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PHYSICAL SCIENCES AND TECHNOLOGY
No. 18

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No. 18

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EFFECTIVENESS OF AUTOMATIC CONTROL SYSTEMS IN A MANPOWER SHORTAGE

Kiev MEKHANIZATSIYA I AVTOMATIZATSIYA UPRAVLENIYA in Russian No 2, Apr/ May/ Jun 77 pp 47-48

[Article by Candidate of Economic Sciences N.I. Tsybakin: "Manpower Shortage and the Effectiveness of ASUP's"]

[Text] According to the usual method for determining the economic effectiveness of ASUP's [automatic control systems], the effect of releasing workers is computed by the savings in wages. *

Formerly, this approach was in complete accord with actual socioeconomic development conditions in the country's national economy. At the present time, these conditions have been changed substantially, which should be reflected in the evaluation of the economic effect of introducing ASUP's and other equipment associated with the release of manpower.

At this point, one of the most crucial features in the economic development of the country is the shortage of labor resources. For this reason, along with the savings in wages, the factor of reducing the manpower requirements of a given industry alone has a decisive importance since manpower is vitally necessary in other areas of the national economy.

An objective demand of economics during rapid increase in the technical machine-worker ratio is that at the base of the process of replacing manual labor with equipment must lie a more important and significant effect on the national economy than saving on wages. This effect must be examined by its elements in two areas: first--it is brought about by the release of men from a particular industry: second--as its result, it is of further use for expanding production.

*"A Tentative Method for Determining the Economic Efficiency of Automatic Control Systems in Industry", M., "Ekonomika", 1973.

A more basic analysis of the given problem shows that savings in wages does not even encompass the first part of the economic effect obtained through the replacement of manual labor with equipment. For the manufacture of a product, (in its assigned volume), releasing one man makes it possible to reduce the outlay of capital funds on all of its parts, i.e. by savings in funds for wages, in funds for material incentives and in general funds. The total at the present time consists of approximately 2500 rubles per year on the average for one worker, which is almost 40% greater than the amount of his wages.

Further development of the economic effect takes place as follows. A man detached from a given industry is used in that particular plant or in another for increasing the production rates. Provided that his further participation in material production is carried out on the average technical level, it is possible to produce a national income totaling about 5,000 rubles, of which the net product for the company will amount to approximately 2,500 rubles.

Thus, the full economic effect connected with the release of workers as a result of installing ASU's will amount to about 5,000 rubles per year computed for one man, which is 2.8 times greater than the amount of his wages.

From 1971 to 1974, work at the polytechnical institute in Chelyabinsk was aimed at developing automated computations of the basic factors of the entire Five-Year Plan for the development of the national economy in the Chelyabinskaya Oblast'. The annual economic effect caused by introduction of this equipment, when computed by the method proposed, turned out to be approximately 20% higher than the effect as computed by the ordinary method.

8945
CSO: 1870

COUNTING DEVICE WITH A PROGRAM CONTROLLER

Yerevan PROMYSHLENNOST' ARMENII in Russian No 5, 1977 p 45

[Text] Many sectors of the national economy use automatic packing and wrapping control machines which require special devices for counting and issuing of a command after reading a pre-set number.

These operations are usually performed by a photoelectric device, and the indication--by an electromechanical counter. However, practice has shown that existing devices are unreliable and their counting rate is not high. In addition, they are quite cumbersome. Modern production requires reliable and high-speed counting devices--this raises the effectiveness not only of individual types of equipment and production sections, but also of the entire enterprise as a whole.

In the local control systems laboratory of the Yerevan division of the VNIILTEKMASH [All-Union Scientific Research Institute of Textile and Light Machinery], at the order of the SKB [Special Design Office] of automatic packing and wrapping control machines, a device has been developed which is unique to this country.

Researchers worked at the state of the art taking users' requirements into account. The electronic counting device with a program controller is compact, reliable, has high-speed and is feasible to manufacture. The counting rate is high--20 million pulses per second, and power input is 10 volt amperes. The principle of operation is based on conversion of luminous flux into decimal code.

The range of application of the new device is quite broad. It can be used in instrument building (pulse engineering), and in various sectors of light, food and cable industries where counting of piece goods, metric lengths and others is required. Besides performing counting operations, a signal is also put out after program realization.

Preliminary estimates show the economic impact from use of 500 devices amounts to more than 90,000 rubles. Production tests of a prototype, made in various enterprises in the country, confirmed the high quality of the new counting device.

In the laboratory, modernization is underway on the counting-program devices at the same time as their manufacture. Garri Mirzoyan (at right) and Avetik Gukasyan discuss component arrangement alternatives.

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MULTICHANNEL ANALOG MEMORY

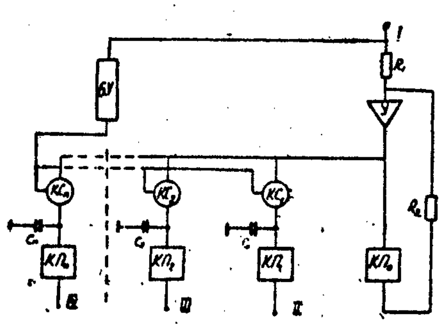
Yerevan PROMYSHLENNOST' ARMENII in Russian No 5, 1977 pp 62-63

[Article by I. G. Sarkidzhan, candidate of engineering science]

[Text] In developing specialized analog computers with frequent use of decision units, and in coupling general-purpose analog and digital computers, analog memory (AZU) is needed.

