripheral; these signals are usually employed to report on the state of the device.

The signal of bus GT-T is used to indicate whether the peripheral is ready to begin (continue) the input-output operation. This signal can be analyzed by special processor instructions. A cut-off request is formed on the basis of the signal of bus GT-T during servicing of the device through the processor or channel cut-off system.

In design, any peripheral contains a so-called interface block located directly in the processor or the input-output matcher. The peripheral device may be structurally formulated in the form of one or several interface blocks (for example, a timer, analog-digital converter, discrete signal input modules and so on) or in the form of a unit module which contains one or interface blocks. In the latter case the interface blocks are connected to the remaining part of the module by special bunches.

When executing the data output operation under microprogram control, a signal is transmitted from the processor registers to the input-output busses. At the same time control signals which identify the interface block by the sampling code indicated in the instructions and which provide data reception to a specific register of this block, are generated along with the data. The output operation is completed with this. Further processing of the data received in the register is accomplished under control of the peripheral circuits.

Upon execution of the input operation, the data recorded in the buffer register of the peripheral, which may be located directly on the interface

block or in the main structure of the device, is transmitted to the input-output busses and is then received in the processor registers. The interface block which issues data to the input-output busses is identified by the sampling signal according to the sampling code indicated in the instructions. The number of signals of busses VBR-K and GT-T used in the interface block depends on the complexity of the connected peripheral and on which interface blocks connect the given device to the complex. Several signals of busses VBR-K and GT-T at each interface output make it possible to connect through a single interface block a complex multifunctional device in which more than one signal of bus GT-T and more than one signal of bus VBR-T is used to separate the functions.

The following peripheral service modes are distinguished: interrogation of readiness signals by the processor program; interrogation of readiness signals by the channel microprogram (in the SM-1 UVK); servicing of peripheral requests in the program cut-off mode; servicing of peripheral requests in the microprogram cut-off mode (in the SM-1 UVK); and servicing of KPDP devices (in the SM-2 UVK).

In the readiness signal interrogation mode by the program, the processor, having received or transmitted the next portion of data and having processed it, expects to receive a readiness signal from the device. This mode is accomplished without integration with calculations and the operation of other devices and is feasible during servicing of high-speed peripherals. The maximum capacity in this mode is approximately 30,000 words per second.

In the peripheral interrogation servicing mode, the processor by using special instructions establishes through the program cut-off system which devices may interrupt the program, after which it continues to carry out the program.

If a readiness signal from the peripheral appears and if all the conditions are satisfied, a request is formed to interrupt the processor program and control is transferred to the program for processing the cut-off request. Upon completion of request processing, the interrupted program continues. In this mode the operation of the peripherals is integrated with completion of the main program by the processor. The capacity of the program channel during operation with interruptions depends on many factors, specifically on the response time of the processor to interrogate the device and the time to service the request. The processor response time to interrogate the device is determined by the priority of the given device, the time to service the requests of devices of higher priority and by the configuration of the UVK.

The peripherals of the KPDP in the SM-1 UVK may also be serviced in the monopole mode (without integration with readout) or by interruption of the microprogram. In the first case the maximum capacity is 250,000 words per second, in the second case it is equal to 100,000 words per second, but in this case integration of input-output with readout is provided.

The KPDP performs input-output operations independently of the processor in the SM-2 UVK. A mutual effect is manifested only upon an attempt at simultaneous access to the same storage module. In this case priority is given to the channel, while the operation of the processor is delayed by the time of a single storage cycle. The maximum capacity for devices connected to the SVV is 400,000 words per second and for those connected directly to the KPDP it is 700,000 per second.

Description of the nomenclature of peripherals will be presented in the following issues of the journal.

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SOFTWARE FOR THE SM-1 AND SM-2 UVK

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[Article by deputy general designer of the SM EVM, Deputy Director of NII UVM for Scientific Work, Candidate of Technical Sciences V. V. Rezanov and Candidate of Technical Sciences V. M. Kostelyanskiy]

[Text] The software for the SM-1 and SM-2 UVK was constructed by the unit-module principle, which permits configuration of program systems according to the required operating modes and functions performed in a given configuration of apparatus facilities.

The software for the SM-1 and SM-2 UVK includes operational systems, files, problem-oriented packets of program modules, a program preparation system and service and monitoring diagnostic programs.

The software is delivered according to the user's specifications in the form of specified program systems or a set of program modules, from which the user himself configures the required program system.

Operational Systems

The operational system realizes the given set of functions upon generation for control of the solution of problems, input-output, files, for communications with the system operator and also for logic reconfiguration of the complex in abnormal situations (equipment failures) and correction of them.

All the working programs in a single-problem operational system are configured into a single problem and are carried out in a given sequence during configuration without interruption of each other. But time integration for completing the problem and one or several input-output operations are provided in this case.

The working programs in a multiproblem single-processor operational system are configured into several problems, for each of which priority and starting conditions are given (for example, the time of the first start and the period of repetition).

The processor solves at each moment of time the highest priority problem among those ready for completion. The remaining problems in a state of readiness are controlled if problems with higher priorities are in a state of waiting for any event (completion of an input-output operation, passage of a time interval, a change of state of the initiative signal input module and so on). A problem with low priority is interrupted if such an event begins. The maximum storage capacity occupied by a single problem is 32K words. The problems can be joined into groups (sections) and the total storage capacity occupied by a section should also not exceed 32K words.

Storage protection between sections and also protection of the input-output system against unprivileged (user) programs is provided in the SM-2 UVK. This permits debugging of the programs simultaneously with completion of crucial problems. There may be only a single section in the SM-1 UVK and storage protection is not provided. But modernization of the SM-1 UVK is planned in which basing and storage protection will be introduced.

The multiprogram multiprocessor operational system (it operates only in the SM-2 UVK) is distinguished from the multiprogram single-processor system by the fact that it simultaneously provides completion of two old problems in priority on two processors. Like the operational system, the problems are stored in the general internal storage of the UVK in a single copy and are not assigned in any way beforehand to the processors. If a problem solved by one of the processors changes to a state of waiting for any external event with respect to it, this processor is switched to solution of a less important problem which is not being completed by another processor. If there is no problem ready for completion for the processor, it is switched to a dynamic stop state.

If there is a reverse change of state of any of the problems (transition from a standby state to a state of readiness for completion), the processor in the dynamic stop state or one completing a problem of lesser priority is switched to accomplish it. If both processors solve problems with less priority, the processor realizing a problem with lesser priority compared to the other processor is switched to complete the new problem. Switching to a new problem does not occur if both processors have completed more important problems at the moment the problem is transferred to a state of readiness.

There is a possibility of assigning another problem distribution mode between processors during generation of the system in which, besides problem priority, shifting of the problems to the internal storage modules is taken into account. In this mode two old problems, but located in different internal storage modules, are completed at each given moment. Because of this higher productivity of the system as a whole is achieved since delays related to simultaneous access of two processors to the same storage module are eliminated.

In nondisk variants of operational systems, all the programs of the operational system and all the working programs are continuously located in the internal storage of the complex. In disk operational systems both the system

and working programs are divided into two types: OZU-resident which are permanently located in the internal storage during operation of the system and disk-resident, stored on a disk and summoned to the internal storage only if they must be completed. This makes it possible to save the internal storage of the system at the price of an additional delay in calling up the disk-resident program (the average loading and starting time of the disk-resident program is approximately 100 ms, while the average time of switching OZU-resident programs is approximately 1 ms) and the impossibility of simultaneous completion of two programs adjusted to the same storage region. Therefore, seldom completed programs and programs insensitive to delays should be referred to the disk-resident bit.

By using an operational system, the user programs the input-output operations in his own problems regardless of the specific type of peripheral and the method of connection. The user program has access to the peripherals by so-called "logic numbers." Conformity between logic numbers and specific (physical) devices is established upon generation of the system and may be changed during operation upon the operator's instructions.

The operational system gives the user the following additional capabilities, related to input-output: assigning several logic numbers to the same physical device; assigning several physical devices to the same logic number (so-called alternative devices)*; postulation of a request in turn upon access to a device occupied by an input-output operation (given by one or another problem); integration of completing an input-output operation while continuing to complete problems or while a problem is awaiting completion of input-output; intermediate automatic buffering during input-output; operation with separate initiating devices and with groups of them; untying collisions with simultaneous appearance of an initiative from a device and access to it from the program; working with a device connected with another UVK connected to the given UVK by an intermachine communications line (lines); and monitoring the input-output operations and completing standard actions or transfer of control to the user's problem if an abnormal situation is detected.

The logic method of access to files located on disks and other information carriers is provided in disk operational systems. The file control system provides automatic distribution of the disk storage, memory, storage, sampling and modification of named collections of data files. Any information which is a logically connected combination of data by processing and which has been given a name is a file.

To create a new or to work with an already existing file on a disk, the user indicates the name and logic number of the file by special instructions of the operator. The processing subprograms will have access to the file by using this number. After the file has been opened, the user's programs accomplish access to individual data recordings according to their number with respect to the beginning of the file or in sequence, beginning with the first element. Thus, the user's programs become independent of the location of the file on the disk. A special mechanism for protecting the

*In this case the interrogation is transmitted to any free device in the group.

files of one user from unauthorized access from the program of another user has been introduced into the file control system.

The operational systems also present opportunities related to the time service (receipt of current time by the program, awaiting a given moment or passage of a given interval) and to control of the system operation. The required set of system operator instructions (related to starting, stopping and changing the priority of problems, logic connection and disconnection of peripherals and changing their logic numbers, receipt of information on operation of the system and so on) is determined by the user and is taken into account during generation of the operational system.

Problems unrelated to real time (such as translation, editing, debugging, user program configuration and completion of various calculations) can be carried out in the dialogue or packet mode. Any of these modes may exist autonomously in the system or may be a background for real-time problems. Dialogue processing may occur on a background of packet processing.

Each user working in the dialogue mode summons the required programs to the section of internal storage allocated to him by using operator instructions introduced into the system from the console device (keyboard printer or symbolic display). All systems messages related to the work of his programs are transmitted to this device. The system may contain several operator consoles which permits several users to operate independently at the same time.

The productivity of the UVK in the dialogue operating mode is determined to a large degree by the speed of the person working at the console. Short intervals of completing user programs and systems processing programs are alternated with long intervals during which the system is in a state of awaiting new operator instructions.

The periods of waiting for new instructions according to operation of the system are reduced to a minimum in the packet processing mode. In this mode the user's instructions on operation of the system together with data and programs if required are prepared beforehand on punched carriers and are processed by a special systems program -- a packet processing controller.

The packet processing controller, being neglected for completion in any of the internal storage sections by the operator's instructions, sequentially reads and processes the control operators of the input flow. If a control operator for starting the systems program or user's program were encountered in the input flow, this program is loaded to the same internal storage section instead of the controller. After the program is completed, the packet processing controller, which continues to process the given user, is again loaded in its location. If necessary, packet processing of the corresponding number of input flows of tasks may be carried out simultaneously in several sections in the system. Depending on the operating mode, the functions performed and the set of peripherals, the operational system occupies 2K-12K words or more in the internal storage.

Besides the above operational systems, configured from a packet of ASPO program modules, M-0000 operational systems adapted to single-processor configurations of the SM-1 and SM-2 UVK with internal storage capacity of not more than 32K words, are delivered (upon request) to users of the SM-1 and SM-2 UVK. These systems include a main control system (OUS) which provides a single-problem operating mode, a real-time supervisor (SRV) which works with the OUS and permits completion of up to 28 real-time problems without mutual interruption of them, a modified real-time supervisor (SRV-M) which operates with the OUS and provides completion of up to 98 real-time problems affiliated to two groups (problems of the first group interrupt those of the second group), a disk operational system (DOS) which prepares, debugs and completes user programs in the packet and dialogue operating modes, a real-time disk operational system (DOS-RV) which provides simultaneous operation of the UVK in the multiproblem mode in real time and in the dialogue and packet processing mode, a final control system (SUF) which functions within the DOS-RV and which presents additional opportunities to the user for effectively working with data organized in the form of files on a disk and other standard input-output devices, and a BASIC interpreting system, designed to solve mathematical and engineering problems in the high-level BASIC dialogue language.

Libraries and Problem-Oriented Packets

To reduce labor expenditures for programming problems in the main fields of application of the SM-1 and SM-2 UVK, the following libraries are supplied to users: a main subprogram library, including programs for calculating elementary functions, input-output programs, service subprograms for translators, matcher-subprograms for working according to standard ISA S61.1-1972 in FORTRAN language and other subprograms; a program library for working in real time, which includes input-output and analog and digital production data processing subprograms; a subprogram library for graphic display, consisting of administrative programs, generator-programs of main graphic elements, scaling and graph display programs and also interaction with man and so on; a subprogram library for a graph plotter which provides drawing of basic geometric figures, signatures and graphs in different coordinate systems; a numerical analysis program library containing programs for solving systems of differential equations, matrix calculations and so on; a statistical data processing programming library; and a data file sorting-collating program library.

A packet of applied programs which permit configuration of the production data gathering, analysis and processing system has been developed and supplied to users for applications of the SM-1 and SM-2 UVK in production process control systems. The set of macrocalculations contained in the packet permits the designer to write the sources and receivers of analog and digital data and to provide processing for each point or group of points in a language understandable to him. Calculation of real values, linearization, smoothing, introduction of corrections for temperature and pressure, required monitoring of production parameters and so on may be indicated for analog sensors.

Messages of disruptions in the production process are issued to the technologist-operator to a higher level of the control system. In turn the technologist-operator or the program operator of higher level control may have access to the system for any data on the course of the process or the condition of the equipment and if necessary may introduce the appropriate corrections. The system may also include software for recording the trend of variation of parameters on automatic printers and also facilities for periodic recording of measured and average values of parameters. Moreover, the monitoring systems provide to the user the capability of reading and changing the boundary values of monitoring the parameters of the production process, the periods of interrogation and also other, frequently variable processing constants from the operator-technologist's console.

The capability of expanding the functions of the packet by including subprograms which perform special processing required by the user is also provided.

The software contained in the packet provides servicing of the operator-technologist's position, equipped with an operator's console, mimic flow-sheet, device for printing deviations and actions of the operator, automatic recording devices for recording the trend in variation of parameters of the production process. If part of the capabilities mentioned above are not required by the operator-technologist in a specific ASU TP, the problems corresponding to them may be excluded from the data gathering and processing system at the generation stage.

Any user problems, for example, optimum control problems which comprise the specifics of control of a specific production process, may be joined to the data gathering and processing problems through the communications subprograms developed in the packet. These problems may be written in mnemonic, FORTRAN or ALGOL language.

The task for generation of data gathering problems, processing and communicating with the operator is prepared in the problem-oriented input language of the packet. Special knowledge in the field of programming is not required for using the language.

The Program Preparation System

The programs for the SM-1 and SM-2 UVK may be prepared (translated, edited, configured, debugged and so on) both in the SM-1 and SM-2 UVK (in the manual, packet or dialogue mode, autonomously or as a stock for real-time problems) and in the M-6000 and M-7000 UVK. A program packet has been developed which permits one to prepare programs for the SM-1 and SM-2 UVK on YeS EVM machines. Large programs may be translated and debugged by parts with subsequent configuration into a unified program.

The following programming languages are supplied to the users for preparation of programs for the SM-1 and SM-2 UVK: the M-6000 UVK mnemonic code; the M-7000 UVK mnemonic code; macrolanguage; FORTRAN-II; FORTRAN-IV; and ALGOL-60 dialect. BASIC language may be used when solving problems in the interactive mode (the stages of translation and execution are combined into a unified interpretation step).

The mnemonic code machine-oriented language provides the programmer with all the capabilities of a processor instruction system and at the same time a number of conveniences which facilitate the programming process: mnemonic notation of operation codes, symbolic addressing, memory redundancy, determination of address, octuple, decimal and symbolic constants, literal operands and specific translation for a single parameter. The program in mnemonic code language may be divided into several parts, each of which may be translated separately. An external reference apparatus is used to combine these parts into a single program. It may not be used for combining with the programs written in other languages.

The M-6000 UVK mnemonic code language includes only M-6000 UVK instructions and is a subset of the M-7000 UVK mnemonic code language. The programs written in mnemonic code language for the M-6000 UVK may be used both in the M-6000 UVK and in the M-7000, SM-1 and SM-2 UVK, but all the capabilities of these processors are not used in the latter case. The programs written in the mnemonic code language for the M-7000 UVK may utilize all the capabilities of the M-7000, SM-1 and SM-2 UVK, but they may not be executed in the general case in the M-6000 UVK. Translation from any of these languages (as from any of those described below except FORTRAN-IV) can be carried out on any of the machines of the M-6000, M-7000, SM-1 and SM-2 UVK both in disk and in nondisk configuration.

The input language of the macrogenerator -- the macrolanguage -- is an expanded mnemonic code language. It permits determination of frequently encountered instruction sequences in mnemonic code language as a single macrooperation -- a macroinstruction. Moreover, the operator sequences of mnemonic code language generated by the same macroinstruction may be distinguished as a function of the operands given in the macroinstruction. By determining the macroinstructions required by him, the programmer may configure his own language in a similar manner, the programs in which have brevity and expressiveness, like programs in high-level languages, and at the same time they retain all the advantages of programming in mnemonic code language.

The SM-1 and SM-2 UVK macrolanguage corresponds approximately in its functional capabilities to the macroassembler language of medium class machines of type YeS EVM or IBM/360. The macrolanguage is used to generate operational systems and other program systems from packets of ASPO program modules.

FORTTRAN-II problem-oriented programming language corresponds to the rules of FORTRAN-II language.* Specifically, programming of bit operations, call-up of supervisor functions and access to devices for communicating with the object according to standard ISA S61.1-1972 in FORTRAN expansion language for industrial applications is provided.

*I. S. Pyle, "General Description of FORTRAN Language," in "Sovremennoye programmirovaniye" [Modern Programming], Moscow, Sovetskoye radio, 1966.

FORTTRAN-IV language corresponds to ANSI FORTRAN-IV language, with the exception of the following: the names of the programs, subprograms and external functions may have no more than five symbols; it is not permitted to use named COMMON blocks and BLOCK DATA subprograms; and the internal (intrinsic) functions are interpreted as external subprograms. Besides this, FORTRAN-IV language contains a series of expansions required for compatibility with FORTRAN-II language.

Translation from FORTRAN-IV language may be carried out only on disk configurations of the M-6000, M-7000, SM-1 and SM-2 UVK. The input translator from ALGOL language is a program written in ALGOL-60 dialect. The ALGOL language for the SM-1 and SM-2 UVK has the following differences from ALGOL-60 language: recursive procedures are not permitted; simultaneous use of variables of the REAL and INTEGER type in the left side of the confer operator is authorized; an unlimited number of additions of conditional operators is permitted; dynamic distribution of memory does not occur in the translator; therefore, all variables are interpreted as own and the boundaries in file declarations should be given in whole numbers; there is the possibility of making an initial conferral to variables and elements of files inside the type declaration; values may be given to variables by using the equality (EQUATE) declaration; external devices in input-output operators are given by logic numbers; the data format (FORMAT) declaration is introduced for input-output operations.

Completion of bit operations, call-up of supervisor functions and also working with devices for communicating with the object by using the CODE procedure are provided to supplement this.

The BASIC language is designed to solve mathematical and engineering problems in the man-machine dialogue mode. In view of its simplicity, training in programming in this language requires a very short time and it may also be used to solve rather complex problems. The BASIC language for the SM-1 and SM-2 UVK corresponds mainly to a version of the BASIC language outlined in the publication Proposal Standard for Minimal BASIC ANSI 1975 with expansions which provide work with matrices.

Besides translators and an interpreter, a symbolic data editor, configuration specialist, debugger, rewrite programs from carrier to carrier and so on are used for program preparation.

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THE SM-3 CONTROL COMPUTER COMPLEX

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[Article by Director of InEUM, Corresponding Member of the USSR Academy of Sciences B. N. Naumov, Deputy Director for Scientific Work, Doctor of Technical Sciences M. A. Boyarchenkov (deceased) and Candidate of Technical Sciences A. N. Kabalevskiy]

[Text] The small computer system (SM EVM) is being developed as a modular unit system. Considerable experience in development of these systems has already been accumulated in the USSR. The system of computer equipment facilities (ASVT-M) developed by organizations of Minpribor [Ministry of Instrument Making, Automation Equipment and Control Systems] has gained wide recognition. Experience shows that, along with individual devices and program modules which can be used as "building blocks" in development of different systems, the set of unit facilities should also include totally finished complexes delivered to the user from plants in the form of finished articles. In some cases these complexes may be used as ordinary computers, but they usually perform the role of a central nucleus of the system to which only a number of additional devices must be connected to achieve the required configuration, which considerably reduces the laboriousness of the user developing the systems. Therefore, together with individual devices and program modules, standard complexes are also being developed in the SM EVM where the composition of the devices and software corresponds to the requirements of many users. This complex is the SM-3 control computer complex (UVK) described in this article.