A great number of AZU's (1,2) are well known. The simplest of them are those using a capacitor as the memory element. Since it should usually store up to several dozens of values, the AZU, to decrease cost and size, is made multichannel (3).

However, existing multichannel AZU's make significant errors in recording data (3,4), since in channel switching, the DC amplifier (UPT) feedback line is broken, and it becomes saturated. The transfer process time also increases which leads to a limitation in the recording rate.



The figure shows a circuit diagram of a multichannel AZU for storing voltages in the $\pm$ 100 V range in which these deficiencies have been eliminated (5).

The input signal in the form of a sequence of pulses through R_1 enters amplifier У, the output of which is connected to the input to cathode repeater $K\Pi_0$, and they both are enveloped by a common feedback.

Memory cells, consisting of capacitors C_1 - C_n and cathode repeaters $K\Pi_1$- $K\Pi_n$, through keys KC_1 - KC_n are connected to the amplifier output. Control unit БУ is used to sequentially key KC_1, KC_2 ... KC_n , and data is stored in the corresponding channel.

Synchronization between input pulse entry and switching-on of the key circuits is necessary for proper circuit operation. To decrease transfer process time, the key circuits are switched on somewhat later than the entry of the incoming pulses. To prevent possible distortion of the data being recorded (due to capacitance discharge), they are switched on earlier than the end of the input pulses.

Data recording rate and accuracy depend on the amplifier transmission band and the fixed interval of capacitance charge. Therefore, wideband UPT's are used in a multichannel AZU.

The fixed interval of charge is

$$\tau_3 = C\frac{R_3 \cdot R_{BX}}{R_3 + R_{BX}},$$

where C is the capacitance. R_{BX} is the input resistance of the cathode repeater; $R_3 = R_{BblX} + R_{KC}$ is the resistance of the charge circuit, where R_{BblX} is the amplifier output resistance, and R_{KC} is the resistance of the key circuit in a closed state.

Since $R_{BX} \gg R_3$, $\tau_3 = R_3 \cdot C$.

Consequently, to increase the data recording rate, capacitance and resistance of the charge line must be reduced.

After data recording comes the period of storing it in a memory cell. It is characterized by a slow change in data recorded from the fixed interval of capacitance discharge τ_p.

Data storage time can be extended by increasing the storing capacity and resistance of the key circuit in the open state, and by using waterfilm condensors and tubes with small grid current. In the process, it must be kept in mind that the maximum value of the size of the capacity is limited by the data recording rate.

In using a UPT with a 100 khz transmission band, the data recording error does not exceed 0.1%. A memory cell of a 6N1P-Ye tube with a 0.5 mf capacitor and bipolar key circuit, assembled on P309 inversely switched-on transistors provides data storage with a 0.2% error over 220 seconds.

When it is necessary to store voltage within the limits of $\pm$ 10 V, a multichannel AZU can be made by using an integrated amplifier and memory cells of field transistors.

A 20-channel AZU, which has been developed, is used in a specialized analog-digital computer to optimize the system at the Ural United Power System.

Literature

1. Zhovinskiy, V. N., "Skhemy zapominaniya i bloki zapazdyvaniya" [Storage Circuits and Retarding Units], Gostekhizdat, M.-L., 1963.

2. Netrebenko, K. A. "Kompensatsionnyye skhemy amplitudnykh vol'tmetrov i ukazateley ekstremuma" [Compensation Circuits of Peak Voltmeters and Indicators of Extrema], Izadatel'stvo "Energiya," Moscow, 1967.

3. Borozinets, B. V., and Yakovleva, T. S. "Mnogokanal'noye zapominayushcheye ustroystvo" [Multichannel Memory], Works of the VNIIE [All-Union Scientific Research Institute of Electric Power Engineering], issue 27, Izdatel'stvo "Energiya," 1967.

4. Arkhovskiy, V. F. "Analiz skhemy dinamicheskogo zapominayushchego ustroystva" [Analysis of a Dynamic Storage Circuit], VOPROSY RADIOELEKTRONIKI, series 7, 1964.

5. Vanin, V. K., and Sarkidzhan, I. G. "Mnogokanal'noye analogovoye zapominayushcheye ustrostvo" [Multichannel Analog Memory], Patent No 434483, Bulletin of Inventions, No 24, 1974.

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CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

'PROYEKT' COMPUTER-ASSISTED DESIGN SYSTEM

Moscow PRAVDA in Russian 26 May 77 p 6

[Article by O. Gusev, Pravda correspondent: "Thirty Volumes in a Match Box"]

[Text] A remarkable book, of which only a few copies were printed, has been published by the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences. It not only discusses the development of cybernetic systems in our country, but also graphically demonstrates their tremendous potentialities. Nonetheless, the book consists of only two pages.

On one of them is the compactly printed text of the chapter, "The Development of Science", from "The Basic Guidelines for the Development of the National Economy of the USSR for the Years 1976-1980." And in the center of the other is noted only a minute metallic circle of about a square millimeter.

"What else can be seen here?" I ask Doctor of Technical Sciences V. Derkach.

"Almost nothing without the use of optics."

We go over to the next laboratory and put the millimeter-sized circle on the stage of a microscope.

"We'll set the magnification so that the stage is raised to four hundred thousand times," says Candidate for Physiocomathematical Sciences Yu. Kapitonova, and she invites me to look into the eyepiece.

The inscription is clearly visible: "To make provision for the further expansion of research which opens principally new paths and capabilities for altering the productive forces of the country, and creates the technology and manufacturing processes of the future."

These lines, reduced hundreds of thousands of times, were successfully embodied into the metal on the miniature stage primarily thanks to new automated technology.

But not only is this novelty profitably distinguished by its smallness. The fact is that the electrical diagrams of the logic units of electronic computers (EVM) are produced with the aid of a computer. Thus an individual puts his own ideas to paper with a pen. But if the researcher is free to dictate to himself, then the machine as the "leader" requires an accurately assigned sequence of operations. Specifying this turned out not to be easy. First of all it was necessary to devise a new division of applied mathematics--the so called theory of discrete converters--to enrich computer system design methods.

What is the essence of the innovations proposed by Academician V. Glushkov, Doctor of Technical Sciences V. Derkach and Candidate for Physicomathematical Sciences Yu. Kapitonova?

Considerable experience in the designing of various systems with the aid of electronic computer technology has been accumulated in the Soviet Union. However, life demands even more effective communications in the "man-machine" link, especially when the discourse concerns developing and designing of computers of the future which demand the application of the most progressive devices, processes and materials. In order to achieve the maximum effect in the man and machine interfaces, a language understood by "both sides"--the engineer and the EVM--is needed. Scientists persistently search for their dialogue the devices for contact and effective methods for direct EVM and man interface.

As a result of the cycle of research, a mathematical apparatus, built on the technology of expression transformation into so called polybasic algebras and permitting the solution of heterogeneous design problems with regard to diverse communications between them, was proposed and developed. To get answers to such problems is becoming ever more complex.

A present-day computer, as an example, contains hundreds of thousands of logic elements connected electrically with one another: analogs of customary transistors, diodes, resistors, condensers, and conductors of micron sizes. The composition of the diagrams of so many complex devices, the arrangement of the elements, and the tracing of the connections between them without the aid of EVM became too difficult for man. A series of new tasks of this type are posing difficult problems with which numerous institutes throughout the world are struggling.

The "Proyekt" system, produced in the Institute of Cybernetics, assists in automating the design and manufacture of electronic calculator equipment. How does it look in practice? It's an entire cybernetic complex--the BESM, M-222, and the miniature "Kiev-70" electronic machines, and peripheral apparatus (teletype, displays and others). The first of these is located a few kilometers from its smaller colleague, and it produces a program and sends the assignment to it. The "Kiev-70", having received it, flawlessly implements each element of the program.

The operator, with the aid of a luminescent screen, monitors what it is producing and can quickly make corrections. Indisputably, this significantly raises the efficiency of its work and the quality of the product. Under traditional conditions, for example, the preparation of computer programs, which implement the design of complex electronic systems, required on average a year's work for two researchers. The "Proyekt" system contains a complex of programs (more than two million commands) for mechanical and technical devices. During the realization of a new technology, the design and calculation, for example, of a processor, the heart of a computer, the system permits the accomplishment of the very same task which would require tens of man-days for a specialist.

"The advantage here is twofold," says corresponding member of the USSR Academy of Sciences V. Skurikhin. Directly for the enterprise--the manufacturer of EVM assemblies, and for the theorists who receive the real opportunity to verify empirically their own scientific propositions. If, for example, not so long ago it required 20 man-months to create programs for the "Kiev-70" machine to control the manufacturing process of a product, then for "Proyekt" only 4 hours are sufficient.

At the same time, the system is characterized by remarkably "keen vision": aiding, let us say, the manufacture of ultraminiature text, each line of which has a width of only a half micron and is capable of placing 70 thousand letters within one square millimeter. With such a density, the textual material of the thirty-volume edition of the "Bol'shoy Soviet Encyclopedia" could fit in only 22 square centimeters--approximately equal to the area of one side of a match box. The system increases the labor productivity tenfold, providing a significant improvement in the quality of output which is guaranteed automatically.

Thus, exciting prospects for building ultraminiature transceiving and memory instruments and devices are opening up for the developers of various electronic systems--from home radio and television sets to complex electronic computers. it is possible to create reliable electronic diagrams of very small size.

Aside from the benefits, which provide the electronically produced diagrams, with the assistance of the "Proyekt" system, the specialists, busy in the production of mathematical computer support, also gain a significant economy in time. Thus the labor productivity of the programmer grows by approximately thirty times, and that of the designer of the schematic layout--tenfold. Naturally, the quality of the planning decisions is significantly improving.

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SOCIALIST COMPETITION IN THE INSTITUTE OF CYBERNETICS

Kiev VISNYK AKADEMIYI NAUK UKRAYINS'KOYI RSR in Ukrainian No 7, 1977 pp 3-5

[Article by T. P. Mar'yanovich, candidate of physical and mathematical sciences, party committee secretary, Institute of Cybernetics, Academy of Sciences Ukrainian SSR, and V. I. Vasyl'yev, doctor of technical sciences, head of the trade union gorkom]

[Text] Co-workers of the Institute of Cybernetics and the Special Design Office of Mathematical Machines and Systems (SDO MMS) are preparing to worthily greet the 60th anniversary of the Great October. The collective assumed increased socialist obligations in honor of the noteworthy date and is successfully fulfilling them.