The standard complexes developed in the SM EVM may be expanded if necessary by introducing additional devices in them. All devices of the SM EVM, developed in different countries, satisfy unified technical requirements, are compatible with each other in electrical characteristics, design version and external formulation and have standard interfaces. Program and test support is also constructed by the modular principle and is easily reconfigured by simple generation procedures with respect to specific configurations of technical facilities. These conditions facilitate configuration of SM EVM complexes of different composition and technically provide the capability of their design configuration in which the design of complexes

of arbitrary composition is mainly reduced to selection of the required devices, since problems of arrangement of the latter in the complex and their electrical connection are solved according to standard recommendations of procedural handbooks.

The composition and main features of the SM-3 UVK -- the first standard complex based on the SM-3P processor -- are described in this article. A number of other standard complexes of the first unit of the SM EVM -- both universal and problem-oriented -- is planned for production. These complexes will be distinguished from the SM-3 UVK by the composition of the devices and software and considerably more productive processors compatible with the SM-3P will begin to be used in some of them as a central processor.

Complexes based on the SM-3P processor and other processors of the SM EVM compatible with it have identical configuration and unified principles of design and electrical configuration are realized in them.

The Configuration of the SM-3 UVK

The SM-3 UVK contains the following devices: the SM-3P processor, a magnetic internal storage (MOZU) with storage capacity of 32K 16-digit words, a punch tape input-output device (UVvVPL), a symbolic data input and display device based on an alphanumeric display (ATsD), a printer (ATsPU) and an external storage device based on magnetic cassette disks (NMD) one of which is interchangeable.

Let us consider the main features of SM-3 UVK configuration. The concept "configuration" includes the following combination of characteristics of the complex: the processor instruction system, the instruction and data formats, the addressing modes, the internal storage and interrupt system structures and organization of input-output and direct storage access.

The main feature of the SM-3 UVK configuration (Figure 1) is the same organization of processor communications with the internal storage and peripherals. All these devices, like the processor itself, are connected to a common series-parallel exchange channel. Each device periodically presents a request to use this common channel. Requests and distribution of the channel between devices handle a processor-controlled special controller block. With the selected communications structure, input-output operations in the processor are performed at ordinary address instructions, which considerably simplifies programming of the peripherals. The peripheral address zone (usually 4K words) may be increased by the internal storage addresses (usually 28K words). The universality of connecting the devices to the exchange channel permits rather simple organization of extraprocessor exchanges of data of the devices both between each other and with the internal storage.

Two-address instructions are used in the SM-3 UVK along with unaddressed and single-address instructions; operations on bytes can be carried out besides operations on 16-digit words. Twelve addressing modes are used.

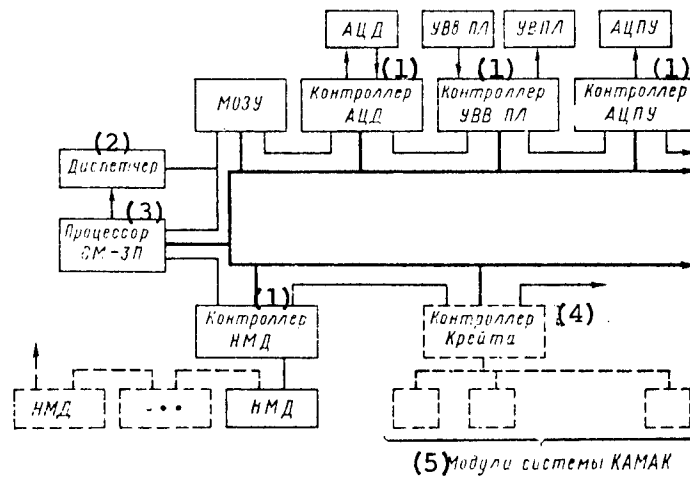


Figure 1. Structure of SM-3 UVK

KEY:

- | | |
|---------------|----------------------------|
| 1. Checker | 4. Crate checker |
| 2. Controller | 5. Modules of KAMAK system |
| 3. Processor | |

Equipment-wise, the possibility of organizing a flow in the memory, i.e., the region of the memory in which the information is processed by the "blast-in -- first-out" principle, has been realized. The subprograms permit recursive access. Along with ordinary access to the subprograms, there is also a second method of access -- by using the program interrupt instructions -- in the instruction systems.

All the enumerated configurational characteristics of the SM-3 UVK were first realized in the USSR in the M-400 UVK, significantly simplify programming and improve the effective speed of the SM-3 UVK.

Composition of the SM-3 UVK and the Possibilities of Expanding It

The main characteristics of devices contained in the SM-3 UVK are described below. An external view of the complex is shown in Figure 2.

Representation of arithmetic operands is binary with fixed decimal in supplementary code. The addressing system is direct, indirect, relative and index with auto-increase and autoreduction (a total of 12 types). The address capacity is zero-, single- and two-address instructions.

The interrupt system is priority, four-level, with essentially an unlimited number of sublevels at each level and with the capability of masking the interruptions of both individual devices and of several levels immediately. The interrupt processing system is automatic with storage of the contents of the instructions and word counter of the state of the processor in apparatus-organized flow. Program compatibility is with the ASVT-M of the M-400 UVK.

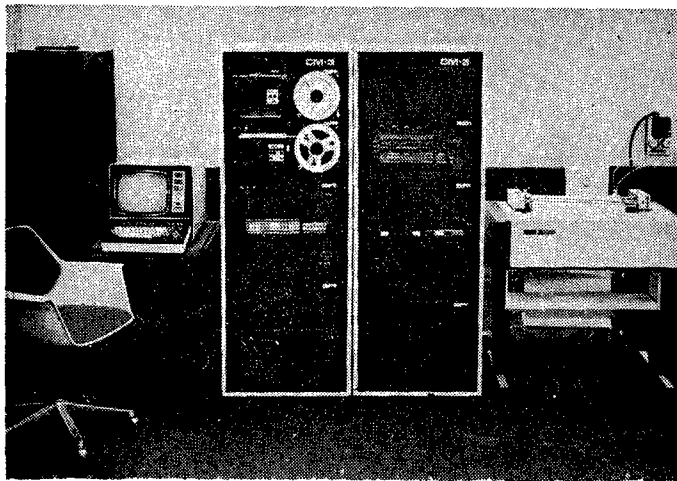


Figure 2. External View of Complex

Main Specifications of SM-3P Processor

Type	Parallel
Digit capacity of logic operands	1, 8 and 16
Number of universal registers	8
Maximum number of addressable cells	32K (4K for addressing the registers of peripherals)
Time to complete short operations (of the register-register type), microseconds	Less than 5
Consumed power, V·A	Less than 500
Time to transfer control upon interruption, microseconds:	
for all devices	Less than 10
for direct-storage access devices	About 3

Main Specifications of the OZU-P-32K Internal Storage

Capacity, K words	32
Digit capacity, bits	18
Sampling system	2.5
Time, microseconds:	
access	1.2
sampling	0.6
Consumed power, V·A, not more than	700

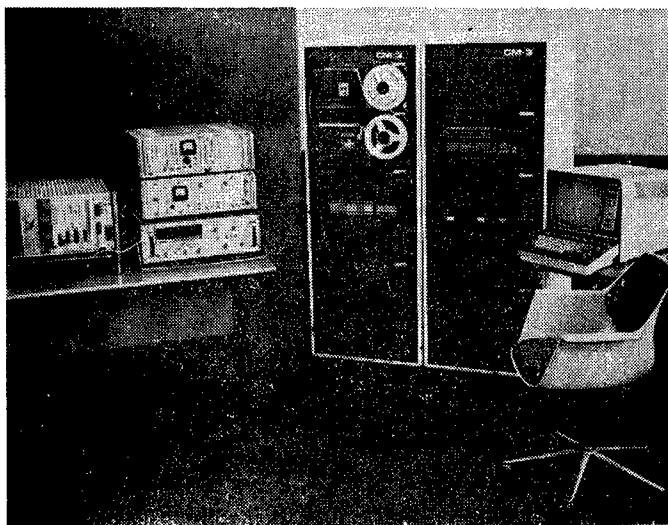


Figure 3. Expanded SM-3 UVK

Main Specifications of the Input-Output Punch Tape Device
Based on the MPR 51/301 Mechanism (Hungary)

Composition	Two independent mechanisms (input and output)
Operating mode	Start-stop
Speed, lines per second:	
reading, not less than	300
perforation, not less than . .	50
Number of tracks	5 and 8
Consumed power, V·A, not more than	400

Main Specifications of the Sequential Type Alphanumeric Printer
Based on the Dato 1156 Mechanism (East Germany)

Printing speed, symbols per second	Up to 100
Number:	
characters per line, not less than	132
copies	3
Character size, mm	2.7 x 1.9
Horizontal spacing, mm	2.54
Vertical printing spacing, mm	4.23
Consumed power, V·A, not more than	250

The information carrier is paper perforated tape 420 mm wide.

The functions are input, display, editing and tabulation of data.

Main Specifications of Alphanumeric Terminal
Based on the "Videoton 340" Mechanism (Hungary)

Screen size, mm ²	200 x 140
Number of symbols	16 x 80
Buffer storage capacity, bytes	1,280
Input-output speed, characters/second, not less than	1,000
Consumed power, V·A, not more than	150

Main Specifications of Magnetic Disk External Storage Device
Based on the IZOT 1370-II2 Mechanism (Bulgaria)

Number:	
of disks	2
of tracks per disk	200
of sectors per disk	12
Disk capacity, M words:	
of one	1.2
of two	2.4
Average time of positioning heads, microseconds	45
Consumed power, V·A, not more than	150

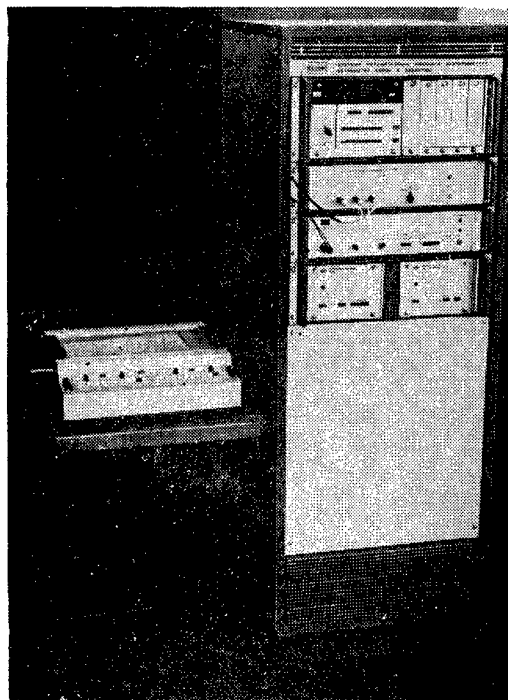


Figure 4. Device for Communicating With Object Realized on the
Basis of Modules of the ASET System

The main part of the complex is installed in two standard racks. The SM-3P processor, the MOZU and the UVvVPL are located in the left rack. The NMD checker, designed to connect one-four storage devices (up to eight disks), and one two-disk storage device are installed in the right rack. The alpha-numeric display, which performs the role of system console in the complex, and the ATSPU are located outside the racks with the possibility of separating them up to 15 m from the processor.

The following methods of build-up are provided in the SM-3 UVK: connection of an additional five input-output devices (supplementary displays, graph plotters and modules of devices for communicating with the object) to the processor without additional assembly blocks; installation of additional disks, external magnetic tape storage devices and devices for communicating with the object, data transmission apparatus or additional assembly blocks in the racks.

Different devices located outside the racks may also be connected to the complex. One of these expanded complexes is shown in Figure 3, where the crate of the KAMAK system, used extensively in modern laboratory experiments, is located on a desk to the left of the complex. The crate is controlled directly from the SM-3P processor. Another example of a device connected to the SM-3 UVK -- a set of modules of the ASET system, from which the device for communications with the object, controlled from the SM-3P processor and containing a number of analog-digital and digital-analog converter modules and a two-coordinate graph plotter, is configured.

Software for the SM-3 UVK

The SM-3 control computer complex is basic to the SM EVM disk operational systems. The presence of a two-disk external storage in the device permits use of one of them (fixed) as a systems disk in which the operational systems are stored and the second (interchangeable) as a disk for user programs and data. A disk with the file library of the operational system is installed instead of the replaceable disk during generation of the operational system.

The software for the SM-3 UVK includes the following main groups of programs: 1) operational systems, including a disk operational system (DOS), a disk operational real-time system (DOS-RV) and a punch tape operational system (PLOS); 2) translators with FORTRAN-IV languages, an Assembler and a Macro-assembler; 3) self-contained translating systems for the dialogue mode with FOCAL and BASIC languages; 4) an applied program library; 5) a set of software for program development and debugging, including a symbolic text editor program, debugging programs and configuration programs; and 6) a set of facilities for test monitoring of the equipment, specifically a test-monitoring system, a systems test of the complex, tests of the processor, OZU and other devices contained in the complex.

The complete program compatibility of the SM-3P processor with the M-400 UVK processor permits the use of programs developed by users of the M-400 UVK in the SM-3 UVK without any modifications.

The Main Features of the Circuitry for the SM-3 UVK

The devices contained in the SM-3 UVK are constructed on components of small and medium degree of integration with use of microminiature circuits of expanded series K155. The microprogram method of control is used in the SM-3P processor, which provided a considerable reduction of the volume of the processor apparatus. Conversion to microprogram control and the use of microminiature circuits with increased degree of integration made it possible to reduce the number of microminiature circuits in the SM-3P processor 3-3.5 times compared to the number in the processors of the M-6000 and M-400 UVK. Considerably fewer microminiature circuits began to be used in peripheral controllers in which the new series K599 of semiconductor integrated microminiature circuits of the interface with increased degree of integration became widely used. The volume of power supply sources in the complex decreased significantly. This was achieved, specifically, by reducing the total number of microminiature circuits in it, but the main effect provided conversion from sources with linear and pulsed stabilizers to new source converters having more than three times the improved watt-liter ratio compared to sources of the M-6000 and M-400 UVK.

As a result the total effect for individual devices of the SM-3 UVK and for the complex as a whole was expressed in a reduction of its volume approximately five times compared to the M-6000 and M-400 UVK of similar composition, the dependability of the devices was improved two times and the cost of the complex was reduced two times.

Design Realization of the SM-3 UVK

One of the significant features of the SM EVM is the extensive use of devices in it, formulated in the form of self-contained complete blocks (AKB), which include as functional components subassemblies such as blowers and power supply sources.

Complete blocks are now the main units of configuration in the SM EVM. A rather complex functional device (for example, an MOZU) or a complex of devices can be assembled in this block. The chassis of the AKB provide instrument and rack-installed versions of the latter. All the block chassis have identical width equal to 482.6 mm according to recommendations of the International Electrical Engineering Committee. The height of the blocks is always a multiple of the module used in the system $u = 44.45$ mm.

The main devices of the SM-3 UVK: the SM-3P processor, OZU and NMD, formulated in the form of an AKB, are shown in Figures 5-7. The NMD controller is similar in design to the SM-3P processor.

Self-contained complete blocks do not require special installation when they are placed in racks. Therefore, the devices formulated in the form of these blocks can be installed by the users themselves upon expansion of the system.

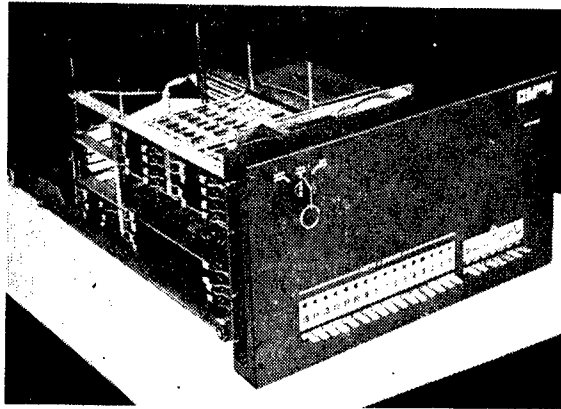


Figure 5. SM-3P Processor

One or several special installation cassettes for installation of component blocks on printed circuit cards is located inside the AKP. In some cases this installation cassette is a design type in which an independent functional component is realized. The design of one of these cassettes is shown in Figure 8.

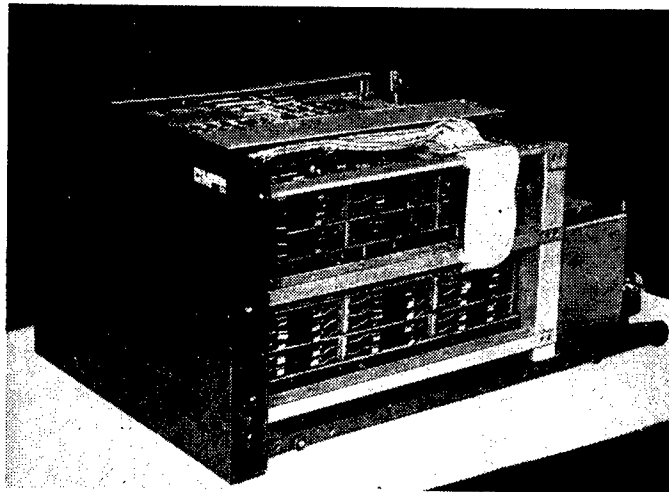


Figure 6. Internal Storage

Conclusions

Along with the SM-3 UVK described above, a number of other complexes based on the SM-3P processor, designed for use in different branches of industry and distinguished from the SM-3 UVK by the composition of the devices and software, has already been developed and is being planned. All these

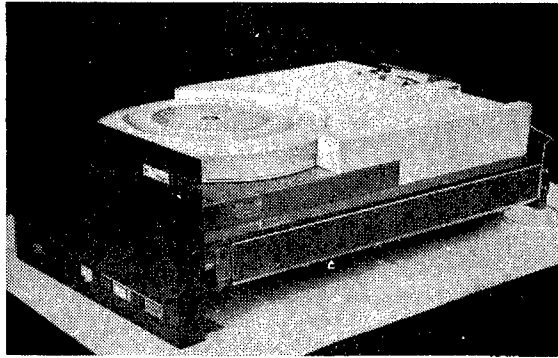


Figure 7. Magnetic Disk Storage

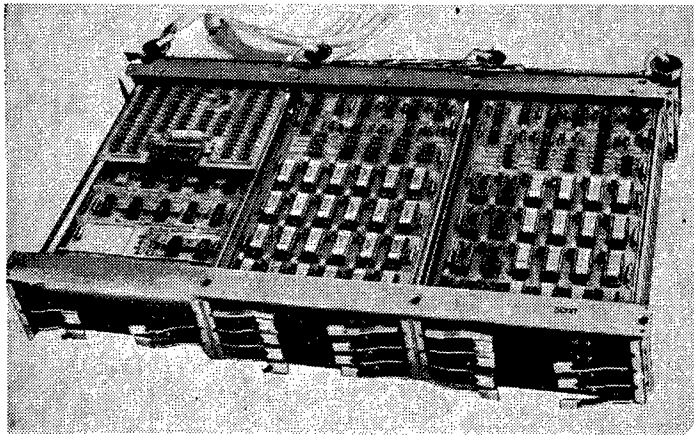


Figure 8. Installation Cassette With Installed Component Blocks

complexes are designed for connection of peripheral devices, which provides the possibility of expanding them if necessary for orientation to problems of specific users.

The devices contained in the SM-3 UVK are also being modified, which is directed mainly toward further improvement of their operational characteristics, improvement of dependability and reduction of cost.

The complexes of the SM EVM based on the SM-3P processor find broad application in ASU, automatic instruments and devices.

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SOFTWARE FOR THE SM-3 UVK

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, 1977 pp 15-17

[Article by Deputy Director of InEUM for Scientific Work, Candidate of Technical Sciences Ye. N. Filinov and Candidate of Physicomathematical Sciences V. P. Semik]

[Text] Control computer complexes (UVK), developed on the basis of the hardware of the small computer system (SM EVM), are designed mainly for use in control systems for different processes and objects in real time.

The quality of functioning of control systems is determined to a considerable extent by the software characteristics (PO) and in turn by the characteristics of operational systems (OS).

When developing the software for the SM EVM, the following use characteristics of the SM EVM were primarily taken into account: the variety of areas of application and the extensive range of problems solved; orientation toward problems of medium complexity; the use of machines directly at operator's positions usually without intermediaries -- operators and systems programmers; the use for control in real time and also in the user-system dialogue mode; the possibility of operating in multimachine, including different types of complexes; an extensive set of peripherals; and restricted resources (short word length, small internal storage capacity and so on).

The designation of SM EVM software includes provision of problem orientation of SM EVM complexes, efficient functioning of different hardware functions, hardware and software monitoring and the possibility of developing PO.

The software system (SPO) of the SM EVM should be organized as an open system with built-in capabilities of supplementation and expansion, the use of newly developed peripherals, different methods of data processing and expansion of the spheres of application. These properties of the SPO of SM EVM should be combined with simplicity of SPO components of the SM EVM in operation and with low expenditures of the internal storage and other machine resources.

Machine resources can be divided into absolute and relative. Absolute resources are understood as those of the physical level -- hardware (the processor, various types of memory, peripherals and so on) made available to carry out programs; relative resources are understood as those of the logic level: resources obtained from absolute resources by special programming. A new logic level of resources can be constructed by using the absolute and relative resources of some level.

The resources of some level, accessible to a given executed program, together with a number of service facilities which permit access of the program to these resources, are called its environment. The combination of software from which the new environment is constructed on the basis of that already available is called the program layer.

Using the concept of the program layer, OS serve as the binding link between the user's requirements and the capabilities of the hardware. The user sees the OS in terms of service procedures used for program preparation, translation, debugging and execution and as resource control procedures.

A wide range of SM EVM users with their different needs on the one hand and the different capabilities of the hardware on the other, inevitably lead to complication of OS functions as the binding link and consequently to large labor expenditures for development of them.

If the requirements of efficiency and simplicity of use are taken into account in this case, the typical dilemma of selection between specialization and universality becomes clear. The principles of modularity, generability, functional specialization of program layers and industrial production of software are used to overcome the resulting difficulties in development of the SPO for the SM-3 UVK.

According to these principles, the SPO for the SM-3 UVK (and other developed models of the SM EVM, program-compatible with the SM-3 UVK) is constructed as a universal, multipurpose system which is achieved by representing the SPO for the SM-3 UVK in the form of a set of separate program systems of different designation. Among these systems are those of broad designation and narrowly specialized systems which provide effective solution of given classes of problems. Both generated systems and systems generation facilities can be delivered to the user for given applications and configurations of hardware.

All software is constructed from a common set of program modules and layers.

Program layers, depending on the orientation toward realization of specific functions, are divided into the following main groups: logic-mathematical data processing (mathematical); gathering, organization, storage and display of data (production); maintenance of hardware which supports production functions (technical); monitoring and checking of hardware (test); organization and control of the computing process (control); simplification of

man-system communications and creation of maximum convenience in the user's work (ergonomic).

This organization of the PO permits one to construct the PO of problem-oriented complexes from a relatively limited set of program components, maintaining in this case the compatibility and standardization of the software, and it creates prerequisites for conversion to industrial methods of design and production of programs and program documentation.

One of the main problems in development of the SM EVM was the problem of development and delivery of a sufficiently complete set of software with the first serial models. This problem was facilitated for the SM-3 UVK by providing total program compatibility with the M-400 UVK.

The software supplied with the first serial models includes punch tape and disk OS designed for development and debugging of the PO and execution of programs in the single-program mode; a real-time punch tape and disk OS for execution of programs in the multiprogram mode (up to 128 simultaneously executed problems) in real time; and program packets for solving scientific-technical problems, data processing by mathematical statistics methods and so on.

The punch tape operational system (PLOS) is a set of self-contained programs which provide the single-program mode of functioning of the minimum hardware configuration and which are designed for preparation, debugging and use of programs in the following languages: Assembler in machine-oriented language; BASIC in dialogue language oriented toward solution of computing problems; and DS-SM in dialogue language, oriented toward working with peripherals.

The PLOS contains a translator from Assembler language, interpreters with dialogue languages, loaders, a text editor, debugger, service programs and an input-output controller which provides asynchronous servicing of input-output for devices not oriented to files, data transmission in the interrupt mode parallel with realization of the main program, independence of the program from input-output devices and so on.

The disk operational system (DOS) is a set of systems programs designed for preparation, debugging and testing of programs in the single-program dialogue and packet modes in macroassembler and FORTRAN-IV languages. The disk OS is the baseline system for development of ASU of scientific experiments and production processes operating under control of a DOS or real-time and self-contained systems.

The SM-3 processor with storage capacity of 16K words, a punch tape input-output device, a shielded alphanumeric console and magnetic disk external storage device are required for operation of the DOS. The disk storage device is used to store systems and user files. The system permits expansion of the internal storage up to 28K words and connection of additional peripherals.

The DOS contains generation facilities which provide its operation with different hardware configurations. The system is very simple to use and hardly requires the interference of the operator.

The DOS monitor handles access to the input-output at different levels, beginning with direct access to the storage and ending with formatting. Independence of the programs from the devices is provided in this case: the programs can be compiled without regard to any features of special input-output devices. When executing the programs, the user may select the most convenient and efficient input-output device suitable for a given function.

Symbolic access to any device is authorized if the devices of the system are given logic names.

The size of the input-output buffer in the user program has no principal value, but the user retains the right to directly control the input-output buffers.

The DOS monitor is organized such that its individual modules can be summoned to the internal storage only if necessary and this means that they may not occupy a permanent position in the memory. The possibility of being given the monitored configuration permits one to more efficiently use the user program storage. The latter may successfully utilize individual logic parts of the monitor for its own purposes; by following a simple set of rules, it has the right to place its own specialized programs for control of peripherals into the system and to use the monitor with these programs.

The peripherals are placed in conformity to one or several sets of data. The user may change the conformity of some device to one set of data, leaving in this case its conformity to all remaining designations as before.

The disk OS has a developed system of working with files. The file data is stored in multilevel catalogues, which eliminates conflicts when the names of files of different users coincide. The files can be increased sequentially and can be created even if their final length is unknown. The file length is logically unrestricted. Files may be created and cancelled during execution of their programs for maximum use of the memory. The disk OS includes a wide range of service programs and also means of file identification and protection.

The service programs include a symbolic text editor, configurer, debugger, program packet for working with files, a librarian, translators from macro-assembler and FORTRAN-IV languages and so on.

An input language corresponding the ANSI standard and expanded by input-output devices, by devices for working with mixed type expressions and use of formats of single and double accuracy when working with a floating decimal and with logic variables and digit data processing devices, is used in the translator from FORTRAN-IV language. The translator has a developed system of error diagnosis.

The real-time punch tape operational system (PLOS-RV) is a real-time control system resident in the internal storage. The system provides planning of the computing process in the multiproblem mode and development of user programs in the background mode.

Problems are planned in real time at three levels of program priorities. Up to 127 priority problems and one background problem may be used simultaneously in the system. Program execution may be initiated by requests of the operator and program and by interruption or request from the synchronization device. The time and priority of executing the problems are monitored. If a problem having high priority exceeds the time allocated to it, the value of its priority is reduced. The time of executing problems with low priority is unlimited and all problems of this level receive equal quanta of remaining processor time.

The user may introduce, start, stop and eliminate a problem by using simple instructions transmitted from the operator's console. Up to eight of these consoles may be connected. The problems may be independent to the extent as if only they were being executed in the internal storage. Completion of joint actions by several problems, establishment of communications and mutual control between them are provided in the system, which ensures complex interaction of problems.

All input-output operations are carried out by the control program in response to simple summons. The control program accomplishes input-output buffering. If any input-output device is engaged or is not operating, the input-output operation may be automatically transferred to the alternative device. The problems may reserve input-output devices for themselves or may share them with other problems.

The system contains facilities for development and inclusion of service programs of devices for communications with objects.

The real-time disk operational system (DOS-RV) is an expansion of the PLOS-RV in the part of handling the direct storage access files and use of available means of constructing structures with superposition (overline structures) in FORTRAN-IV language.

Programs may be prepared autonomously, in the background mode or under the control of the DOS for the PLOS-RV and DOS-RV. The programs may be written both in Assembler and in FORTRAN-IV languages.

The composition of the operational systems of the SM-3 UVK will be expanded by supplying:

a one-user disk background-operative baseline OS, designed to solve high-priority real-time problems in the operative mode, program preparation and data processing in the background mode (the programs may be prepared in the background mode in Assembler, macroassembler and FORTRAN-IV languages and in BASIC and DS-SM dialogue languages);

a multiprogram OS generator with a large number of priority levels (up to 250) for different hardware configurations (both disk and nondisk);

a disk dialogue multiconsole OS with time-sharing oriented toward solution of information problems and control of data bases;

a packet of program modules which expand the capabilities of the main OS in the remote data processing part and which permit development of distributed hierarchical systems based on the M-4030 and SM-3 UVK;

procedure-oriented program packets which realize different mathematical methods of data processing;

a program packet for graphical data processing;

problem-oriented program packets, including those for control of laboratory experiments, medical applications, data processing of an economic nature and so on.

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AUTOMATIC ENTERPRISE CONTROL SYSTEMS AND THE ECONOMIC EFFECTIVENESS
OF PRODUCTION

Moscow PRIBOR I SISTEMY UPRAVLENIYA in Russian No 5, 1977 pp 4-5

[Article by Doctor of Economic Sciences I. A. Kruchinin and candidates
of Economic Sciences V. Kh. Lev and V. S. Starkov]

[Text] In the realization of the tasks of the tenth five-year period in the area of the introduction of computer technology into the national economy, special importance is attributed to questions of the economic effectiveness of automation of the control of production as one direction of new technology. In spite of the broad scales of introduction of automatic enterprise control systems (AECS) into industry, the economic effectiveness of systems is increasing slowly. As shown by an investigation of 287 AECS created by organizations of the All-Union "Soyuzsistemprom" Association during the ninth five-year period, the annual saving from the introduced developments on the average is 0.93 ruble per ruble of expenditures. Only in 1975 did the value of that indicator exceed 1 ruble and become 2.36 rubles. The values of that indicator for 1975 for experimental design work done by the All-Union Association "Soyuzprompribor" was 4.2 rubles, and for the All-Union Association "Soyuznauchpribor" was 3.12 rubles.

The economic effectiveness of the creation of AECS is characterized by the correlation of expenditures on the automation of control of production and the saving obtained thanks to improvement of the use of production resources of the enterprise. Adopted as the main path of investigation of the economic effectiveness of automation of control was determination of existing losses and unused possibilities and reserves in production, and also estimation of the role of AECS in their curtailment and elimination.

Among the principal sources forming the economic effectiveness of an automatic control system are production losses, which affect the cost of production, especially intrashift losses of working time, irrational expenditures of material resources and losses from rejects, production losses affecting the use of fixed production capital, losses on which the use of

circulating capital depends, and omissions in production activity leading to reduction of the balance sheet profit of the enterprise. Corresponding to the main indicators of effect from the introduction of AECS are increase in the volume of realized product with existing production equipment, reduction of production costs, increase of profit and release of circulating assets of the enterprise. Among the generalizing economic indicators of the application of AECS are the annual economic effect and the coefficient of effectiveness or correspondingly the period of repayment of expenditures on the creation of the system.

An important distinctive feature in the determination of the economic effectiveness of AECS in the planning stage is the use of expert estimates of the developers of the system and specialists of the ordering enterprise. A forecast of the qualitative changes in control with the introduction of AECS and their influence on the results of production is made through analysis of the functions and problems included in the AECS, and also by studying the object in order to discover losses and omissions caused by imperfection of organization of control of the given object.

Side by side with estimation of the systemwide effect of the functioning of the AECS as a whole, special attention should be given to determination of the results of solution of problems in the management of production resources, which have a direct and unequivocal reflection in change of the economic indicators of the object.

Generalization of the calculations of the economic effectiveness of AECS for a uniform branch aggregate of enterprises makes it possible to determine the limits of the economic effectiveness of introduction of the direction of new technology under consideration. Table 1 presents the mean indicators of the economic effectiveness of AECS for 287 industrial enterprises. The scientific and technical level of the investigated systems can be characterized by the number of problems solved -- 29 on the average for industry (31 for machine building and 30 for instrument making) -- and the percentage of those promising in the sense of giving results in the management of problems relating to subsystems for the technical preparation of production (TPP), technical and economic planning (TEP), operational control (OC) and quality control of production (PQC) (machine building -- 48%, instrument making -- 54%).

Capital expenditures on the creation of AECS amount to 910,000 rubles on the average, including pre-production expenditures (on the development of the plan and machine programs) of 326,000 rubles. It is interesting to note that during the ninth five-year period there was a considerable reduction of the cost of planning work in the area of AECS. Whereas in 1971-1973 the cost of the plan of a system for a machine building enterprise was 461,000 rubles on the average, in 1975 it was 362,000 rubles. AECS introduction gave a reduction in the cost of the annual volume of sold product of 252,000 rubles, a release of circulating assets of 226,000 rubles and a saving of 303,000 rubles at an industrial enterprise. The calculated coefficient of effectiveness of capital expenditures on the creation of AECS was 0.55, which corresponds to a repayment period of 1.8 years.

Table 1

А	В	Число об- следован- ных пред- приятий	С Показатель										Срок оку- пачности		
			1 Число задач АСУП		2 Капитальные затраты в Р.		3 Снижение себестоимости гото- вого объема произвед- ной про- дукции в Р.	4 Высвобож- дение обо- ротных средств с учетом роста объема прои- зводства при внедрении системы в Р.	5 Годовой экономиче- ский эффект в Р.	6 Коэффи- циент эффектив- ности затрат					
			а	б	а	б									
											всего	в том числе по подсе- текам ЦАП, ТЭЦ, ОУ и УАП в %		всего	производ- ственные
а	Промышленность в целом	297	29	43	910 000	336 000	252 000	226 000	303 000	0,55	1,8				
б	По машиностроению (в том числе)	186	31	43	1 024 000	362 000	273 000	246 000	331 000	0,56	1,8				
с	Из них по приборостроению	60	30	54	863 000	306 000	198 000	149 000	313 000	0,56	1,8				

Key: A - Investigated branch B - Number of investigated enterprises C - Indicator
 1 - Number of AESC problems a - total b - including shares of TPP, TEP, OC and QPC, %
 2 - Capital expenditures, rubles a - total b - including production
 3 - Reduction of cost of annual volume of sold production, rubles
 4 - Release of circulating assets with consideration of increase of volume of production when system has been introduced, rubles
 5 - Annual saving, rubles
 6 - Coefficient of effectiveness of expenditures
 7 - Repayment period
 a - Industry on the whole b - For machine building c - For instrument making

Table 2

А	Обслуживаемая отрасль	В	Число обследованных предприятий	С	Годовой прирост прибыли в р./%	С										2	В
						Годовой прирост прибыли в р./%											
						1											
						Благодаря снижению издержек производства											
						в том числе определяемые											
а		б		с		д		в		г		Эксплуатационные расходы АСУП	Пропорциональные расходы АСУП				
всего	1)	материальные затраты	2)	заработная плата промышленно-производственного персонала	3)	потери от брака	4)	непрямые расходы	1)	расходы постоянные и изменяющиеся пропорционально росту объема производства							
а	Промышленность в целом	152	430 900 100,0	216 900 48,9	130 900 30,4	55 700 12,9	20 200 4,7	17 800 4,1	204 700 47,5	-218 500 -50,7	220 000 51,1						
б	По машиностроению (в том числе)	99	501 900 100,0	249 100 49,6	120 100 23,9	68 100 13,6	26 100 5,2	22 700 4,5	271 700 54,1	-259 500 -51,7	252 800 50,4						
с	Из них по приборостроению	26	469 000 100,0	208 000 44,3	38 000 12,4	76 100 16,3	15 500 3,3	4 900 0,8	249 900 53,3	-200 600 -42,6	266 000 56,7						

Key: Investigated branch B - Number of investigated enterprises C - Annual increase of profit, rubles/% 1 - Thanks to reduction of production costs a - total b - including those determined c - by direct count 1) material expenditures 2) production wages 3) losses from rejects 4) non-production expenditures d - indirectly 1) expenditures, constant and variable not in proportion to increase of production volume 2 - AECS operating expenses 3 - In proportion to increase in volume of realized production

For 152 systems introduced into industry in 1974-1975 a fairly detailed analysis was made of the sources of the annual increase of profit due to functioning of the AESC. The results of the analysis are presented in Table 2. At an average increase of profit of 430,900 rubles, 51% of that amount is assured by a corresponding increase in the volume of sold production and 49% by reduction of the cost of production. The data cited in Table 2 testify that the proportion of reduction of direct expenditures (raw materials and supplies, industrial production wages, losses from rejects and non-productive expenditures on which the problems solved by the system exert an unequivocal and direct influence) is not large: 30, 13, 5 and 4% respectively. As for all the other components of the annual increase of profit, they are a function of the indicator of change of the volume of production when the AESC has been introduced, that is, during the calculation they are indirect. It should be taken into consideration that the indicated reduction of cost of the annual production is subject to decrease by the amount of the annual AESC operating expenses of 218,500 rubles, that is, by 51%. A similar tendency is observed in both machine building as a whole and in instrument making.

In our opinion, for the practical aspects of economic substantiation of AESC it is useless to consider the mean values in Table 3 for the amounts used in determining the economic effectiveness of automation of production control and characterizing the change of working indicators of an industrial enterprise as a result of creation of the system. Presented in Table 3 are all the indicators on which the components of the annual effect of the AESC depend. The presented data can serve as a reference in the corresponding calculations, one permitting the developers to weigh the degree of reliability of the expert estimates used by them.

Table 3

Reduction of intrashift losses of working time for organizational and technical reasons in relation to the base year, %	42
Increase of labor productivity in relation to the base year, %	29
Reduction of raw material and supplies expenditures in relation to the base year, %	1.2
Coefficient characterizing the rate of increase of the mean wage of production workers per percent of increase of labor productivity	0.46
Reduction of additional charges for overtime work of production workers in relation to the base year, %	15.6
Reduction of losses due to rejections in relation to the base year, %	16.1

Table 3 (Continued)

Reduction of non-productive expenditures in relation to the base year, %	12.4
Coefficient characterizing the dependence of the increase of shop expenses on the increase of the volume of production	0.38
Coefficient characterizing the dependence of the increase of general plant expenses on the increase in the volume of production	0.31
Reduction of expenses per ruble of realized production in kopecks	0.54
in relation to the base year, %	0.6
Reduction of the requirements for circulating assets in relation to the base year, %	4.8

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CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

THE V5/40 CONTROL COMPUTER COMPLEX AT THE 'ELEKTRO-77' EXHIBITION

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 5, 1977 p 57

[Article by Yu. M. Samoylov, methodist-editor, Soviet section of the International Exposition "Elektro-77"]

[Text] The second International Exhibition of Electrical Equipment and Transmission Lines "Elektro-77" will take place in June 1977. It will reflect the successes achieved by the countries of the world in the creation of the latest equipment for the production, transmission and use of electric power [1].

In the section "Automatic Electrical Complexes" articles graphically reflecting the organic synthesis of power equipment and electronic controls characteristic of our time will be demonstrated. Among the exhibits of the section is a full-scale model of the V5/40 control computer complex. It is intended for modern, complex automatic control systems for technological processes of large rolling mills, atomic electric power plants, complex power engineering installations and automatic testing complexes.

An important feature of the complex is its assurance of increased "vitality" to the automatic control system for technological processes in which it is used. This is achieved by designing the control computer complex as a multi-processor, multichannel, multimodular system with a dynamic distribution of equipment and programs. The failure of any device does not disrupt the work of the entire complex, since the program continues to be executed on other working equipment of the same type. By means of apparatus and programs the complex automatically changes its functional configuration, as a result of which the system does not go out of order.

In the V5/40 control computer complex the possibility is provided of disconnection, testing, repair and re-connection of equipment without interruptions in the work on control of the object.