The competition between sections, divisions and individual workers has been expanded. Twelve hundred workers have been granted the title of shock-worker of communist labor, and three subdivisions and the special design office itself are collectives of communist labor. Five more subsections of the institute and two special design offices are winning honorary titles. The results are being summed up for the shock quarter. Competitions are being conducted for the best scientific work and technical developments of the year. The competition staff is the coordinating agency.

A number of subdivisions have assumed joint obligations with enterprises, scientific research institutions, VUZ's and design offices of the country.

The collectives of all sectors and sections and each co-worker of the institute and the SDO MMS understand their responsibility for fulfilment of their pledges. The communists are proceeding in the vanguard of the competition.

This year new principles have been developed and are in effect regarding the socialist competition, in which the great help of the CC CPSU, the Council of Ministers USSR, the All-Union Central Trade Union Council and the CC Komsomol to its organization is taken into account. The main things in this matter are clarity, publicity, study according to plan and active encouragement of advanced experience. Deserving of further development is the movement for the preparation and execution of individual and collective complex plans, in which workers, engineering and technical personnel and scientific associates are participating.

We are introducing the experience of our academy in contractual joint collaboration with the collectives of VUZ's and productive enterprises. Matters are proceeding regarding agreement on the creation of educational-scientific-production associations. Two such agreements have been drawn up: "Cybernetics and Metrology" (corresponding member of the AS Ukrainian SSR B. M. Malinovskiy, director) and "Development and Introduction of a Standard ACS of Quality of Production" (corresponding member of the AS Ukrainian SSR A. A. Stogniy, director). Whereas the latter agreement is still in the stage of seeking optimal alternatives of its implementation, the former has already been created and sections are working in six directions: creativity of youth, economics, the training of personnel, scientific research, planning and design work and technology.

It is worth while dwelling on one form of socialist competition which has received the praise of the CC CP Ukraine and has recently been expanded in the AS Ukrainian SSR. One has in mind joint socialist obligations of scientific collectives and collectives of enterprises and organizations. Such a form strengthens the ties of science and production, accelerates the introduction of the results of research and contributes to the implementation of agreements on collaboration. In January joint obligations were agreed upon between the Institute of Cybernetics and the Zhdanovskiy Metallurgical Plant. In all, the collective is fulfilling more than 50 pledges, as a result of which much research work is being done ahead of schedule and a number of above-plan developments have been completed. This is of great national economic importance. We hope to obtain a saving from the introduction of the work amounting to 27.4 million rubles. Of the nine themes which will be accomplished in the jubilee year, a large portion is being done in accordance with the coordination plan of the State Committee for Science and Technology under the Council of Ministers USSR.

The basis of execution of the themes on the development of an information system and a complex of means of special methodological and informational servicing of the collection, processing and analysis of proposals to improve the management of the national economy was the idea of academician V. M. Glushkov on the conversion of automated reporting and information systems (ARIS) from an auxiliary tool into a very effective tool of control. This involves the combination of ARIS with generalized dynamic models which are investigated in systems analysis. Proposed is systems analysis of the calculations for reconciliation in control tasks of precise mathematical-economic and qualitative methods in which expert estimates and dialog working conditions of computers are used.

The language of logical categories and its dictionaries make it possible to describe a complex multi-level system and to change in its analysis to any generalization level -- from the model of a "photograph" containing qualitative and quantitative information to an abstract mathematical model.

Informational and mathematical software have been developed for the construction and analysis of an effective model of a graph of the tree type with a volume of up to 10,000 sources, including determination of the semantic resemblance between the sources of the systems diagram constructed by means of expert estimates.

A special package of practical programs has been created, one intended for processing data of a different nature by the methods of mathematical statistics and realized for machines of a single series (ES computers).

As a result of use of the package a high economic effectiveness is achieved, for users are given the possibility of solving, not individual problems, but an entire complex, including special programs for processing expert estimates.

The obtained results were made the basis for a standard automatic subsystem of quality control of light industry production worked out here in the institute especially for the "Kyyanka" factory. Such a systems approach gives a saving of 200,000 rubles per year, even for a small enterprise of light industry such as the "Kyyanka" factory.

Much effort is required to implement such a theme as the development of methodical materials for the mathematical servicing of subsystems of organizations to perfect control in the branch and departmental ACS. The concluding stage has already been completed ahead of schedule: a program has been created to assure effective analysis of proposals to improve control through use of a control system for a base by means of relations. On the level of the technical task the principle of construction of software of a system of processional analysis of proposals has also been worked out ahead of schedule.

In addition, the mathematical servicing of the system for effective analysis of proposals, including the creation of a data processing system, packages of practical problems and software for the processional analysis of proposals, will be completed ahead of schedule, before the 60th anniversary of the Great October.

The collective has pledged to create and introduce into operation program servicing for the operation of universal data banks with a complex structure, which envisages the development of a complex of universal program devices assuring functioning of ACS of an organizational type of different levels and purposes on the basis of ES computers.

The OKA and KAMA systems approved by an interdepartmental commission, which are becoming the basis of developed equipment, are being successfully introduced into practice. The OKA system of data base control is widely used in the creation of large data banks and is intended for the centralized informational servicing of practical programs. The KAMA system is effectively used to assure the interaction of users with computers through the terminal equipment of ES computers under conditions of multiple access.