All the equipment of the complex is based on small, medium and large integrated circuits by means of multilayer printed wiring and assembly of a

microwinding with automatic designing of printed structures and the main technological processes for manufacturing them.

The V5/40 control computer complex includes the main devices (a central processor, an input-output channel and an immediate-access memory), peripheral equipment (a device for communication with the external interface of the ES computer, a colored alphabetic-graphic display and equipment for communication with the object), peripheral equipment of the ES computer (tape and disc memories and an alphanumeric printer) and an electric power system.

The software of the complex includes the programming languages ASSEMBLER and FORTRAN and an operating system for work on a real time scale. Numbers are represented in the machine with a fixed and floating point.

Indicative of the properties of the complex are its technical characteristics. It has a speed of 100,000 operations per second in addition and 40,000 in multiplication. The capacity of the memory module is 32,000 words. The data input rate from tape is 300 lines per second. Readout is at the following rate: printing on a teletype at 400 characters per minute, on perforated tape at 150 lines per second and on an alphanumeric printer at 10 lines per second.

At the exhibition the application of a complex of V5/40 control computer complexes to drive the mechanisms of a hot rolling mill and automatically control the mill will be demonstrated. The Soviet exhibit will include a model of the working stand of a wide-band mill for the hot rolling of belts of ferrous metals 1.2 mm or more thick with an electric drive included in an automatic control system based on the V5/40 control computer complex.

The V5/40 control computer complex can also be used in blast furnace production and in the ultradeep drilling of petroleum and gas wells, that is, in the automation of technological processes of continuous production.

FOOTNOTE

1. See the article of Yu. M. Samoylov in No 4.

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CZECHOSLOVAK PRINTERS EXHIBITED IN KIEV

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 5, 1977 p 58

[Article by Engineer S. I. Yaroshenko]

[Text] In the autumn of 1976 the exhibition "Precise Machine Building and Electronics of the Czechoslovak SSR" was organized in Kiev by the Czechoslovak Foreign Trade Enterprise KOVO and the Trade and Industrial Exhibition Halls of the USSR and CSSR. Peripheral equipment of computing technology, offset polygraphic machines, laboratory equipment and instrument, electronic components and communications equipment were exhibited at the exposition.

Among the presented printers the following should be noted.

The "Konsul-256" (ES-7172) electric typewriter is the latest modernized model of a machine of that type and is intended for the issuance to an electronic control unit of symbol codes composed on a keyboard, an alphanumeric printer of data and characters on paper sheet or rolls in accordance with signals from the electronic control unit, a computer used as a peripheral device, and automatic printing, organizational and computing machines.

The machine consists of four main parts readily distinguished from one another. In the lower, basic part are electromagnets for the control of the printing and tabulation, a diode decoder and connectors. The upper, main part can be lifted off the lower on hinges located in the rear, and this assures rapid access to the machine's mechanisms and equipment. Situated in the main part are an electric motor, a printing mechanism, the register drive, the carriage return, the tabulator and the ribbon color changer. The third part is the contactless keyboard, which can be removed from the machine; the fourth is a removable carriage with a paper-support roller.

Technical characteristics

Average printing rate, characters per second
Type
Pitch of letter, mm

12
Pica
2.6

Distance between bases of adjacent lines, mm	4.25
Number of type levers	46
Number of clear copies	5
Machine voltage, V	220 (50 Hz)
Electromagnet voltage, V	12
Data input and output	Parallel
Mass (dependent on carriage length), kg	32-34

There is no direct mechanical connection between the keyboard and the other mechanisms. The keyboard has electrical blocking of operation when several keys are pressed simultaneously. The placement of letters, numbers and characters on the keyboard, and also the inclusion of carriages of different length (for 106, 136 and 175 characters per line) is done by agreement with the customer. Connection to the network is by means of a plug with a grounding contact, and to the control unit by means of four or five 26-filament cables with plug and socket units. The machine can also be shipped with an electromechanical keyboard.

The "Konsul-2596" (ES-0101-01...04) alphanumeric contactless keyboard is intended for use in the ES-7920 display system and in the peripheral equipment of third-generation computers, where it is necessary to code the signs with electric signals. It is expected that thanks to the electronic contactless solution the keyboard will be reliable and durable.

The keyboard permits creating independent code combinations in four registers by means of 87 keys arranged in four rows. To improve the orientation of the operator the keys of different groups are of different colors. The keying mechanism of the keyboard itself can be readily changed. When pressed for more than 2 seconds, nine keys act as repeat keys. The keyboard is equipped with color and sound signaling and electronic blocking when several keys are struck simultaneously.

Technical characteristics

Working speed, characters per second	Up to 25
Length of STROB output signal	During depression of key
Length of code information on outputs of 1-9th channels	Until following key is depressed
Key travel, mm	4
Necessary force for depression of key, H	0.83
Voltage, V (direct current)	5± 5%
Current, A	1.2
Keyboard code	VK018
Keyboard arrangement of keys according to	GOST 14289-69
	OST 6331-52
	ISO/DIS2530

The "Konsul-2111" (ES-7181) sequentially printing mechanism is intended for the output of information on paper with a perforated margin or on roller or sheet paper according to signals from an electronic control unit and transmission of alphanumeric data to interacting equipment by means of a separate keyboard. The type carrier is a point matrix with 5x7 or 7x9 points. The design of the printing head permits using later a matrix containing 11x9 points. The printing is done in sequence character by character. The keyboard output and the printer input are independent of one another.

The mechanism of the "Konsul-2111" was demonstrated at work at the exhibition: working automatically with use of a data accumulator, perforated tape and a counting device and manually with use of a separate electronic contactless keyboard. One feature of the mechanism is the possibility of reverse automatic rotation of the paper roller. The printing rate during the demonstration was somewhat higher than the rated. With consideration of the fact that a worn printing head can be replaced, in the opinion of the Czechoslovak specialists the "Konsul-2111" mechanism ought to be durable and reliable.

Technical characteristics

Printing rate, characters per second, at least	
in start-and-stop conditions	80
in continuous printing	150
Number of printable characters	96
Number of characters in a line	132
Number of copies (when an original on paper with a mass of up to 60 g/m ² is used)	3
Paper width (sheet, roller), mm, not more than	360
Pitch of letter, mm	2.54
Distance between bases of adjacent lines, mm	4.23, 6.35, 8.46
Width of two-color ribbon, mm	13
Dimensions, mm	648x544x204
Mass, kg	47

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CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

NEW BOOKS ON AUTOMATIC CONTROL SYSTEMS

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 5, 1977 pp 60-61

[Book reviews]

[Text] Ableskov, V. K., Zubkov, P. I., and Frolov, A. V. "Opticheskaya i optoelektricheskaya obrabotka informatsii" [Optical and Optico-electrical Data Processing]. O. A. Chembrovskiy, editor. Moscow, Izdatel'stvo Mashinostroyeniye, 1976, 254 pages, 6000 copies, 1 r 07 k.

Methods of optical coherent data processing. Description of optical devices (optical circuits) performing integral transformation of a two-dimensional optical signal. Holographic methods of recording and processing data. Principles of construction of new types of optical instruments and technical means of optical information.

For engineering and technical workers engaged in the planning of systems and instruments for optical data processing.

"Avtomatizirovannyye sistemy upravleniya. Materialy konferentsii "Opyt sozdaniya i raboty ASU na predpriyatiyakh, v ob'yedineniyakh i v otraslyakh" [Automatic Control Systems. Materials of the Conference "Experience in the Creation and Operation of Automatic Control Systems at Enterprises and In Associations and Branches]. D. G. Zhimerin and A. P. Vladislavlev, editors. Moscow, Izdatel'stvo Ekonomika, 1976, 214 pages, 1150 copies, 1 r 78 k.

Generalization of experience in the use of computer technology and automatic control systems. Revelation of shortcomings and designations of paths to very effective use of automatic control systems both in branches of industry and in the non-industrial sphere of the national economy.

For engineering and technical workers engaged in the planning, introduction and operation of automatic control systems.

Zhuravlev, Yu. P., and Akin'shin, Yu. S. "Sistemnoye proyektirovaniye pamyati TsVM" [Systems Planning of Digital Computer Storages]. M., Izdatel'stvo Sovetskoye Radio, 1976, 344 pages, 10,600 copies, 1 r 23 k.

The organization, planning and estimation of the efficiency of systems of working storage of digital computers. Classification of the working storage systems. Criteria for estimating efficiency and procedure for the selection and calculation of optimal technical characteristics of working storage systems -- the number of levels and independent channels, the number of modules in each channel, the capacities and speed of modules of devices on the basis of the requirements presented for computer equipment.

For engineering and technical workers specializing in the development and operation of digital computers.

Pal'tov, I. P. "Nelineynye metody issledovaniya avtomaticheskikh sistem" [Nonlinear Methods of Investigating Automatic Systems]. Leningrad, Izdatel'stvo Energiya, 1976, 127 pages (Library on Automation, No 565), 9000 copies, 39 k.

Principles of the most widespread methods of investigating closed automatic systems. Precise methods used in the planning of low-order nonlinear systems. The method of harmonic linearization as an approximate universal method of application of the oscillation indicator for designing nonlinear systems.

For engineers engaged in the development of closed automatic systems.

"Sintez upravlyayushchikh ustroystv" [Synthesis of Control Devices]. Collection of articles. V. G. Lazarev, editor. Moscow, Izdatel'stvo Nauka, 1976, 109 pages (Automata and Control), 2500 copies, 63 k.

Data on the synthesis of discrete automata and control systems. Automatic selection of a block structure of a control system. Methods of decomposition of the algorithm of functioning of control devices into frequency algorithms, and also combinations of parallel logical algorithm schemes.

For specialists in automatic control.

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AUTOMATED OPTICAL INFORMATION POSITIONING SYSTEM

Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 77 pp 46-51

[Article by Yu. A. Ivannikov, N. S. Kruchinin, V. P. Mayorov, A. K. Movshev, V. N. Nekuryashchev, V. I. Nikulin, V. S. Pegov, and V. I. Khalimonov: "Industrial Development of Universal Automated Positioning System for Recording and Reading Optical Information"]

[Text] Measurement of coordinates and optical density of image elements recorded on a transparent photographic carrier is performed as a rule on narrow-specialization, custom-made coordinate-measuring units which provide data input into a computer. The most promising within this equipment category are "Zenit" universal automated units [1], a model of which was developed at the Institute of Automation and Electrometry of the Siberian Department of the USSR Academy of Sciences. The Zenit automatic photogrammetric unit provides capability not only to feed into a computer photographic information with efficient procedures of search and recognition of informative elements but also, which is equally important, makes it possible to obtain from the computer data files in the form of images on light-sensitive material.

The results obtained in developing the Zenit automatic photogrammetric unit were utilized in developing a universal automated positioning system for recording and reading optical information. Figure 1 contains a structural diagram of this system.

The system contains the following devices*: Elektronika 100 I computer 1; control system 2; power converter 3; scanning system 4; video monitoring unit 5; coupling device with M-4030 computer 6; cathode-ray tube 7; focus-deflection unit 8; photomultiplier 9; motors 10; laser displacement indicators 11; table with optical-mechanical part of scanning system 12; moving carriage with photographic carrier 13.

* All figures in this article contain the same indexing of identical system elements.

Figure 1.

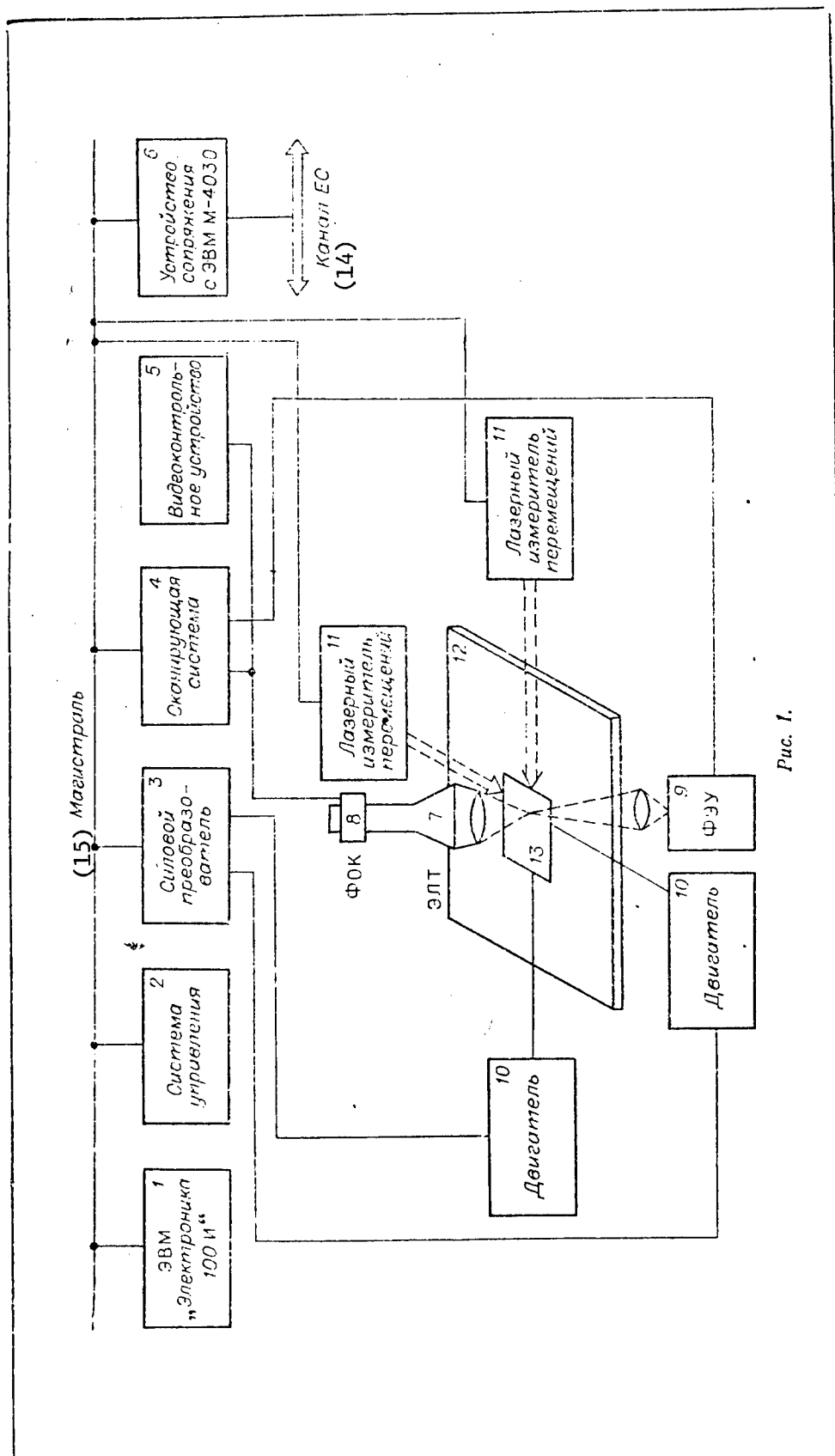


Рис. 1.

Key to Figure 1 on preceding page:

- | | |
|---------------------------------------|----------------------------------|
| 1. Elektronika 100 I computer | 8. Focus-deflection unit |
| 2. Control system | 9. Photomultiplier |
| 3. Power converter | 10. Motor |
| 4. Scanning system | 11. Laser displacement indicator |
| 5. Video-monitoring unit | 14. Unified System |
| 6. Coupling unit with M-4030 computer | channel |
| 7. Cathode-ray tube | 15. Main line |

This positioning system, just as in the automatic Zenit unit, employs a combination of an optical-mechanical system of precision displacement of a 300 x 200 mm large-format flat photographic carrier, with two-coordinate displacement, and a CRT optoelectronic scanning system with 2 x 2 mm format raster on photographic carrier. The scanning system [2], which scans for informative image elements and measures their optical density, contains high-resolution cathode-ray tube 7, focus-deflection unit 8, photomultiplier unit 9, electronic scanning control system 4, and a video-monitoring device with a memory CRT. The raster, formed on the CRT screen by a luminous spot of the "scanning beam" type, is projected by an optical system into the plane of the data carrier and is utilized either for illuminating selected image points (in read mode) or for exposing photographic material (in write mode). Luminous spot brightness and duration are determined by binary codes received from electronic scanning system 4. This same electronic unit forms a raster of 4,096 x 4,096 addressed points and creates alphanumeric symbols and vectors. Scanning system control, collection and preliminary processing of scanning results are handled by a program-control main line-modular system with an Elektronika-100 I mini-computer.

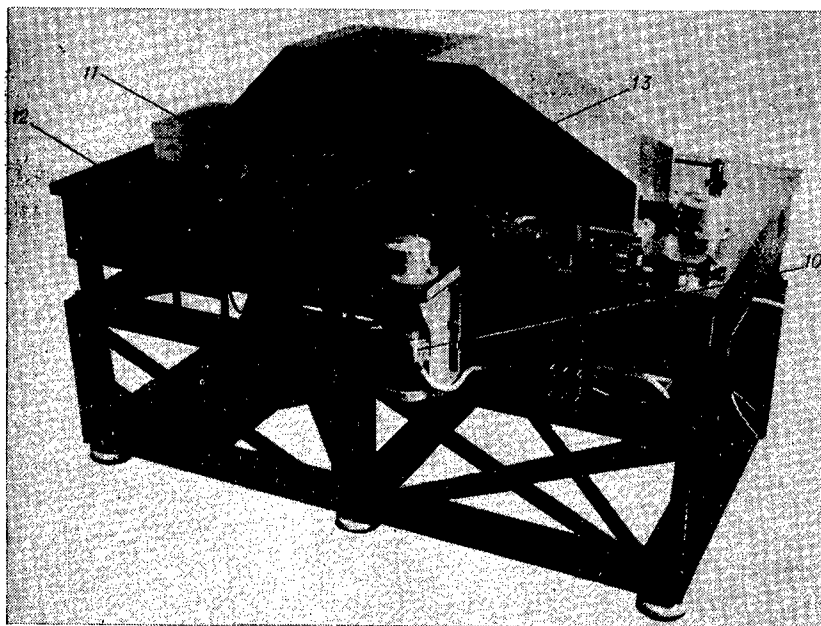


Figure 2.

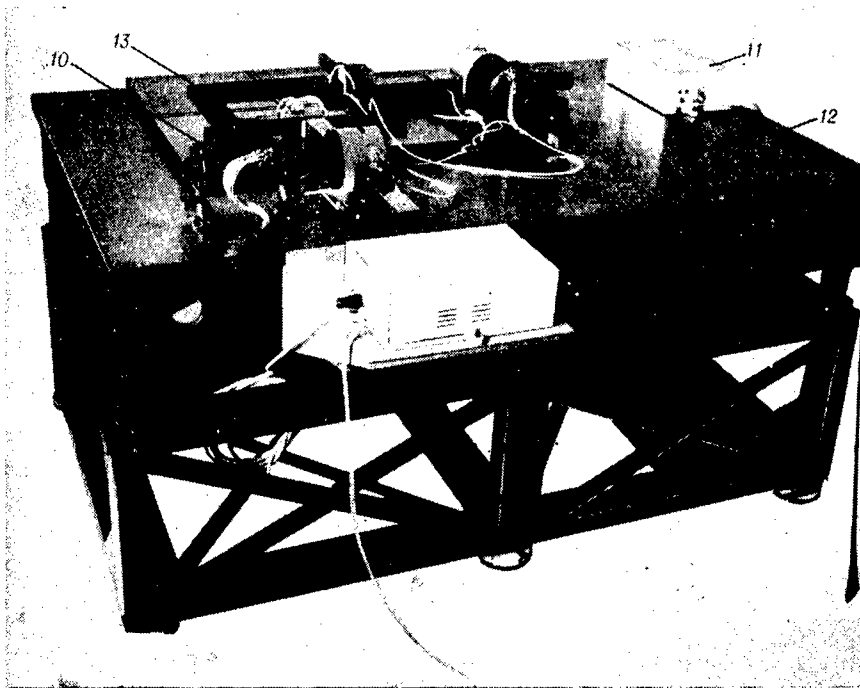


Figure 3.

Carriage 13 with affixed photographic carrier stands on massive table 12 and is displaced in a horizontal plane by two motors, controlled by a system of orthogonal guides. Control of motor speed and direction is handled by power converter 3. Carriage position relative to the table is monitored by two feedback sensing elements based on type FOU-1 laser displacement indicator [3].

In contrast to the automatic Zenit unit, where the drive control algorithm is implemented by an equipment setup, this system is based on a standard program-controlled main line modular structure on line with a computer. It is comparatively simple with this arrangement to organize development of the hardware part of the system, with software handling the electric drive control and scanning system algorithm, as well as preliminary processing of measurement results. Employment of a mini-computer for numerical program control ensures simplicity of adaptation to changing demands on the system and provides the capability to make additions and changes at the final stages of development in the process of operation, and provides system auto-diagnosis capability, which is very important, since the system focuses on a broad range of tasks, performance of which may require, for example, only precise displacement of the carriage with a specimen mounted on it (in particular a printed circuit board, the layout configuration of which is implemented in the process of vaporization of unneeded portions of the metallized layer by a laser, mounted in place of a cathode-ray tube).

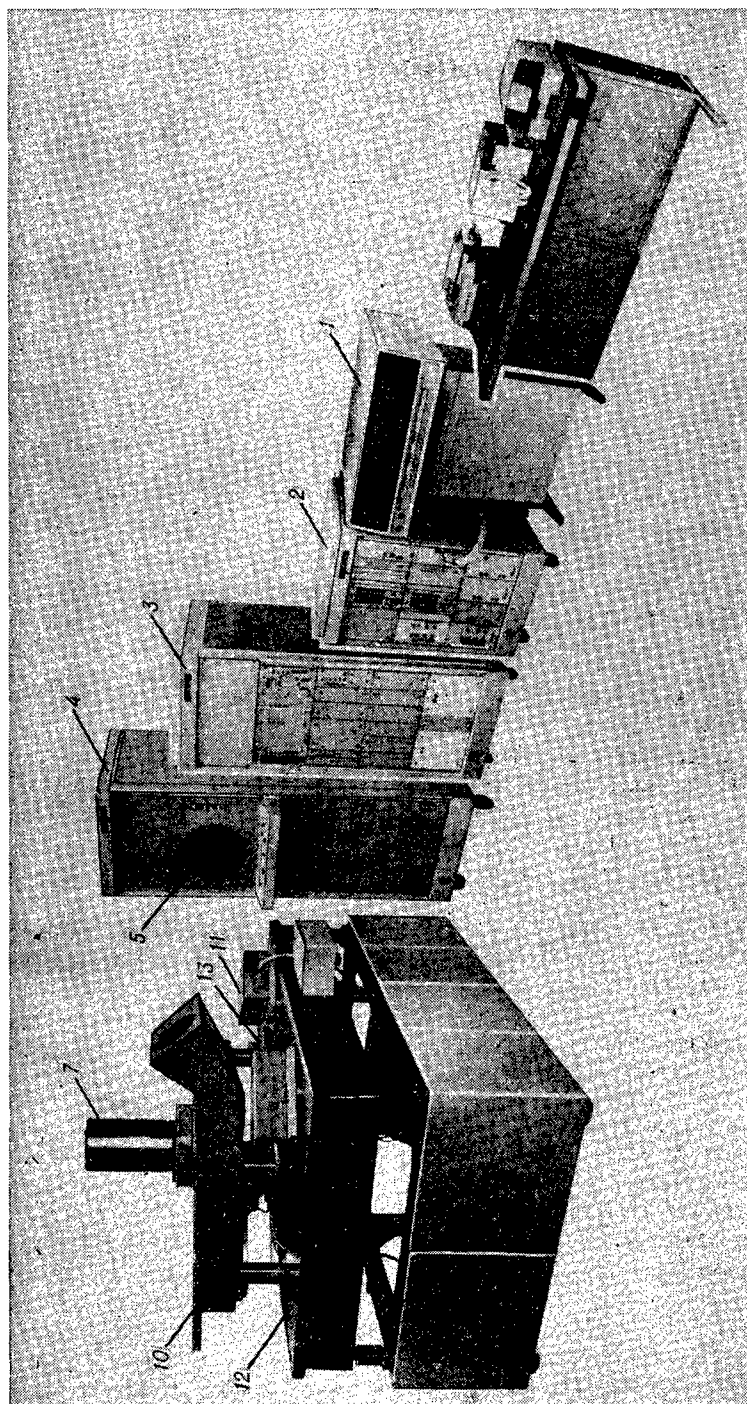


Figure 4.

An Elektronika 100 I mini-computer is employed in the system for control, data gathering and preliminary processing. This computer is employed due to the multiplicity of its data system (12 bit) with data main (24 bit) of program-controlled modular system control structure, as well as computer memory word time (two modules must be replaced when utilizing another mini-computer). In connection with the large volume of information obtained in processing photographic images, the system provides for two-way information exchange through a coupling device with an M-4030 computer.

Three carriage displacement mechanism versions were built and tested in the process of developing an industrial model of a universal positioning system: with belt drives, with friction drive and aerostatic supports, with linear motors and aerostatic supports.

Figure 2 contains a precision carriage positioning system with two-coordinate belt drive, powered by electric motor 4. The entire displacement unit sits on cast iron plate 12, measuring 1,200 and 2,000 mm, mounted on a rigid welded frame resting on shock-absorbing mounts. Carriage 13 with information carrier has a separate drive, motor 10 with type DPYa-0.4 printed armature, for each coordinate. Drive is transmitted from the motor to the carriage through reduction gears by means of flexible steel belts. Laser interferometers 11 serve as displacement indicators and feedback sensing elements; the interferometer corner reflectors move along prismatic guides and simultaneously slide along mutually perpendicular guides attached to the carriage.

Figure 3 contains a general view of a positioning system with friction drive. The entire positioning mechanism is mounted on the same kind of plate and frame as the first version. Coordinate displacement is provided by a printed-armature motor through a friction reduction gear to a rod and to the carriage, as a result of which shaft rotation is converted to rod translational motion. The rod, just as the carriage as a whole, displaces on aerostatic supports, which substantially reduces dry friction and parts wear. The pressing force between reduction gear and rod, essential for ensuring operation without slipping, is also created by an aerostatic support in the vertical plane. Linear displacements are monitored by laser displacement indicators, the corner reflectors of which are mounted inside the rods of the corresponding directions.

Figure 4 contains a general view of an automated multiple-function positioning system. The mechanical part of this system is based on research performed by the Institute of Automation and Electrometry of the Siberian Department of the USSR Academy of Sciences, which developed a two-coordinate mechanism on linear electric motors and aerostatic supports. Employment of linear motors made it possible to improve the accuracy and dynamic characteristics of the system as a whole. Carriage displacement in the horizontal plane by the linear motors is monitored by direct-current laser displacement indicators. For operator convenience the positioning system is equipped with a manual control unit and a second video-monitoring unit 14, which projects on a screen a 35 x 35 mm area of the photographic carrier image, magnified

five times. The electronics of this system are designed, as noted above, on the main line-modular principle, with an Elektronika-100 I mini-computer. Software and testing have been developed for control of all system electronic units.

Following are the principal system specifications: photographic carrier format 300 x 300 mm; accuracy of positioning not worse than 1 micron; maximum positioning time not exceeding 2 seconds, scanning field 2 x 2 mm; number of scanning field addressable points 4096 x 4096; number of quantization levels for light passing through carrier -- 16.

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Submitted 1 February 1977

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A VERTICAL GYROSCOPE WITH ADAPTIVE PROPERTIES PROVIDED BY THE ADDITION OF A NONLINEAR ELEMENT IN THE CORRECTING CIRCUIT

Leningrad IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY. PRIBOROSTROYENIYE in Russian Vol 20, No 6, 1977 pp 66-69

[Article by A. V. Dubovikov, Ryazan' Radio Engineering Institute; manuscript received 12 Dec 76]

[Text] An analysis is made of the possibility of using a relay element in the correcting circuit to give a vertical gyroscope adaptive properties.

In solving the problem of statistical optimization of gyroscopes the structure of the correcting circuit is completely determined by the spectral composition of the input signals (by random drift of the gyroscope, random acceleration at the point of suspension, etc.) [1, 2]. The parameters of the correcting devices depend in that case on the intensity of the disturbing effects. But if the shape of the spectral density curves has been fairly well studied and substantiated [1, 3], really existing indefiniteness in the intensity requires the use of correcting devices optimal for certain medium parameters of effect or optimal for the worst conditions. And in both cases losses of precision arise [2]. To eliminate those losses the correcting devices should be given properties of self-adjustment in relation to the changing intensity of disturbance. One of the simplest methods of solving this problem is the use in the structure of the correcting device of a nonlinear element the properties of which vary as a function of the change of intensity of the input signal [1].

The proposed method [5] is similar to the method examined in [4] and consists in the fact that in the initial stage an optimal stationary Kalman filter is examined (a continuous variant [6]). Then some linear inertialess filter elements are replaced by a nonlinear element, the set of characteristics of which must provide the adaptive properties of the circuit. The method of statistical linearization is used in the solution. If we take into consideration the dependence of the coefficient of statistical linearization on the input effect we can select a form of linear dependence so that during change of the characteristics of the effects the

statistical linearization coefficient varies in accordance with its calculated value (or is similar to it in some sense). In [5] it was shown that each of the filter elements can be replaced independently of the other elements, and this simplifies the calculations.

Figure 1 presents a block diagram of one channel of an uncorrected vertical gyroscope, where Ω is the random rate of drift of the gyroscope; W is the random acceleration of the point of suspension; Ω and W are centered random processes with the spectral densities $S_\Omega = 2\sigma_\Omega\mu_\Omega^{-1} = Q$ and $S_W = 2\sigma_W^2\mu_W^{-1} = R_g/2$, that is, they are approximated by white noise (a similar simplification was used repeatedly in works on the statistical synthesis of gyroscopes [2, 7]); $\sigma_\Omega = (10^{-3} - 10^{-1}) \text{ s}^{-1}$ is the rms deviation of the random drift rate; $\mu_\Omega = (10^{-3} - 10^{-2}) \text{ s}^{-1}$ is the coefficient of irregularity of the drift rate; $\sigma_W = (0.1 - 0.5) \text{ ms}^{-1}$ is the rms deviation of the random speed of the vessel; $\mu_W = (0.2 - 0.6) 10^{-4} \text{ s}^{-1}$ is the coefficient of irregularity of the speed of the vessel [7]; R_3 is the earth's radius and g is the acceleration of gravity.

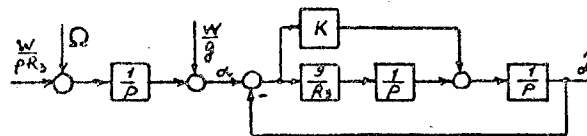


Figure 1

A solution of the problem of filtration (for $\sigma_\Omega = 10^{-3}$ to $5 \times 10^{-2} \text{ s}^{-1}$) is presented by the diagram of Figure 1, where $k = \sqrt{Q/R}$. The output signal $\hat{\alpha}$ is used to compensate the vertical gyroscope error α . It can readily be shown that the open estimating circuit can be transformed to the form of Figure 2. Optimality is achieved by introducing feedback to the gyroscope ($\Delta\alpha = \alpha - \hat{\alpha}$). It is further proposed, while preserving the linearity of the integral correcting circuit (its parameters do not depend on the properties of the input signals), to replace in the proportional correcting circuit the linear term with the transfer coefficient by a nonlinear element. The form of the nonlinearity is subject to determination. The method of statistical linearization cannot be used directly for this, as the input signal of the nonlinear element contains a component of the white noise type. Therefore, to limit the spectrum of the input signal it is proposed that a linear filter be connected at the input of the nonlinear element (Figure 3). Its transfer function can have the very simple form $W(p) = (\tau p + 1)^{-1}$, where τ is the time constant. Its value must be such that insertion in the correcting circuit has no influence on the frequency characteristics of the optimal vertical gyroscope. It is sufficient for that to require that τ be much smaller than the time constant of the optimally corrected vertical gyroscope, that is $\tau \ll 2\sqrt{R/Q}$. Together with that condition it is advisable to select such a value of τ that the filter $W(p)$ effectively smooths pitch acceleration—one of the main disturbing factors [1, 3]. Meeting that requirement is not a complex matter, as the

time constant of a vertical gyroscope is of the order of magnitude of 10^4 s [7] and the predominant wave frequency is of the order of 1 s^{-1} [1, 3]. When a filter with the transfer function $W(p)$ is inserted the dispersion of the signal on the input of the nonlinear element has the value

$$D = 2D[\Delta x] + \frac{R}{2\tau} = 2\sqrt{QR} + \frac{R}{2\tau} \approx \frac{R}{2\tau}. \quad (1)$$

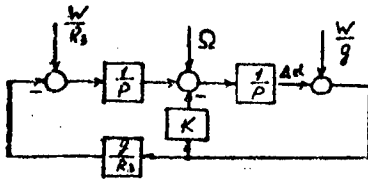


Figure 2



Figure 3

Optimization of the characteristics of the nonlinear element proves to be a readily solved task if, being given the type of nonlinearity correctly within the parameter, its optimum value is sought [5]. Let us examine the simplest characteristic of the nonlinear element, the relay characteristic, depicted on Figure 3. The statistical linearization coefficient of a relay element is determined with the following formula:

$$k_c^2 = \frac{1}{D} \int_{-\infty}^{\infty} [a \operatorname{sign} x]^2 f(x) dx = \frac{c^2}{D} \approx \frac{2\tau a^2}{R}, \quad (2)$$

where $f(x)$ is the probability density of the signal x .

From a comparison of the optimal transfer coefficient in the proportional correcting circuit with the obtained value of the statistical linearization coefficient it can be concluded that $\alpha = \sqrt{Q}/2\tau$ satisfies the condition of optimality at any value of R . Therefore for a known value of Q , the value of which can be determined in stand tests, the block diagram of the vertical gyroscope under consideration is insensitive to change of the intensity of acceleration (the parameters of the vertical gyroscope remain optimal). If the value of Q is unknown, then Q can be considered a random value with a known law of its distribution $\varphi(Q)$. In that case closeness of the statistical linearization coefficient to the calculated value on the average should be required. For example, α can be selected from the condition of closeness of the dispersion of the output signal of the nonlinear element to the calculated:

$$\int_{-\infty}^{\infty} \left[\frac{Q}{R} \left(2\sqrt{QR} + \frac{R}{2\tau} \right) - a^2 \right]^2 \varphi(Q) dQ \rightarrow \min. \quad (3)$$

From (3) with consideration of (1) one can readily obtain the following approximate correlation for α :

$$\alpha \approx \sqrt{\frac{\bar{Q}}{2\tau_1}}$$

where $\bar{Q}$ is the mean value of Q .

Thus the use of even a very simple nonlinear element in the correcting circuit of a vertical gyroscope leads to substantial improvement of the quality of the instrument. The obtained gain in precision is illustrated by the diagram on Figure 4, on which are presented:

a) the dispersion of the error of an optimal vertical gyroscope, calculated at $R^* = 10^{-4}$ s, $\bar{Q} = 5 \times 10^{-3}$ s $^{-1}$, and

b) the dispersion of the error of a vertical gyroscope with a nonlinear element in the correcting circuit,

on a relative scale.

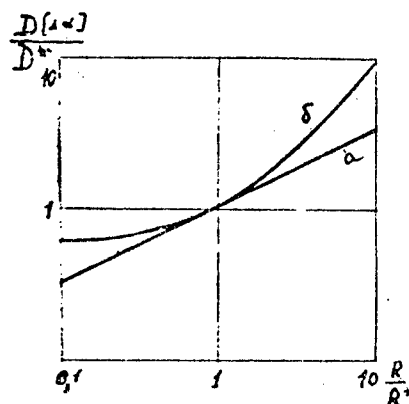


Figure 4

In both cases Q was assumed to be a random value distributed according to a uniform law in the interval 10^{-3} s $^{-1}$ to 1.1×10^{-2} s $^{-1}$. Comparison of curves a and b indicates the advisability of inserting a relay element in the correcting circuit of a vertical gyroscope.

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GEOPHYSICS, ASTRONOMY AND SPACE

USSR-FRANCE: 'SNEG-3' EXPERIMENT

Moscow NAUKA I ZHIZN' in Russian No 9, 1977 pp 58-59

[Article by B. Andreyev and B. Novikov, staff members of the Institute of Space Studies]

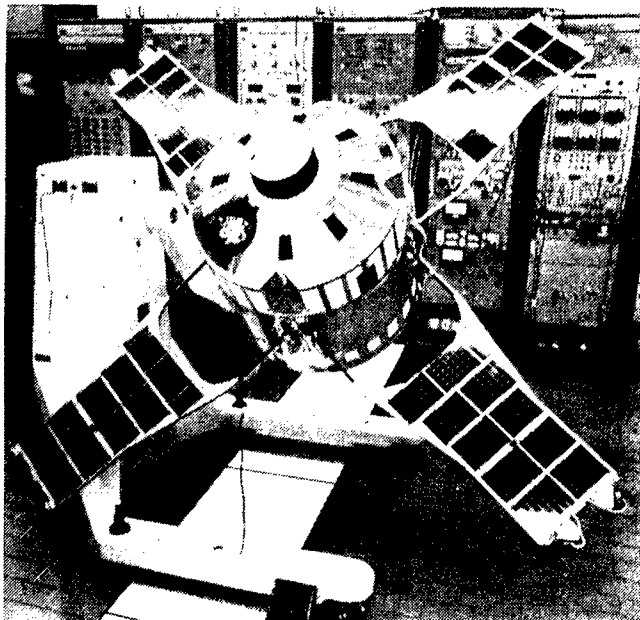
[Text] On 10 May 77: the Institute of Space Studies, USSR Academy of Sciences. As usual, seminars are in session; scientific results of studies are being discussed; ground tests of equipment for new space experiments are going on. In the studies under the Soviet-French 'Sneg-3' Program the day, 10 May, was associated with a quiet prosaic operation, but one very meaningful for the experiment participants--packaging of the French satellites and the control station for dispatch to the Soviet cosmodrome was ended.

And before this there were lengthy and painstaking tests of satellites in a special wing of the institute intended for ground operations with space equipment. Not only scientific instruments and the readiness of the satellites as such were tested, but also the adequacy of the testing facilities proper. Docking of the satellite with a launch vehicle simulator was reproduced. And, lastly, operating coordination of Soviet and French specialists was checked out.

Testing hall. Complex equipment here maintains the needed climate--a given humidity and temperature and keeps dust out of the air. Midway in the hall is the so-called clean room; here stands the satellite. The clean room is equipped with an auxiliary system of filters that ensure virtually dust-free air.

The 'Sneg-3' satellite is a version of the French D2V-gamma satellite, scheduled for insertion into orbit by the French Diamant rocket. But since production of this rocket was halted and the D2V-gamma satellite was already just about complete, the National Center for Space Studies in France requested the Interkosmos Council, USSR Academy of Sciences, to launch the D2V-gamma satellite using a Soviet rocket. In 1975, when the Soviet side gave its agreement, joint work in carrying this program to completion got underway. An adaptor was developed for mating the satellite with the rocket, for reliable stability of the satellite relative to g-loads in the powered section of the trajectory.

Protecting the satellite from overheating was a difficult task, since the D2V-gamma was designed for a smaller velocity head at the instant of staging of the rocket fairing. The problem was solved by careful calculations and tests; ultimately, a certain delay in the dumping of the rocket nose fairing has to be introduced.



French "Sneg-3" rocket during testing

The D2V-gamma satellite was designed for investigating gamma and X-ray background radiation and for studying the sun in the ultraviolet range. On the suggestion of scientists at the Institute of Space Studies, USSR Academy of Sciences, the scientific instrumentation on board the satellite was supplemented with a "Vsplesk-gamma" instrument for detecting recently discovered gamma flashes of cosmic origin. During the period of these flashes, the intensity of gamma-radiation rises by tens or even hundreds of times (see *NAUKA I ZHIZN'*, No 3, 1974); this rise is certainly caused by some complex and as yet unclear processes in deep space. The "Vsplesk-gamma" instrument can serve in the investigation of each flash with a time resolution to 1 msec, that is, the level of radiation a thousand times a second will be measured. The instrumentation is built so that it continually tracks gamma-radiation. As soon as its level markedly rises, the instrumentation is automatically switched over to the mode of high rate of interrogation of gamma-ray detectors. This, change in a flash with time is recorded at a high precision.

With all the "changes and additions," the satellite came to be called "Sneg-3." The word "sneg" in this case is the acronym for "Spektrometr Neytronov i Gamma-izlucheniya" [Spectrometer for Neutrons and Gamma-Radiation] and the numeral "3" means that this is the third experiment that Soviet and French scientists are conducting on the investigation of cosmic gamma-radiation.