The implementation and introduction of proposals of the institute ahead of schedule in the first half of the year has already saved over 10 million rubles, and that in turn has made it possible for developers not only to fulfil but even to overfulfil socialist pledges regarding savings.

The party, trade union and Komsomol organizations of the institute and the SDO MMS are contributing to the course of the socialist competition, maintaining the initiative and research activity of the co-workers, spreading knowledge of the achievements of the best and forming in each participant in the competition high ideological and political qualities, and mobilizing the collectives for the successful fulfilment and overfulfilment of the plan tasks and socialist pledges.

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CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

CONFERENCE ON INSTRUMENTATION FOR THE PRODUCTION OF MICROELECTRONIC DEVICES

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 6, 1977 p 64

[Article by Engineer V. S. Yekaterinin]

[Text] In December 1976, a conference was held in Penza on providing non-standard testing equipment for instrument-manufacturing enterprises for the production of microcircuits and microassemblies.

In his opening address, Candidate of Engineering Sciences I. D. Goloto (Moscow) noted that the accelerated development of the instrument-making industry envisaged by the resolution of the 25th CPSU Congress is one of the main factors of steady and rapid development of other sectors of industry. Extensive introduction of electronic equipment and methods for its design on the microelectronic basis will open up fundamentally new possibilities in the acceleration of the development of instrument making both with respect to the technical level of the instruments, and the effectiveness of their manufacturing.

Overall microminiaturization makes it possible to expand the functional potentialities of the equipment, introduce widely analog-digital methods of processing measuring information, reduce the labor-intensiveness of assembly and installation operations, accelerate the development of new products, and shorten their production cycle. The changeover of this branch of industry to microelectronic technology must yield more effective and qualitatively better results than the changeover from point-to-point wiring to printed-circuit wires.

During the years of the Tenth Five-Year Plan, on the basis of special-purpose integrated circuits, microassemblies, functional blocks and units based on microelectronic technology, it is planned to build a number of "Iskra"-type electronic computers, a series of digital electric measuring instruments, recording measuring instruments, oscillographs and magnetographs, measuring amplifiers, transformers and stabilizers, multipurpose measuring instruments, etc.

The creation of shops and plants for series production of microelectronic elements during the Tenth Five-Year Plan is the determining factor in the introduction of microelectronic devices and microelectronic technology in the instrument-manufacturing industry. It is planned to develop a number of scientific research, design, and technological organizations with experimental production facilities, and to create enterprises producing special technological and testing equipment.

The condition for the most complete solution of the problem of providing series production enterprises with testing equipment is the complex approach to the problem of technological monitoring which consists in providing monitoring equipment for the entire technological cycle of production. Doctor of Engineering Sciences A. G. Ryzhevskiy (Penza) reported on the development and introduction of a complex of such facilities.

In order to reduce the cost of the monitoring-measuring equipment, shorten the development time, and solve the maximum number of problems, it was expedient to develop an aggregate complex of technological monitoring facilities (ASTK [automatic system of technological control]) which would be compatible from the informational, design, and metrological viewpoints. The complex includes the equipment for measuring and monitoring the parameters of microelectronic elements of microcircuits, equipment for the monitoring and parametric adjustment of the passive part of microcircuits and functional adjustment of assembled microcircuits, and equipment for the final monitoring and measuring of the microcircuit parameters. The complex also includes facilities for input monitoring of microcircuits by consumers and developers of the equipment. The complex is based on ASET [expansion unknown] designs with utilization of various aggregate complexes.

In 1975-1976, the first-priority designs within the framework of the complex were introduced at a number of enterprises of this sector of industry and yielded an economic effect of about 2 million rubles. At the present time, work is in progress on solving the problem of creating a complex of instruments for monitoring the production processes of digital BIS [expansion unknown] on the basis of the principles of aggregation with the use of electronic computers. The realization of these research projects will make it possible to ensure the monitoring of time BIS, OZU [internal storage systems], PZU [permanent storage systems], microcalculators, microprocessors, etc, and facilitate rapid transition of instrument making to the microelectronic basis.

Representatives of enterprises and organizations, developers and users of microcircuits, reported on their experiences in the creation of new microcircuits, development of microelectronic technology, and monitoring devices for microcircuits. Candidate of Engineering Sciences Yu. V. Isayev (Yaroslavl') reported on accelerated development of designs and technological documentation for series production of microcircuits. Candidate of Engineering Sciences Yu. G. Tamberg (Leningrad) discussed the problems of coordinating the interrelations of the developers of microcircuits, their manufacturers, and developers of monitoring and measuring equipment.

During the conference, there was an exhibit of new monitoring and measuring devices for the production of microelectronic equipment.