Launch of the "Sneg-3" satellite is one of the stages of the space experiment conducted simultaneously with several spacecraft scattered over wide distances. Because of this, scientists are looking forward to determining the location of the sources of gamma-flashes in the celestial sphere and--possibly--to clarifying the nature of this phenomenon. Besides the detailed study of gamma-flashes, the "Sneg-3" program envisions many other interesting and important investigations. They include the study of background gamma-radiation of extraterrestrial origin in the 20 keV-10 MeV energy range and the search for possibly anisotropy, that is, inhomogeneities in the direction of the center or anticenter of our galaxy; search and investigation of "point" sources of gamma-radiation; exact estimate of changes in solar ultraviolet radiation as a function of solar activity; and measurement of certain parameters of the earth's upper atmosphere (concentration of oxygen molecules and atoms and ozone concentration in the stratosphere), as a function of the solar radiation flux.

The experiment studying gamma-sources was drawn up by the Center for the Study of Cosmic Radiation at the Paul Sabatier University in Toulouse; the experiment studying the sun was formulated by the Aeronomy Service of the National Center for Scientific Research in France.

The weight of all scientific instruments on the "Sneg-3" satellite is 28 kg; total weight of the satellite is 102 kg. In flight, the satellite is continuously oriented toward the sun with an accuracy of up to 50 angle seconds; it rotates about its axis at a rate of 15 rph.

The parameters of the "Sneg-3" orbit are: altitude--500 km; inclination--51°; and period of revolution around the earth--96 min. The first satellite tracking station is in Australia; other stations will go into action later on. The principal receiving center is in France, in Toulouse. Data taken from the satellite are computer-processed, then made available to scientists and technical specialists.

After the launch vehicle with the satellite goes into the calculated earth orbit, from the rocket a command is sent to switch on satellite power and start its program. In a few seconds the satellite separates from its last stage. Panels of solar batteries deploy and "Sneg-3" begins its major and interesting research work in space.

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

DEVELOPMENT OF SOVIET SCIENCE PRAISED

Moscow IZVESTIYA in Russian 18 Nov 77 p 2

[Article by Yu. Ovchinnikov, vice-president of the USSR Academy of Sciences: "Science in a Nation of Developed Socialism"]

[Text] A new society appeared on our planet 60 years ago, which proclaimed and, for the first time in history, asserted the triumph of the working people, the conquest of reason and genuine justice. Our people, guided by the party of Lenin, participated in a revolution that has no equal in history with regard to its worldwide significance and consequences to mankind.

The October victory demonstrated the unsurmountable force and effectiveness of progressive social thought, which became the legacy and ideal of the masses. Conceived under the fire of 1917, the first nation of socialism started, with inspiration, on the pilgrimage toward building powerful productive forces, for universal education, enlightenment and disclosure of the creative capabilities of the people, for the development of the most progressive science and culture.

From the very first days of its existence, the Soviet State displayed deep concern about the fate of the scientific centers and schools then existing in Russia, and rendered every possible spiritual and material support to them. The new society did not discard the knowhow accumulated by prior generations, but used it in the interests of the people, enriching it with new content and new, lofty goals and ideals. In those years, V. I. Lenin, the founder of our party and state, wrote: "... crushed capitalism will not satiate you. We must take all of the culture that capitalism left behind and build socialism from it. We have to take all of science, engineering [technology], all knowledge and art. Without this, we cannot build life in a communist society."

In a historically extremely brief time, a wide front of research was deployed in the Soviet Union dealing with many of the main disciplines. The rapid progress of technology was very important to our country, and in this regard K. Tsiolkovskiy, A. Baykov, I. Grebenshchikov, S. Chaplygin, G. Krzhizhanovskiy, A. Krylov and other scientists deserve considerable credit. The largest deposits of minerals were discovered and began to be developed, and this is

directly linked with the work and activities of V. Vernadskiy, A. Fersman, I. Gubkin, P. Lazarev and their followers. The brilliant research of S. Lebedev, who developed synthetic rubber, the work of V. Khlopin dealing with radiochemistry, that of N. Kurnakov dealing with physicochemical analysis and that of V. Tishchenko, S. Nametkin and V. Rodionov dealing with natural substances led to the inception and development of new branches of the chemical industry. The basic research of K. Timiryazev, D. Pryanishnikov, N. Vavilov and many others played a sizable role in the development of agriculture.

The most outstanding scientific schools were formed in the USSR in the prewar period, and they determined the development of entire branches of natural science, providing for the careers of many generations of Soviet scientists. We refer to the world-renowned schools of our mathematicians and mechanics, the brilliant school of physicists, founded by A. Ioffe, at the Leningrad Physicotechnical Institute; the outstanding school of organic chemists famous for the names of N. Zelinskiy, A. Favorskiy, A. Chichibabin and A. Arbuzov; the remarkable Pavlovian school of physiologists, Vavilov's school of geneticists, the school of biochemists founded by A. Bakh and many others. Soviet scientists have made some basic discoveries in physics and chemistry in these years (L. Mandel'shtam, S. Vavilov, L. Landau, I. Tamm, Ye. Zavoyskiy, V. Fok, Ya. Frenkel', I. Chernyayev, A. Frumkin, A. Vinogradov and others), as well as in biology (N. Kol'tsov, A. Serebrovskiy, V. Sukachev, I. Shmal'gauzen, Ye. Pavlovskiy); some first-class work was done in the field of the science of earth (A. Karpinskiy, O. Shmidt, V. Obruchev) and in many directions of the humanities (B. Grekov, V. Volgin, V. Nemchinov, S. Strumilin and others).

During the years of the Great Patriotic War, the scientific teams of our country underwent genuine toughening, withstood rigorous trials, demonstrated their ability to solve the most complex problems in the shortest period of time. During the period of devastation by the enemy, a considerable contribution was made both in the form of work and innovative thinking by A. Tupolev, S. Il'yushin, I. Bardin, A. Tupolev, I. Kurchatov, P. Kobeko, A. Blagonravov, N. Burdenko, M. Keldysh, A. Aleksandrov and dozens of other outstanding figures in science and technology.

At the present time, Soviet science has a powerful potential that extends over virtually all branches of natural science and teaching on society, and it has no equal in the world with respect to scale of its development. There are more than 1.3 million scientific workers in the Soviet Union, or about 25% of all scientific workers on our planet.

The USSR Academy of Sciences is the world's largest center for basic research. In accordance with the decisions of the 25th CPSU Congress, at the present time its role as a theoretical research center and coordinator of all research in our country is growing even more. The creation and strengthening of national academies of sciences in 14 Union republics is a triumph of Lenin's national policy. The Academy of Medical Sciences, All-Union Academy of Agricultural Sciences imeni V. I. Lenin and Academy of Pedagogic Sciences

play a large part in development of the most important research. There is a vast army of scientists working at universities and other VUZ, in numerous specialized institutes, planning organizations and designing offices.

The creation of this well-organized and powerful system of scientific institutions, which are distinctly specialized in different tasks and are organically interrelated, is an important achievement of our party and state, and the constant strengthening, upgrading and development of this system on all of its levels are the cardinal objectives of education, science and culture in our country.

Soviet scientists have made outstanding advances in the most important branches of modern science. They have made a basic contribution to the development of theoretical and applied mathematics, and this earned worldwide fame for Soviet science. The achievements of our researchers in the field of aerodynamics and hydrodynamics, in theory of strength and plasticity, elasticity theory and vibration theory, as well as other branches of mechanics laid the theoretical foundation for the most refined systems in aviation, ship building and rocketry.

The Soviet Union launched the first artificial satellite of earth. In 1961, the world witnessed the first manned flight into space, made by our compatriot Yu. Gagarin. The significant conquests in exploration of space are the result of the heroic and creative work of our scientists, engineers, technicians and among the thousands of names of these remarkable people, the first to be mentioned must be that of Academician S. Korolev. At the present time, extensive use of space technology has begun to solve many national economic problems.

Major advances have been made in astronomy and astrophysics. The recently built optical telescope, which is the largest in the world, with a 6-meter diameter of the main mirror, as well as the unique RATAN-600 radiotelescope open up new prospects.

Some important data were obtained from work conducted with the high-power charged particle accelerators in Dubno and Serpukhov, with reference to the structure and interaction of elementary particles of high energies; new elementary particles have been discovered, new transuranium elements have been synthesized and studied.

Soviet science and industry have been able to rapidly solve the problem of harnessing the energy of the atomic nucleus, and in this regard an enormous role was played by many outstanding scientists of our country, headed by I. Kurchatov. In 1954, the world's first atomic power plant was opened in the USSR. The first atomic power plant with a fast neutron reactor has been put in operation. Larger ["more powerful"] plants of these types are under construction. The historical expedition of the atomic icebreaker Arktika to the North Pole was a major scientific and technological achievement.

Our country occupies a leading place as well in development of the problem of controlled thermonuclear synthesis. Development of theoretical and

experimental work dealing with plasma physics made it possible to obtain a branched thermonuclear reaction on Tokamak type units.

Soviet physicists are to be credited with many outstanding achievements and discoveries in the field of optics and radiophysics, physics of magnetic phenomena and low temperatures, research on semiconductors and other fields. One of the most vivid achievements is the creation of quantum electronics and use of laser technology for practical purposes.

There has been wide development of chemical science in our country. Research in the field of chemical kinetics acquired worldwide fame. Results that are important to a number of branches of industry were obtained with respect to development of complex methods of processing natural raw material, synthesis of diverse materials, electrochemistry, radiochemistry and petrochemistry, as well as development of new and effective catalysts.

Biochemistry, molecular biology and bio-organic chemistry have made great strides in the study of physicochemical bases of vital function processes, which enriched our knowledge about the most important processes in the living cell. Research on the structure of biopolymers is developing rapidly, and this applies primarily to proteins and nucleic acids. Soviet researchers have made a significant contribution to the development of these branches of biology. The advances made by microbiology enabled our country to create the industry of microbiological protein synthesis. Through the work of physiologists, substantial advances were made in development of the teaching on higher nervous activity and research on the main functional systems of the living organism.

Modern standards are inherent in the work pursued in our country on physiology of plants, photosynthesis and agrochemistry. Investigation of the plant and animal kingdoms is gaining increasing importance in the USSR, particularly in connection with the problem of protection and rational utilization of the environment. The advances of biological science are exercising an increasing influence on progress of medicine and agriculture.

The geologists of our country discovered some important patterns in the structure of earth's crust and ore formation; effective methods are being developed for exploration of minerals, as well as new methods of predicting earthquakes and eruptions of volcanoes. Oceanologists, who make use of a modern research fleet, have made some important discoveries in the area of investigation of the mineral and biological resources of the oceans.

Development of the entire set of social sciences is characterized by an extremely wide scope. Progress in these sciences is instrumental in solving some pressing economic, political, social, ideological problems in our country, in implementing national and cultural construction, formation of a Marxist-Leninist world outlook. Important works have been written on the history of our revolution and the study of the richest experience of the Great October Revolution.

The high standards of basic research in all of the main branches of science are a typical feature of our science, and this assures a stable future for scientific and technological progress in our country.

An important feature of the present stage of development of science in the USSR is the development and implementation of national scientific programs dealing with the most pressing problems, with specific target dates for completion thereof, well-organized work and constant checking of performance.

Today the enormous advantages of development of science under socialism are obvious and generally recognized. We refer to the possibility of rapidly concentrating manpower and material resources to solve particularly important problems, national planning of research, the capacity for rapid and well-organized change in the work of research institutions when new facts and trends appear in science. But, primarily, this involves humanism and the lofty social purpose of science under socialism, the ideological conviction and maturity of scientists and the entire army of workers in our science. It is important to stress this distinction at the present time, when some voices are being heard as to the gloomy consequences of scientific and technological progress to the fate of the world and human society, in connection with the latest achievements in nuclear physics, rocketry and gene engineering.

In our society, the role of science is constantly growing. This role is reflected in the program of our Party and in the decisions of its congresses, in the Basic Law of our country, the Constitution of the USSR. In a speech at a solemn meeting commemorating the 60th anniversary of the Great October Revolution, comrade L. I. Brezhnev said: "As we ponder about the future, we attribute much importance to science. It will make an important contribution with regard to solving the most important problems of building communism." And we are completely confident of new victories and achievements of Soviet science, in the future advances of Soviet scientists, gleaned strength, new ideas and creative inspiration in the great talent of their people.

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

DEVELOPMENT OF CYBERNETICS AND OTHER TECHNICAL SCIENCES IN UZBEKISTAN

Tashkent IZVESTIYA AKADEMII NAUK UZSSR. SERIYA TEKHNICHESKIKH NAUK
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[Article: "Development of Technical Sciences in Uzbekistan"]

[Text] The Great October, the triumph of Socialism in our country, the wise Leninist policy of the CPSU and fraternal mutual assistance have caused a mighty upsurge in the economy and living conditions of all of our country's republics over the last 60 years.

Over 100 branches of modern industry encompassing thousands of industrial enterprises with modern technical equipment have been created in Uzbekistan, a former colonial outpost of tsarist Russia whose industry consisted of handicraft and semi-finished handicraft enterprises for which the primary processing of raw cotton was accomplished by primitive machinery and manual labor.

The republic has its own ferrous and non-ferrous metallurgy, its own large-scale machine-building industry, a chemical industry, an advanced fuel-energy base, a mining industry, a multi-sector light and construction industry, etc.

The level of industrial development in the republic is clearly characterized by the amount of electrical energy produced, which by the 60th anniversary of October will be in the order of 35 billion kilowatt-hours.

Large kolkhozes and sovkhoses, armed with modern technology, have been built and have replaced the small peasant farms with their primitive equipment. The principal sector of the economy is cotton growing, whose production volume has increased by more than 10 times, and which is now 90 percent mechanized. The area of irrigated lands has tripled. Unique hydro-engineering installations have been created. A great deal of projects have been completed with respect to the technical revamping and land reclamation of irrigated lands.

Following the Golodnaya Steppe there has been undertaken an impressively large-scale project with respect to developing the Karshinskiye, Dzhizakskiy Steppes and many other regions.

Over the past 60 years the Uzbek nation has achieved a flourishing of socialist culture and science. The tasks in the development of productive forces have facilitated a flourishing of the engineering sciences. The local national skilled cadre ranks have grown and the problem of formulating a large collective of Soviet scientists has been resolved. Suffice to say that at the present time there are 42 VUZ's and tens of scientific-research institutions that are functioning along with the Uzbek SSR Academy of Sciences where the engineering sciences are represented by the Institute for Mechanics, the Institute for Structural Earthquake-Proofing, and the Institute for Cybernetics with the computer center.

Among the technical VUZ's one might name the country's largest Polytechnic Institute (Tashkent Polytechnical Institute), the Institute for Irrigation and Agricultural Mechanization (TII MSKh), the Transportation Institute (Tash ITT), the Institute for Communications (Tash EIS), the Institute for the Textile and Light Industry (Tash TI), the Highway Institute (TADI) and the Fergana Polytechnic Institute (Fer PI).

Among the large industrial institutes one should name the Institute for Irrigation (SANIIRI), the Institute for Power and Automation (Uz NII EiA), the Institute for Gas (Sredazniigaz), the Institute of the Cotton Industry (TsNII Khprom), and the Institute for the Mechanization and Electrification of Agriculture (SAIME), etc. There has been created a multiple of design-research institutions and design offices which include the Central Asian Institute for the Planning of Irrigation Structures and Rural Electric Power Plants, the Central Asian Branch of the Hydro-Power Project, the Central Asian Branch of the Energy Network Project, the State Special Design Office for Cotton Growing, and others. The collectives of the enumerated institutions have been making a worthy contribution to the development of the republic's productive forces and technical progress.

All things in an arid zone begin with water and irrigation. "It is irrigation that is needed most and it is irrigation that will more than anything recreate the country, give it a rebirth, bury the past, and strengthen the transition to socialism,"*--wrote V. I. Lenin. It was therefore no accident that in 1925 there was founded for the purpose of developing the scientific principles of irrigation, land reclamation and water management construction, our country's first

*V. I. Lenin, "Polnoye Sobraniye Sochineniy" (Complete Collected Works), Vol 43, p 200.

scientific center--the Hydrotechnical Institute which was later renamed the Central Asian Scientific-Research Institute for Irrigation imeni V. D. Zhurin (SANIIRI).

The first stage in irrigation research was connected with making improvements in the technology of irrigation, changing the irrigation of cotton from inundation methods to the furrow irrigation method, and a restructuring of the intra-economic network--by an enlargement of cultivation maps which more completely corresponded to the use of tractors and the collectivization of agriculture. Then the world's first scientific bases for planned water utilization were developed.

Subsequently, research on water management was adapted on a gigantic scale for agricultural operations in an arid zone. In this connection, V. L. Shul'ts and his pupils completed a considerable amount of work in identifying the water resources and establishing the characteristics of Central Asian river run-off. A fundamentally new type of water-intake equipment was developed (the Fergana water in-take type), which assures water collection without debris and regulates the regimen of solid waste. Built along the lines of the Fergana collector were the Kampyrravat, the Kuygan'yar, the Sarykul', the Kokand and other hydraulic developments in the mountainous and foothill sectors of rivers and the Takhiatash, the Tuyamuyun, the Kyzylordin, the Kazalin and other developments in the lowlands. New effective installations have been developed which prevent the intake of ground debris into the collector. Corresponding member of the Uzbek SSR Academy of Sciences S. T. Altunin was awarded the USSR State Prize for a series of works in this direction. Scientific research of that period encompassed the problems dealing with the filling of canals and the stability of land beds. These works were utilized in the construction and utilization of a number of large canals, including the Great Fergana Canal.

The broad development of irrigation projects in the Golodnaya Steppe in the postwar period required the concentration of scientific research in problems dealing with the land reclamation of saline and saline-prone lands. During this period scientific principles and designs were worked out for systems of horizontal-vertical and mixed type drainage as well as methods for the effective washing of soil which made it possible to accomplish stable high-level harvests of cotton even in strongly saline earth. The Uzbek SSR State Prize imeni A. Beruni was awarded to a group of scientists for their research with respect to the technical-economic substantiation of using vertical drainage and its broad introduction in large land areas (corresponding members of the Uzbek SSR Academy of Sciences R. A. Alimov, A. M. Reshetkina, S. M. Mamarasulov, and others).

There evolved a concise organizational system which provided for the interacting chain: science-design, construction-exploitation. Scientific projects were now being concentrated in the SANIIRI and partially in scientific-research sections of the design institutes. The planning of water-management installations is especially being done by the design institutes: the Central Asian State Institute for the Planning of Cotton Plant Irrigation, the Uzbek State Institute of Water Management, and partially by the Central Asian State Institute for the Planning of Energy Projects. Construction problems are being resolved by the specialized main administration--the Central Asian Irrigation and Sovkhoz Construction Administration, the Uzbek Main Water Administration, and the Uzbek Hydraulic Power Construction Administration. The Ministry of Land Reclamation and Water Management, together with the administrations, is implementing the exploitation of water management installations.

The 1970's have been a period in which there has been a growing water shortage in Uzbekistan and in the entire Central Asian region, and in this connection the problem of rationally utilizing water resources and working out measures to protect those resources and make up for water deficiency have become the general directions of scientific research.

One of the principal methods for the rational utilization of water is the regulation of river run-off not only in the seasonal aspect but in the perennial one. Model investigations were conducted for this purpose and recommendations were worked out for optimal configurations and designs for the Chardara, Farkhad, Kayrakkum, Charvak, Toktogul', Nurek, Tuyamyun, Kyzylayak, and Rogun hydraulic developments with water reservoirs attached to them. The most important characteristic of the largest hydraulic developments is their complex nature which assures not only a supply of water and expansion of irrigated lands, but also the production of inexpensive water power.

An important means of overcoming the water shortage is a reduction in the expenditure of water for which purpose research is being done on optimal land reclamation systems. Types and varieties of modern drainage corresponding to those systems are being worked out. The essential reserves in water savings lie in an increase of the technical efficiency coefficient of irrigation systems. Effective anti-filtration layers and hydrophobic materials are being developed for that purpose.

In addition, the further development of irrigation will be implemented as a result of partially diverting Siberian rivers to Central Asia. At the present time, research is being conducted on individual problems of this master plan--studies are being made of the hydrodynamics of cross-over canals, the region's water balance, water quality, and others.