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CSO: 1870

ENGINEERING AND EQUIPMENT

COMPARATIVE EVALUATION OF THE TECHNICAL AND ECONOMIC INDICES OF MHD AND THERMIONIC ADD-ON UNITS FOR STEAM-TURBINE POWER PLANTS

Moscow SRAVNITEL'NAYA OTSENKA TEKHNIKO-EKONOMICHESKIKH POKAZATELEY MGD I TERMOEMISSIONNYKH NADSTROYEK K PAROTURBINNYM USTANOVKAM in Russian 1977 signed to press 1 Apr 77 pp 1-13

[Scientific and Technical Report No A 77/5 by G. Morozov, Institute of High Temperatures, Academy of Sciences USSR, 1977, 70 copies, 13 pp]

[Text] 1. Types of Power Plants and Conditions for Comparing Them

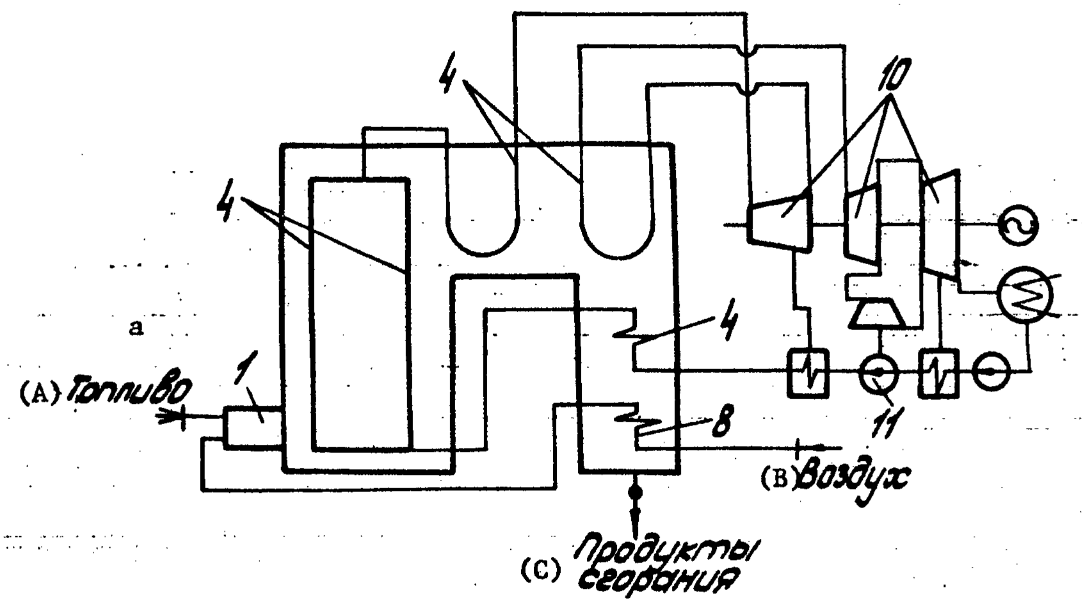
The attainment of high efficiencies in steam-turbine [ST] power plants requires simultaneous increase in both the temperature and pressure of the superheated gas, which is an extremely complicated technical problem due to the low strength of structural materials at high temperatures. One way (and to all appearances the most promising way) to avoid the combined action of high temperatures and pressure on equipment is to supplement the steam-power cycle with a high-temperature add-on unit in which the working fluid is at a relatively low pressure.

This paper examines two types of high-temperature add-on units -- a thermionic energy converter [TEC] and an MHD generator [MHDG] -- and examines their technical and economic characteristics on the basis of comparative analysis. For this purpose, the following types of gas-operated electric power plants were compared: I--with ST (Fig. 1a), II--with TEC + ST (Fig. 1b), III--with MGDH + ST (Fig. 1c), IV with MGDH + TEC + ST (Fig. 1d). It was assumed that equipment of the same kind had identical characteristics:

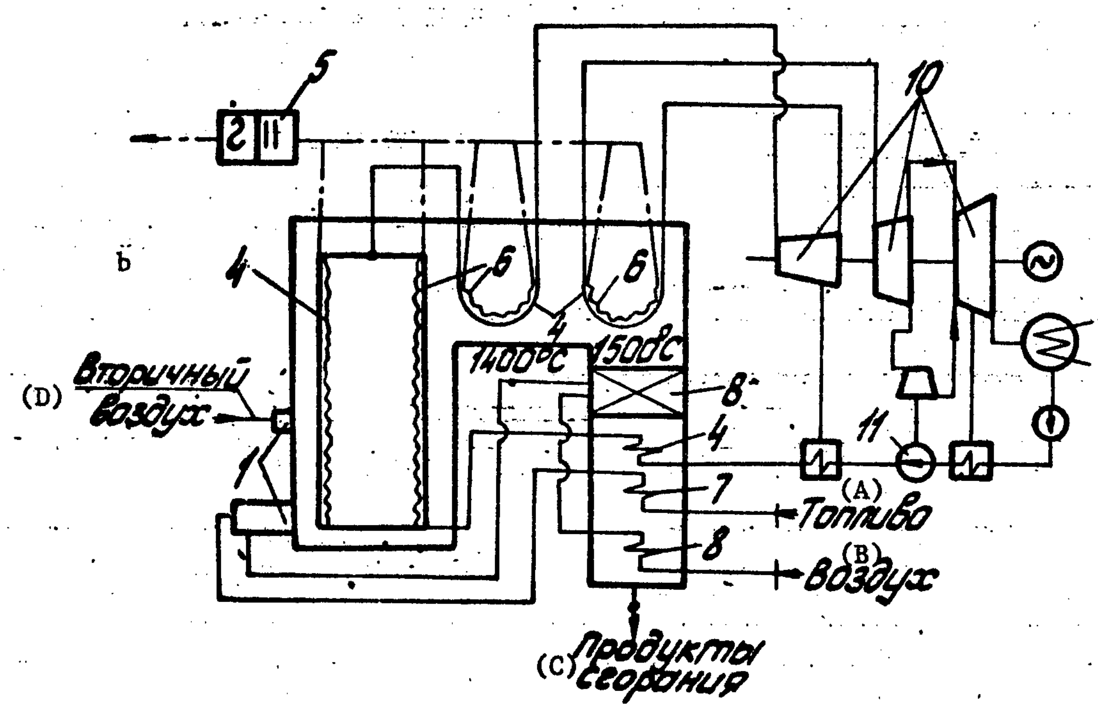
1) the steam turbines, designed for initial steam parameters of 23.5 MN/m^2, 540/540°C, had an efficiency of 47%;

2) thermionic energy converters, located on water and steam heating surfaces [Ref. 1] in the region of combustion product temperatures of 1500°C and higher, had an efficiency of 20%;

3) MHD generators of diagonal type with average magnetic field induction of 5 T had a coefficient of conversion of initial enthalpy of combustion products to electric energy of 21%.



Diagrams of electric power plants with ST (a), ST + TEC (b), MHDG + ST (c) and MHDG + TEC + ST (d): 1--combustion chamber (burners); 2-- MHD generator; 3--MHDG current converter; 4--heating surfaces of the high-pressure steam-water channel; 5--TEC current converter; 6--thermionic energy converters; 7--fuel heater; 8--air heater; 9--compressor with turbodrive; 10--turbine units; 11--feed pump; 12--low-pressure economizer; 13--cooling system for the MHDG channel; 14--cooling system for the combustion chamber; A--fuel; B--air; C--combustion products; D--secondary air; E--530 kN/m^2, 225°C



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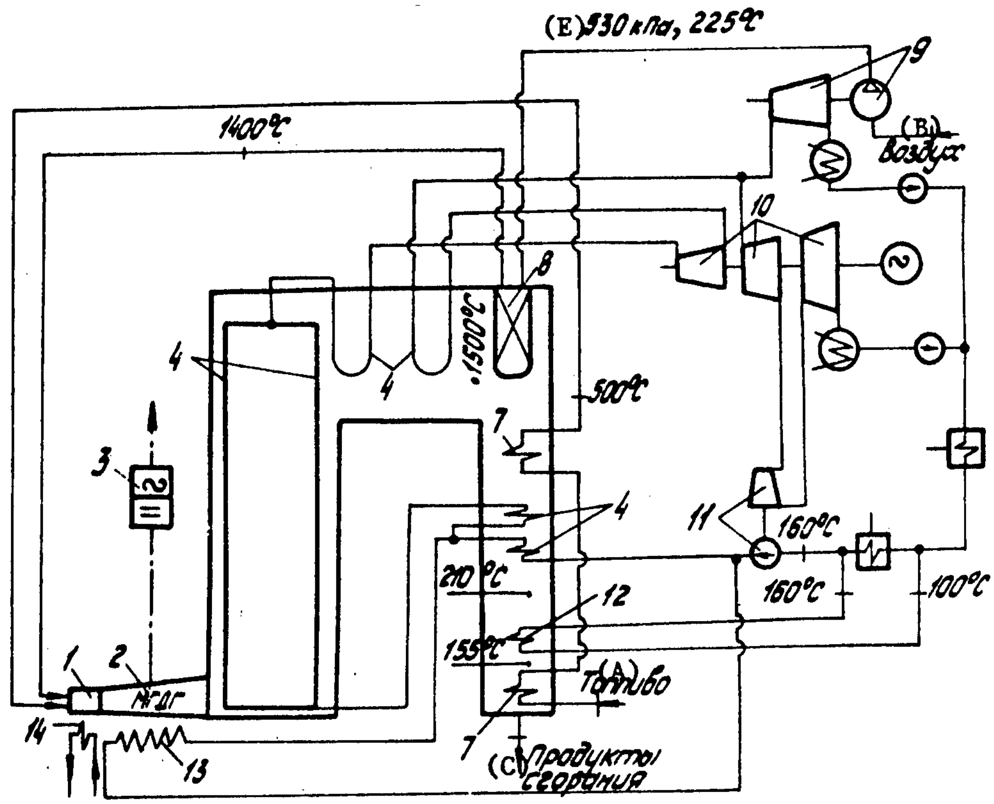
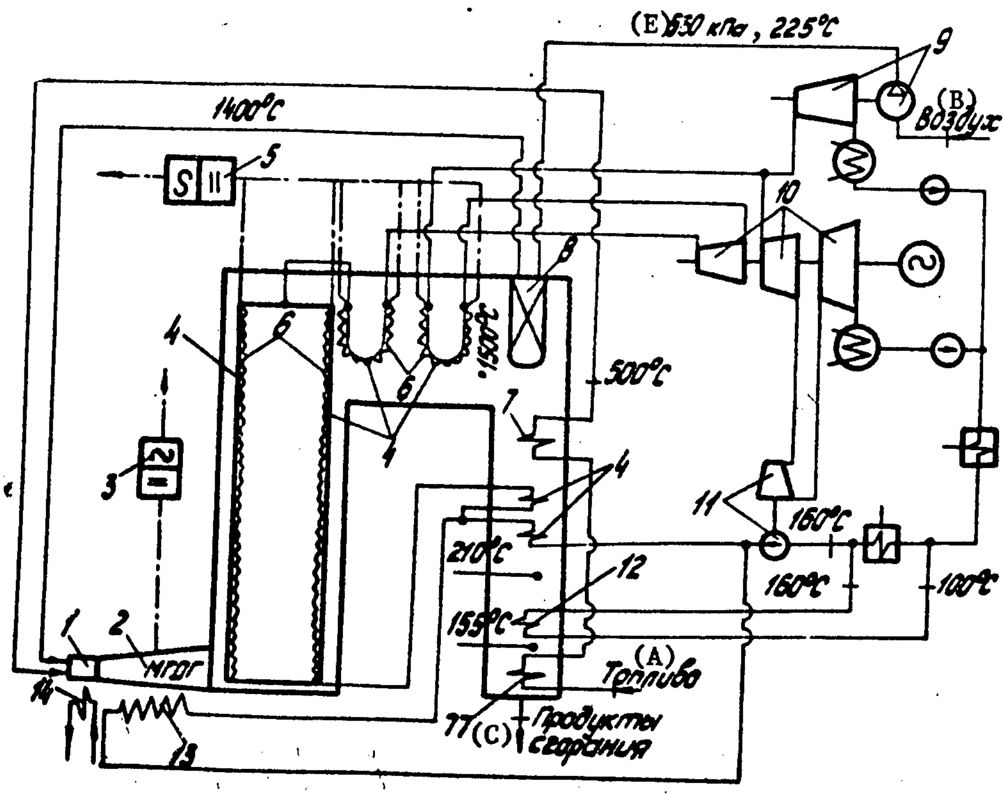