Investigation in the area of hydroengineering and land reclamation are connected in the closest way with the names of a number of major scientist-researchers and science administrators such as V. D. Zhurin, N. A. Yanishevskiy, Ye. A. Zamarin, A. N. Gostunskiy, D. Ya. Sokolov, academicians of the Uzbek SSR Academy of Sciences A. N. Askochenskiy, V. V. Poslavskiy, corresponding members of the Uzbek SSR Academy of Sciences R. A. Alimov, M. S. Vyzgo, S. T. Altunin, and corresponding members of the All-Union Academy of Agricultural Sciences A. M. Mukhamedov, V. A. Baranov, D. P. Kolodkevich, A. A. Rachinskiy, and A. I. Alekseyev.

The impressive development of cotton-growing in the republic over the past 60 years would have been unthinkable without the radical replacement of manual labor in this sector by advanced mechanization. Today all plowing, sowing and multiple cultivation of cotton are completely mechanized. Much is being done for the mechanization and automation of irrigation. A fundamental solution to the problem of mechanizing the harvesting of raw cotton has been obtained. A great scientific and technological development in the republic was the creation of a vertical-shaft cotton harvester. Having applied an enormous amount of work to the creation and continuous improvement of cotton harvester technology were not only the special state design offices but also a number of research organizations, machine-test stations and the VUZ departments. One should first of all take note of the Institute for Mechanics and Structural Earthquake-Proofing of the Uzbek SSR Academy of Sciences and the SAIME. Tens of thousands of cotton harvesting machines operate on the fields of the republic at the peak of cotton harvesting. The direct creators of this technology have been awarded the Lenin and USSR State Prizes.

The complexity of the working processes and operational dynamics of individual units in the cotton-harvesting machines has facilitated a profound study of the structure, kinematics and dynamics of mechanisms and machines with the broad use of mathematical modeling (under the supervision of corresponding member of the Uzbek SSR Academy of Sciences Kh. Kh. Usmankhodzhayev).

A fundamentally new design of shafts has been created having rigidly wound and freely wound keying elements which has been called a link shaft. It has been shown that the use of a link shaft significantly increases the productivity of cotton harvesting machines.

A new type model of a kinematic pair has been developed. Its fundamental theory is the one utilized in the construction of the automatic link-shaft. A mathematical method and monogram has been proposed for predicting an increase in the productivity of cotton harvesters equipped with link shafts. A connection has been established between the absolute speeds of pinion points and gearing ratio in planetary mechanisms as well as between the trajectory,

speed and acceleration of pinion points. A planetary screw-cam shaft mechanism has been constructed and its theory has been worked out.

The dynamics of the link screw shaft of cotton harvester machines has been theoretically and experimentally studied. Theoretical research has made it possible to decipher and take stock of its various characteristics and has assisted in understanding more profoundly the nature of the complex mechanical working process.

It has been proven that in the general case the cotton-harvesting machine constitutes a three-frequency mechanical system and each of its points completes a complex nonharmonic movement and interconnected oscillations in the vertical-linear and vertical-transverse planes. Equations for two groups of oscillations in the machinery of the shafts' reverse rotation have been worked out and the physical causes for their emergence have been described.

The characteristics of the power load of shafts and gears as well as their drive mechanism have been identified under field conditions. Experimental research has established the characteristics of the shafts' interaction with the cotton plant shrubs and with the drive gears and lifters. Also proven was the significant influence that those processes have on the vibrations of the individual parts, the coupling, and the shaft drum as a whole (A. D. Glushchenko).

Studies have been made of the chassis system, particularly that of the cotton harvester, on the basis of the initial parameter method (M. R. Daminov). By using a computer, the frequencies of buckling vibrations in the chassis of the KhT-1.2 cotton harvester have been determined.

A method has been worked out for establishing torsional oscillation, the load of the drive gear fans in the 14KhV-2.4 cotton harvester under field conditions, and broad experimental projects have been carried out. A new arrangement has been proposed for the drive gear fans in the series cotton harvesters 14KhV-2.4.

SAIME has completed major projects with regards to creating organizations concerned with cultivation, kurako [term unknown] harvesting, and cotton stem and boll pulverizers. One should particularly note the work of the non-packaged hauling of cotton that is being broadly put into effect and where the safety and maneuverability of four-trailor tractor trains have been assured.

Quite a few works have been completed by collectives of the TsNIIKhPROM [Central Scientific Research Institute of the Cotton Industry] and the Textile Industry on the theory and practice of ginning, the

mechanization and automation of primary cotton processing plants, and cotton drying.

The Chatkal earthquake of 1946 that occurred in Tashkent at an intensity scale of seven stimulated scientific research on earthquake-proofing in Uzbekistan.

On the basis of an analysis of material collected by a specially organized expedition, the government and the Uzbek SSR Academy of Sciences considered transferring Tashkent to an eight-point intensity scale region. The initial responsibility for this work rested with the Uzbek SSR AN [Academy of Sciences] Institute for Structures (created in 1947 and now called the Uzbek SSR AN Institute for Mechanics and Structural Earthquake-Proofing imeni M. T. Urazbayev).

M. T. Urazbayev's article "Approximate Means for Determining Frequencies of Natural Oscillations of a Cylindrical Shell Section" has made a considerable contribution to the theory of seismic stability. The research on spatial rod systems (Sh. M. Gofman), and studies of arch and chassis system stability and vibrations (Yu. R. Leyderman) were of considerable importance to the development of dynamic methods for designing structures supporting horizontal loads.

Recommendations were formulated in 1948 with respect to classifying the Central Asian territory into seismic regions and utilizing local materials in earthquake-proof construction, etc.

The material on the Ashkhabad earthquake of 8 October 1948 which was collected by the Institute for Structures was used by scientists to design buildings with load-bearing walls to withstand the effects of earthquakes and to construct a dynamic theory of seismic stability (M. R. Pil'dish). This required intense research on the theory of plates bearing loads in their plane, which in turn is related to two-dimensional problems in the elasticity theory (academician of the Uzbek SSR AN V. K. Kabulov).

The Tashkent School of Structural Earthquake-Proofing resolved a number of dynamic problems in fixed and variable cross-sectional rod vibrations in linear and non-linear arrangements. A new area in structural mechanics and structural earthquake-proofing was created, and a theory of oscillations and seismic stability in hydroelastic systems was formulated (academician of the Uzbek SSR AN M. T. Urazbayev, academician of the Uzbek SSR AN V. K. Kabulov, V. T. Rasskazovskiy, Yu. R. Leyderman, and others).

An analysis of seismic effects on structures in the epicenter zone was made at the Uzbek SSR AN Institute for Mechanics and Structural Earthquake-Proofing. The consequences of the Tashkent 1966 earthquake

and its effects on buildings and structures were examined. The basic problems concerned with eliminating earthquake after-effects and the building of a new Tashkent were resolved. Also resolved were questions dealing with reclassifying the territory's principal area to a nine-point intensity scale zone, and determinations were made with respect to the structural design and height of new buildings in the city's central section. Research on the seismic stability of hydroelastic structures was begun in the 1960's. A profound analysis was made of dam-water interaction, viewed as a unified mechanical system. The joint solution of dam movement equations and the La Place equation by the variation method was an important accomplishment (academicians of the Uzbek SSR AN M. T. Urazbayev and R. Mukhutdinova). A large number of works was completed on the theoretical rating of compartments in large-panelled buildings with respect to earthquake shock waves. Those works considered the spatial function of lengthwise walls and crosswalls as well as facings (U. Shamsiyev). Works were also completed on the study of the dynamic characteristics of variously designed buildings of up to 19 stories (K. S. Abdurashidov, A. Ruzmetov).

A completely new area in the seismic stability of underground buildings in the republic was created in the beginning of the 1970's under the supervision of corresponding member of the USSR AN A. A. Il'yushin. A seismo-dynamic theory was formulated for complex systems of underground structures which became the basis for the optimal planning of underground structures in seismic regions (T. R. Rashidov). Subway tunnel design has already been worked out and both the transverse and longitudinal vibrations of subway tunnels in an arbitrarily directed seismic reaction have been studied.

The results of scientific research on the seismo-dynamics of underground structures have been used in the design and construction of the Salar and suburban Karakamysh sewage conduits, and are being used for the design of tunnels built by the subway tunnel heading method as well as for the design of complex junctions of underground structures.

In the area of soil mechanics research is being conducted on improving the existing theory of shearing strength and methods based on that theory for estimating the slope stability of land surface structures. Research is also being conducted with respect to developing new methods for estimating slope stability in planar linearized and linear seismic reaction problems. A solution has been found to the problem of packing tri-phase soil whose layers are constantly thickening, with consideration given to its linear creep. A numerical method has been worked out for estimating the thickening of clay, highly compressed water-saturated ground in unidimensional, planar and three-dimensional situations.

Following the appearance in 1956 of Kh. A. Rakhmatulin's fundamental work on the mutual penetrating movement of multi-phase media in Uzbekistan, research was begun on the hydrodynamics of multi-phase media. The opening of the hydrodynamics laboratory at that time at the Uzbek SSR AN Institute for Mechanics and Structural Earthquake-Proofing enhanced the development of multi-phase system hydrodynamics in Uzbekistan (corresponding member of the Uzbek SSR AN D. F. Fayzullayev). Along with hydrodynamic problems, an examination was also begun of biphasic current gas dynamic problems (academician of the Uzbek SSR AN Kh. A. Rakhmatulin, corresponding member of the Uzbek SSR AN D. F. Fayzullayev, N. Mamadaliyev). Associates of the indicated laboratory have been giving particular attention to experimental studies of biphasic stream structure in vertical pipes. A theory of a two-speed boundary layer has been developed.

Solutions to problems in the hydrodynamics of mixtures in porous pipes evolved from the need to drill petroleum-gas wells, research on subsoil irrigation, blood movement in blood vessels, etc.

A method has been developed for studying duct resistance in the movement of liquids and mixtures. Studies have been made of conduit resistance to two and three-phase media at various values of engineering parameters, resistance reduction with the aid of a polymer additive as well as a result of magnetic treatment. Also being examined are questions dealing with moisture distribution in soil undergoing reclamation.

An experimental-industrial high-output apparatus has been constructed on the basis of studying the aerochemical delinting of cottonseed for the purpose of developing and building machine systems and devices that will assure the production of high quality seed for precision sowing (S. P. Kagalovskiy).

By the important date celebrating the anniversary of the Great October Socialist Revolution the gas industry of Uzbekistan will have given to the country's economy about 36 billion cubic meters of the most economical fuel which will be fed to our republic's industrial enterprises, to the cities and settlements of all the fraternal republics of Central Asia and the Kazakh SSR, to the industrial centers of the country's European section and to the Urals.

The development of the gas industry in the Uzbek SSR, as was the case in the other sectors of the national economy, has been inseparable from the development of scientific-technological progress and from a greater efficiency of scientific research.

Created in Tashkent in 1965 as an outgrowth of the Moscow Institute of the VNIIGaz [All-Union Scientific-Research Institute of Natural Gas] was the Central Asian Scientific-Research Institute of Natural Gas (Sredazniigaz) which has been conducting research in gas geology, the drilling of gas wells, the development and operation

of gas and gas-condensate deposits, gas transportation and underground storage, gas processing and gas industry economics.

The development and introduction of new improved chemical reagents, formulations of drilling and plugging solutions, and engineering facilities for gas well drilling have made it possible to increase the rate of well-drilling by two to three times at Uzbekistan and Turkmenia gas fields.

The broad introduction of the joint-separate operation of two and more gas levels in one well in multi-layered deposits of Uzbekistan and Turkmenia and the use of wells with larger diameters have made it possible to reduce sharply the number of wells in operation and the time required for the industrial development of gas fields.

To raise the operational reliability of wells and industrial engineering equipment when there is an increase of corrosively dangerous components, hydrogen sulphide and carbon dioxide, scientists and engineers of the institute have developed and broadly introduced a number of corrosion inhibitors without which the operation of such fields as those of Urtabulak and Shatlyk would be practically impossible.

The development and practical introduction of designing major gas pipeline systems and scientifically substantiated forecasting methods, and an analysis of the technological parameters of gas transport in terms of time-wise gas consumption, have become, with the aid of specialized analagous computer facilities, a precondition to the creation of a highly efficient automatic control system for trunkline natural gas transport.

The underground gas reservoirs built within the Tashkent industrial center in accordance with Sredazniigaz plans, have made it possible for both the republic's gas transport enterprises as well as the industrial consumers of natural gas to operate more smoothly.

Energy science in the republic expanded significantly in the war years in connection with active work undertaken by a large group of scientists evacuated from the Leningrad Polytechnic Institute (M. P. Kostenko, L. R. Neyman, V. V. Bolotov, N. N. Shchedrin, I. M. Postnikov, and others) headed by corresponding member of the USSR AN M. A. Shatelon. With the help of their participation the energy section of the USSR AN Uzbek Branch was reorganized in 1941 into the Power Institute (now the UzNIIeIA). A great deal of work was done at the Tashkent Polytechnic Institute and the Power Institute on raising the nominal capacity of hydropower stations on the basis of thermal tests made of their units. A wintertime regimen was studied, and ways were found to overcome slush ice difficulties of GES Cascade in the winter, and methods were worked

out to contro accidents at large mercury rectifier plants, and studies were made of the statistical and dynamic stability of the planned Farkhad-Tashkent Electric Power Line with consideration given to the regulatory effect of one of the system's biggest loads, and measures were developed to improve the operation of equipment and efficiency of electric power consumption by a number of the republic's industrial enterprises. A detailed theory was constructed for electromagnetic processes at mercury rectifier plants (academicians M. P. Kostenko, L. R. Neyman) which was widely acclaimed in the scientific world.

At the present time all inhabited regions of Uzbekistan, without exception, are supplied with electricity, powered by 220 and 500 kilowatt circuits from the consolidated power system of Central Asia and Southern Kazakstan which is controlled from a unified center where there are in operation such giant electrical energy sources as the Tashkent GRES, the Syrdar'in and Navoiysk GRES, the Nurek and Charvak GES, and others.

A great deal of work was carried out in the conduct of research and design projects for substantiating all installation projects of that association by the collectives of the Central Asian Divisions of the All-Union State Planning, Surveying and Scientific-Research Institute of Power Systems and Electric Power Networks, the All-Union Planning, Surveying and Scientific-Research Institute, and others.

In the area of general power engineering, G. A. Grinevich and his pupils (L. B. Gartsman, N. A. Petelina, Kh. R. Rakhimov) developed a fundamental work at the UzNIIIEiA on the cadaster and regimen of renewable energy sources--water, wind and solar radiation. By using the analytical theory of random functions, and particularly the composition of regular and stochastic processes method, data were produced for computing the maximal values of catastrophic floods, hurricane winds, etc., that are of practical significance in designing hydroengineering and other structures as well as electric power lines. G. A. Grinevich has worked out a method for a wind-power cadaster which is being used for the entire Union.

Work at the UzNIIIEiA is being carried out on the optimal development and structure of the republic's fuel management (Ye. D. Rodimkin). The manner and method by which energy can be developed in the lowland regions of the Amudar'ya have been substantiated (S. S. Shikin), and the prospects of developing an energy base of the Uzbek SSR in a unified power system of Central Asia have been analyzed and presented (academician of the Uzbek SSR AN Kh. F. Fazylov, Ye. D. Rodimkin, A. Kh. Khamidov, I. N. Oranskiy, and Yu. O. Alferov).

In the area of theoretical electrical engineering corresponding member of the Uzbek SSR AN G. R. Rakhimov has investigated the characteristics of fluctuating phenomena which emerge in chains with ferromagnetic elements and a physical explanation has been offered for the phenomena of ferro-resonance, lower harmonic and combination oscillations. The existence of an integral invariant of systems has been established in the case of autoparametric oscillation excitation, and a number of monographs has been published. He has also developed electrical engineering terminology in the Uzbek language as well as a first textbook for VUZ's in that language. The authority he enjoys in his elected field of specialization has made it possible to convene on a number of occasions at the Tashkent Polytechnic Institute All-Union inter-VUZ conferences on the theory and methods of computing nonlinear electrical circuits and systems. At the present time, his pupils are in charge of research in the following areas: parametric circuits and a system (Z. I. Ismailov), the theory of elements and technical control facilities (P. F. Khasanov), the transformation of phase numbers and alternating current frequency in circuits with autoparametric fluctuations (A. S. Karimov). Among the works completed by this same group are investigations of linear and nonlinear systems with distributed parameters for the purpose of creating information technology elements (M. F. Zarifov), as well as a profound analysis of subharmonic combinational oscillations in circuits with nonlinear elements (V. N. Ivashev).

Academician of the Uzbek SSR AN Kh. F. Fazylov has developed a scientific direction in the area of electric systems. On the basis of a rigid mathematical formulation he has constructed an orderly theory and methods for computing all the conditions of large electrical systems. Proposed for this purpose was a number of algorithms for solving large-dimensional nonlinear equations which describe a condition of electrical systems, and which consequently became classics in electrical engineering. Practical problems have dictated research on the existence, ambiguity, convergence as well as greater reliability in solutions to those equations (T. Kh. Nasyrov, I. L. Briskin, and V. B. Udovichenko). Created for an operative purpose was a viable algorithm of optimizing the daily performance of the consolidated Central Asian power system and overcoming the difficult problem of accounting for the frequency line factor and a number of limitations (Kh. Yu. Yuldashev).

Joint efforts are being made by the Tashkent Polytechnic Institute and the consolidated traffic control of the Central Asian power system to develop methods for controlling power system operations when available information is incomplete and questionable. Those efforts are of practical value in connection with the problem of building an automatic traffic control system. D. A. Abdullayev

at the UzNIIIEA has worked out the fundamental principles and algorithms for processing and transmitting information with minimal delay in complex hierarchic systems. That work is of broad significance, particularly for the practical realization of an automatic system and for power system traffic control. Research on the electric drive frequency control system has been headed by academician of the Uzbek SSR AN M. Z. Khamudkhanov. He and his pupils have completed a detailed research on one aspect of this problem and have proposed a number of new frequency transformer and conversion circuits. A theory and methods have been worked out on the basis of studies of the properties and characteristics of existing and newly suggested circuits for designing gear systems with asynchronous and asynchronous condenser and synchronous motors in stationary and dynamic operations, and in such systems with various load types on their axles. Studies have been made of electron-ionic devices and automatic control circuits as well as protection of electro-drive systems which perform on an optimal level with high precision. The results of those investigations have been awarded the Uzbek SSR State Prize imeni A. Beruni (M. Z. Khamudkhanov, S. Z. Usmanov, N. M. Usmankhodzhayev, M. A. Khusanov, K. Muminov, and A. A. Khashimov).

Scientific-research and experimental-applied works concerned with electric drive in industrial power have always been undertaken on a large scale at the Tashkent Polytechnic Institute (T. P. Gubenko, academician of the Uzbek SSR AN M. Z. Khamudkhanov, O. P. Il'yin, V. L. Ankhimiyuk, and others) and are continuing to be carried out at the UzNIIIEA (M. Khusanov, A. Ya. Dzeventskiy). The activity of the latter group of workers has been successfully conducted in very close contact with important power-consumer enterprises of the republic.

The development of natural gas production in the republic has made it possible to build powerful thermal plants and place the operations of all large industrial enterprises on that type of fuel. This has resulted in a broad base for thermal engineering research.

In recent years, R. B. Akhmedov has been supervising work on improving the effectiveness of combustible fuels. Significant research has been completed within a short period of time, and much of that research has led to new solutions of engineering problems. A method based on the interaction of cyclonic flames has been worked out for regulating heat exchange in a furnace. The change in the dynamics of furnace gases in relation to twist intensity and rotational direction have been found to have a significant influence on total heat exchange in furnace chambers. The resultant possibility of heat redistribution by means of uniquely designed direct-flow and rotating burners, is being put to use for the purpose of regulating the temperature of superheated steam in

steam boilers along the gas side. The new method of regulating steam boiler temperatures has been recognized as the world's most economical method for this operation. This has been confirmed by the fact that patents for that method have been obtained by all of the leading capitalist countries and by its successful introduction in dozens of the Union's boiler power plants. Studies of the effect that gas supplied by variously designed gas burner devices had on the aerodynamics of industrial furnaces and on fuel combustion in furnace apparatus led to the introduction of many Sredazniigaz proposals into various sectors of our country's national economy.

The group of workers who participated in the development and introduction of all those achievements was awarded the Uzbek SSR State Prize imeni A. Beruni (R. B. Akhmedov, K. Sh. Shakirov, D. A. Akhmedov, A. M. Panov, N. V. Uspenskiy, and I. Kh. Ziyayev).

A common phenomenon in Central Asia is the presence of regions with saline soil. Electric power line and substation insulators that are contaminated under those circumstances frequently lose their electrical strength. Breakdowns in power supply are the result. A large group of associates (S. S. Shikin, A. A. Inogamov, K. P. Morozov, Sh. D. Sakhibov, A. S. Kudratullayev, and B. M. Yuabov) has been successfully working on a systematic study of the nature and dynamics of insulator contamination and insulator electrical characteristics for the purpose of rationally selecting the level of insulation, prevention and control of contamination deposits.

The history of/cybernetics/development in Uzbekistan began in 1956 when the section of computer mathematics was organized at the Uzbek SSR AN Mathematics Institute imeni V. I. Romanovskiy.

In 1962 it was decided to consolidate the computer center with the Uzbek SSR AN Institute for Mechanics and Structural Earthquake-Proofing, and in 1966 the computer center was reorganized into the Uzbek SSR AN Institute of Cybernetics and Computer Center. In 1969 the institute was awarded the Order of Labor Red Banner for successes achieved in scientific research and for the training of highly skilled cadre.

At the present time the Uzbek SSR AN Institute of Cybernetics and Computer Center has a large computer pool and maintains broad business ties to enterprises, ministries, and departments of the Central Asian republics. Organized within that institute is a special design office for automated control systems (SPKB ASU).

From the very beginning the institute has been developing theoretical bases of cybernetics that are related to the algorithm methods for the study of large systems. Research is being conducted in four areas: economics, technical, theoretical cybernetics, and on

information theory and computer technology. The purpose of that research is to develop unified methodological bases for a republic-wide automated control system which would include problems in the planning and administration of the republic's national economy.

The use of economics-mathematical methods and computers in the planning and management of the republic's economy was begun in the 1960's. Those methods are being utilized at the Uzbek SSR Gosplan, the Central Statistical Administration, Gossnab as well as in industry, agriculture, construction, transportation, and other sectors of the national economy.

In 1969-1970 a plan was developed to create ASU [Automatic Control Systems] and industrial automatic control systems at a number of plants, enterprises, transportation and public health bodies, and a study was made of the existing system of production management at all levels, and technical ASU facilities were selected. Many proposals made by the Uzbek SSR AN Cybernetics Institute and Computer Center in this regard have found specific applications.

Methods have been developed for optimizing the industrial structure of kolkhozes and sovkhoses by utilizing economics-mathematical methods on a computer. Methods have also been developed for optimal crop rotation and for determining the optimal need of mineral fertilizers in cotton growing (A. Abdurazakov, S. Artykova, and others).

With the help of a computer, methods have been worked out for the optimal exploitation of water management systems which were used in the planning of the "Zarafshan" ASU. A technical target has been compiled for the ASU and Uzbek SSR Ministry of Reclamation and Water Management (M. Ziyakhodzhaev and others).

Economics-mathematical methods have been used for solving construction problems and a common methodology has been worked out for designing ASUS for ministries and departments, a method has been developed for the optimal planning of construction freight transport and for compiling bus schedules as well as traffic schedules, and a plan has been worked out for train formation. A developed subsystem has been introduced for the operative planning of the Fergana Railroad Automatic Control System. Automatic control system specifications have been compiled for the Uzbek SSR Ministry of Transportation and for railway automatic system management (academician of the Uzbek SSR AN V. K. Kabulov, I. Kh. Ubaydullayev, and M. I. Irmatov).

Together with the Uzbek SSR Information and Computer Center, work is being done on modeling national economic problems and the creation of an automated system of plan accounting in the Uzbek SSR Gosplan. A common methodology has been worked out for constructing

a republic-wide automated control system (RASU). The Uzbekistan Communist Party Central Committee and the Uzbek SSR Council of Ministers have approved a methodology developed by the Uzbek SSR AN Cybernetics Institute and Computer Center for Planning a RASU for the Uzbek SSR (academician of the Uzbek SSR AN V. K. Kabulov).

A complex automated control system has been developed at the Kal'makkyr quarry of the Almalyk Mining-Metallurgy Combine imeni V. I. Lenin (I. B. Tabakman, G. A. Abidov, and S. Rizayev). Research is being conducted on creating analog-digital (hybrid) computers and systems as well as developing methods and algorithms for digital analog modeling and control (T. F. Bekmuratov).

On directions issued by the Uzbek SSR AN presidium, work was begun on creating an automatic scientific research system (ASNI) and a computer system for collective use.

Research on information theory and computer technology has been developed. With the aid of measurement systems and processing and analysis programs, in 1968-1972 complex and experimental studies were made for the first time on data transmission along high frequency channels of electric power lines (T. A. Valiyev, Sh. A. Zargarov). This study was initiated at the All-Union State Planning, Surveying and Scientific-Research Institute of Power Systems and the Electric Power Networks "Energoset'proyekt."

The theoretical principles for the algorithmization of large systems are based on the ideas of academician of the Uzbek SSR AN V. K. Kabulov. They emanate from the fact that the formulation of an orderly systems theory requires a complex study of the extent to which objects and complex systems can be algorithmized, and further requires the creation of appropriate algorithmic systems with the necessary software. In this connection, all seven stages of large systems research have been automated on computers: experimentation, the construction of general functioning rules, problem classification, mathematical modeling of problem classes, selection of optimal algorithms, software, and computation.

The basic principles and methods of algorithmization have been concisely implemented in resolving non-linear problems in the theory of elasticity and plasticity in the mechanics of continuous media.

The Uzbek SSR State Prize imeni A. Beruni was awarded to academician of the Uzbek SSR AN V. K. Kabulov and institute associates K. Sh. Babamuradov, V. A. Tolok, T. Buriyev, and F. Badalov for a cycle of works on the algorithmization of solutions to problems in plasticity and elasticity theory.

A special class of formal-logical algorithms for computing values was developed (under the supervision of Yu. I. Zhuravlev) for solving classification problems and object identification at the Institute. The effective practical application of the developed algorithms and methods is assured with the aid of the program identifying complex PRASK-1 which represents the software for the class of value computation algorithms (M. M. Kamilov, Sh. Ye. Tulyaganov, E. M. Aliyev, V. Buzurkhanov, D. Kh. Gulyamov, and Z. T. Adylova).

Research is being conducted at the institute under the supervision of Academician S. L. Sobolev on the theory of volume formulas, and solutions are being worked out for problems related to approximate methods of computing short integrals of multi-variable functions (G. N. Salikhov, M. I. Israilov, S. Shushbayev, and T. Sharipov).

Research is being conducted under the supervision of corresponding member of the Uzbek SSR AN A. N. Filatov on the development of approximate methods for constructing solutions to differential and integral-differential equations which complement the classic works of the Krylov-Bogolyubov-Mitropol'skiy School, and constitute a further development of those works.

In 1960 Academician A. N. Tikhonov and corresponding member A. A. Samarskiy of the USSR Academy of Sciences formulated the problem of unstable gas and water filtration. In that connection economical differential circuits have been worked out for solving on the computer quasi-three dimensional non-linear parabolic type equations in multi-link arbitrary form areas, and a new method, called the approximate-analytical method, has been worked out for integrating multi-dimensional parabolic type equations. The machine realization of the proposed algorithms and programs has made it possible to predict the vibrational level of ground water in the course of surveying newly developed territories of Central Asia and Kazakhstan, and has made it possible to make hydrodynamic estimates of a number of gas fields, and to suggest numerical methods for solving a complete system of hydrodynamics equations for the purpose of short-term weather forecasting (F. B. Abutaliyev, I. I. Izmaylov, E. Mazhanov, and S. Karimberdiyeva).

Effective methods have been worked out for gas-dynamic computations (E. B. Abutaliyev, A. Sultanov, A. Arslanov). Proofs have been offered for theorems on the existence and uniqueness of solutions to filtration theory problems in mutually linked and non-mutually linked strata (N. M. Mukhiddimov, E. Mamazhanov).

The tasks of the republic's national economy have made it necessary for Uzbek scientists in the technical sciences to formulate and solve a large number of both fundamental and applied problems. Uzbek

technical science today can be proud of the fact that it has made a worthy contribution to the general development of the republic's productive forces and has facilitated the solution of many All-Union problems. An entire plethora of brilliant scientists and collectives have matured in the course of this creative process in Uzbekistan and they are now capable of solving major national economy problems. Scientific schools have been created which are fruitfully operating in various branches of the technical sciences. Accorded recognition as the leaders of those schools are academicians of the Uzbek SSR AN Kh. A. Rakhmatulin, M. T. Urazayev, Kh. F. Fazylov, V. K. Kabulov, M. Z. Khamudkhanov, corresponding members of the Uzbek SSR AN G. R. Rakhinov, D. F. Fayzullayev and Kh. Kh. Usmankhodzhayev.

On the eve of the 60th anniversary of the Great October Socialist Revolution, the scientists of Uzbekistan are applying all their efforts towards the realization of the goals emanating from the historic decisions of the 25th CPSU Congress. This is being facilitated by the powerful industry and scientific base which were created in the republic after the Great October as well as by the constant attention given by the party and government to the development of science in our country.

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

COMMENTARY ON STATE PRIZES FOR SCIENCE AND TECHNOLOGY

Moscow PRAVDA in Russian 7 Nov 77 p 3

[Article by M. Keldysh: "On the Path of Progress"]

[Text.] In the course of the last 60 years our Homeland has been transformed into a country of advanced socialism, and this has been reflected in the new USSR Constitution. The Soviet Union possesses a mighty scientific-technological potential that is essential to succeeding in the task of building communism. The awarding of the USSR State Prizes for 1977 is one more indication of the high level of science and technology and their stronger ties to practical operations.

Of great significance for such areas of theoretical mathematics as the theory of functions and functional analysis is the research of O. V. Besov, V. P. Il'in and S. M. Nikol'skiy on the theory of differentiable functions of many real variables. The methods they have formulated have particularly found applications in mathematical physics.

The work of the collective headed by V. M. Glushkov is concerned with automated designing of computer technology. Currently operating complexes of automated computer design, based on that work, are making it possible to accelerate it and improve the quality of computer technology design.

The cycle of investigations completed by P. A. Cherenkov, A. N. Gorbunov and others on high energy gamma-ray splitting of light nuclei, has made an important contribution to nuclear physics. They have proposed and tested in a physics experiment a method for studying nuclear transformations with the aid of Wilson chambers directly functioning in gamma-ray beams from electron accelerators. The processes studied are playing an important role in understanding thermonuclear synthesis reactions.

Solar x-ray astronomy owes its birth to the development of space technology that has made it possible to place scientific instruments beyond the atmosphere. That research has been conducted in our country on 20 spacecraft by the collective headed by S. L. Mandel'shtam. The investigators studied in detail the basic characteristics of "quiet" sun irradiation. Valuable information was obtained about x-ray irradiation of solar flares.

Prizes were awarded for two works in chemistry. Kh. M. Minachev V. I. Garanin and Ya. I. Isakov laid down the scientific bases for making new zeolite catalysts. They have established very important characteristics of synthetic zeolite catalytic activity as well as the factors which determine their selectivity and stability. The new zeolite catalysts developed by those investigators are helping the productivity of many petro-chemical processes, and in a number of cases, they are helping to avoid environmental pollution.

A major contribution to the study of organic radicals--the active intermediate particles which control the rate and direction of chemical reactions, has been made by A. L. Buchachenko and others, who have for the first time synthesized a new class of organic paramagnetic substances--stable nitroxyle radicals. They have found broad application. They have been instrumental in establishing the mechanisms in a number of complex chemical reactions, characteristics of biochemical processes, the structure of enzyme systems as well as in making new effective stabilizers of polymer materials.

In the area of terrestrial science, the collective directed by Ye. M. Sergeyev, developed a theory and method for the regional geological-engineering study of inaccessible territories. That theory and method are based on the combined use of aerial photo materials, geological and geophysical data. This has facilitated an accelerated development of territories containing large oil and gas deposits.

The fundamental ten-volume work by the oceanologists V. G. Kort, P. L. Bezrukov, and others constitutes a unique summarization of both native and foreign research on the Pacific Ocean from the beginning of the present century.

A number of works which were awarded prizes were concerned with resolving vital tasks in technological progress.

The complex of analogue signaling devices built by the collective headed by G. G. Stepanenkov, as utilized in nuclear and thermoelectric power station control rooms as well as in the metallurgical and chemical industry, has significantly improved the quality of installation control and management, and has markedly facilitated the work of operators, dispatchers and machine operators.

The introduction of an automatic precision optical-mechanical instrument complex for microelectronics (researchers V. I. Mal'to, Ya. A. Raykhman, and others), has facilitated the building of new types of integrated circuits.

The appearance of new instruments which are being successfully utilized in various sectors is based on the high-frequency radio wave method of measuring technological parameters as proposed by V. A. Viktorov, Ye. N. Zakharkin and others.

On the basis of new scientific-technological findings, a collective of specialists (V. F. Romanov, G. A. Storchak and others) has organized the mass production of diamond instruments which are satisfying the needs of our national economy and which is making it possible to export diamonds on the world market.

A group of specialists (A. V. Vysotskiy, A. P. Kurochkin and others) has built an original instrument for automatically controlling the measurement of parts during the process of finishing and sorting. This equipment has made it possible to release hundreds of thousands of persons from auxiliary operations in the vehicle, ball bearing and other sectors.

V. I. Boltunov, G. P. Voytetskiy and others have built a number of all-purpose air-cooled diesel engines. They have organized the flow line-mass production of those engines at the Vladimirskiy Tractor Plant imeni A. A. Zhdanov. Every fourth domestically manufactured tractor has the new diesel engines whose technical and economic characteristics correspond to the world's best models.

An all-purpose complex of machines for the fish canning industry (authors A. T. Zatsepilin, L. P. Koval' and others) has made it possible to mechanize the sorting of fish regardless of their size, and has increased by four to six times productivity, and has made it possible to decrease the loss of raw materials.

A group of scientists and engineers (A. P. Bogdanov and others) has worked out a new highly effective apparatus and technology for the flow line production of magnesium. At the present time a yield of almost 75 percent magnesium is being produced with the aid of that apparatus.

A prize has been awarded to the collective of specialists (M. S. Voronenko, A. F. Zakharova and others) for their construction of a complex system for quality product control by improving technology and the scientific organization of labor as well as by the mechanization and automation of production processes. The award was also made for the introduction of that system at enterprises of the L'vovskaya Oblast and at the Tiraspol'skaya Sewing Factory.

The successful development of atomic energy in our country has opened the way for the construction of a nuclear ice breaker fleet. Indicative of those possibilities is the outstanding scientific-technological achievement represented by the sailing of the world's most powerful ice breaker "Arktika" to the North Pole. Its builders (V. N. Shershnev, O. P. Demchenko and others) have now been awarded prizes.

The research collective (B. R. Bondarenko, V. A. Bratash and others) has designed highly efficient traction machines and introduced them at open coal and mine pits. Their utilization has essentially signified the technical retooling of quarry transportation and has yielded a significant economic effect.

Scientists, designers, petroleum workers and workers (Ya. M. Kagan, I. Sh. Aleyev and others) have proposed and introduced newly highly efficient scientific-technological and engineering methods which have made it possible to shorten significantly the time required for developing the Samotlor Oil Fields under the complex natural conditions of Western Siberia. Applied for the first time in the world was the principle of planned arrangement of oil fields which has made it possible to reduce the number of pumping stations and reduce the length of vehicular roads by one and one half times.

The mine-cutting complex "Kuzbass" has sharply increased the rate of conducting preparatory mining operations at coal mining enterprises (researchers V. S. Gayday, A. I. Goncharov and others). This has assured comfortable working conditions for the drift miners.

An important direction in the progress of industrial construction is the standardization of large-scale planning and design decisions, and the standardization which establishes technically and economically substantiated parameters for industrial buildings, installations and their elements. The standardization system which was developed and introduced by the collective comprised of N. P. Baguzov, B. F. Vasil'yev and others includes a standardized products list and catalogs of designs and parts based on that list. It is now being applied in the construction of over 90 percent of buildings intended for production purposes.

Constituting a major achievement by the research collective (V. D. Gotsiridze, V. S. Vouba and others) is the resolution of complex engineering-geological and scientific-technological tasks connected with the adaptation of the unique Novoafonskaya Cave for wide-scale demonstration and preserving the primordial appearance of this grandiose cavern.

Of great significance for an increase in the harvest of agricultural crops are the works of T. Ye. Tarasenko and other authors on the development and introduction of spring barley types in "Donets-4," "Donets-6," "Nutans-244," "Odessa-36,"

"Moscow-121." Those types of barley are distinguished by high-level nutrient qualities and drought resistance.

The cycle of investigations by V. S. Yershov, A. S. Bessonov and others has laid down the biological foundations for the prevention of farm animal helminthosis. The authors have found rational methods for maintaining the animals and changing their places of habitation for the purpose of breaking the biological cycle in the development of helminths. The use of the recommended measures will prevent significant losses.

The building of a major water management complex in the Kuban', including the Krasnodar Reservoir, has made it possible to irrigate 215,000 hectares of previously unutilized lands, and it is here that the country's largest rice cultivation has emerged. The work of N. A. Ogurtsov, I. P. Mysin and other investigators has facilitated a rapid growth in rice production in the Krasnodarskiy Kray.

The development of the series production of excavator-drainage rigs and their broad introduction into land reclamation construction in drained lands (E. A. Innos, E. N. Shknevskiy and others) are important for agriculture in the super humidified zone. At the present time, more than 90 percent of closed drainage in the USSR is being built by these drainage rigs.

A number of works in physiology and medicine has been awarded state prizes.

Of great scientific and practical value are the results presented in the monograph by B. A. Kudryashov "Biological Problems in the Regulation of the Fluid State of Blood and Its Coagulation." The author advanced fundamentally new concepts about the nature of the coagulating and anti-coagulating system of the blood and their regulation both under normal conditions and in a number of diseased conditions (thrombosis, myocardial infarct, etc.).

A major contribution to the theoretical and experimental study of the principles of blood microcirculation and vascular permeability was made by A. M. Chernukh and V. V. Kupriyanov who proposed original methods of research and appropriate apparatus. This is of great significance for treating diseases of the blood circulatory system.

In the area of bone-plastic surgery, S. T. Zatsepin, A. S. Imamaliyev and others have worked out a highly efficient method for transplanting tubular bones to patients. That method is successfully being used clinically.

In recent years the method of hyperbaric oxygenization has been successfully used for the treatment of many illnesses caused by

oxygen insufficiency. This method calls for an increase in the amount of oxygen in the blood plasma by means of raising the atmospheric pressure in a barochamber. The complex of medical barochambers created by the collective of authors (P. K. Georgiyevskiy, S. N. Yefuni and others) has no equal in world practice with respect to the extent of their use and with respect to the medical-technical possibilities.

High awards have been made in the area of the social sciences.

Yu. V. Knorozov has made a major discovery--decoding written sources of the Mayan people which have not been read earlier. This achievement has been recognized in all the world and has become an important contribution to historical and philological science as well as to the theory and practice of decoding hieroglyphics.

Of important scientific and practical significance, particularly in the preparation of legal documents and the systematization of legislation are the works by S. S. Alekseyev with respect to problems of Marxist-Leninist legal theory.

Undertaken for the first time in a two-volume monograph, prepared by the collective of authors under the supervision of N. N. Inozemtsev, A. G. Mileykovskiy and V. A. Martynov is a complex investigation of vital socioeconomic and political problems of contemporary capitalism under conditions of the general crisis of capitalism, the struggle between the two world social systems and the evolved scientific-technological revolution. The high level of theoretical generalizations is combined here with a practical importance of the conclusions made.

Also receiving state prizes were the textbooks: "Experimental Nuclear Physics," by K. N. Mukhin, "Paleontology of Invertebrates," by V. V. Drushchitsa, "Soil Science," by I. S. Kaurichev and others, and "Economic Geography of Foreign Countries," by V. P. Maksakovskiy and others.

Academician M. Keldysh
Chairman of the USSR Council of
Ministers Committee on Lenin and
State USSR Prizes in Science and
Technology.

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END