(E) 530 кПа, 225°C
9
1400°C
(B) Воздух
10
8
·1500°C
4
4
3
500°C
7
4
11
160°C
210°C
160°C
100°C
12
155°C
(A) Топливо
1
2
МГДГ
14
13
7
(C) Продукты сгорания

d


(E) 530 кПа, 225°C
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160°C
210°C
160°C
100°C
12
155°C
(A) Топливо
1
2
МГДГ
14
13
7
(C) Продукты сгорания

The efficiency of electric power plants with high-temperature add-on units is appreciably dependent on the initial temperature of the combustion products, which depends in turn on the temperature of the air entering for combustion. Therefore in all types of electric power plants with high-temperature add-on units, identical air heating to 1400°C is assumed.

Electric power plants of different types can be compared for example by assuming that they have the same electric power N_i ($i = I, II, III, IV$)*. However, for electric power plants with efficiency considerably different from ST plants we feel that it is more correct to make the comparison on the assumption of equal thermal power (an equal amount of fuel burned). This approach stems from the tendency in recent years to build power plants with the maximum possible capacity for the selected construction site.

The maximum power of an electric plant may be limited by various factors: the availability of fuel and water supply sources, emissions into the atmosphere, the dimensions of the territory. All these factors to some extent place limitations on the possible amount of heat that can be used at the power plant. Therefore the condition

$$Q_I = Q_{II} = Q_{III} = Q_{IV} = Q$$

is a sufficient basis for comparison of variants.

Obviously in this case the electric power is determined from the relation

$$\frac{N_I}{\eta_I} = \frac{N_{II}}{\eta_{II}} = \frac{N_{III}}{\eta_{III}} = \frac{N_{IV}}{\eta_{IV}} = Q\ ,$$

where η_i is the efficiency of the i-th type of power plant.

2. Energy and Cost Indices

The table summarizes the results of calculations of the energy and cost indices of electric plants having identical thermal power of $Q = 2000$ MW. The efficiencies of the electric plants given in the table and in Ref. 1-3 practically coincide. In Ref. 3 the economic calculations were done on the basis of the maximum permissible cost of the add-on unit per kW of its power. This approach requires differentiation of expenditures for components in the overall plant between the add-on unit and the steam-turbine part of the plant. However, in this case we are faced with the far from simple problem of how to distinguish capital investments on such items as apprach tracks, fuel storage, smoke elimination and so forth as to their distribution among the ST, TEC and MHDG. To get around this problem, in this paper the total capital investments in the electric power plant K_i are determined, and then the specific (per kilowatt) capital investments are determined from the ratio

*The indices I, II, III, IV will refer to the corresponding types of electric power plants.

Energy and Technical-Economic Indices of Electric Power Plants with Thermal Power of 2000 MW

(1)Наименование	(2)Тип			
	1	П	Ш	1У
(3) Энергетические показатели				
(4) Мощность паровой турбины $N_i^{пт}$, МВт	851	689	454	361
(5) Мощность МГДГ $N_i^{мгдг}$, МВт	-	-	591	591
(6) Мощность ТЭП $N_i^{тэп}$, МВт	-	329	-	199
(7) Суммарная мощность ΣN_i, МВт	851	1018	1045	1151
(8) Мощность вспомогательных механизмов $N_i^{вс}$, МВт	30	30	30	30
(9) Полезная мощность N_i, МВт	821	988	1015	1121
(10) Расчетный КПД η_p, %	41	49,4	50,7	56,6
(11) Эксплуатационный КПД η, %	40	48,4	49,6	55,3
(12) Капиталовложения				
(13) Группа 1. Компоненты, зависящие от места строительства, количества и вида сжигаемого топлива (подъездные железные и автомобильные дороги, территория, тракт топлива, дымовых газов, включая их очистку от золы и SO_x, и некоторые общестанционные объекты) $K_{i,1}$	$0,3K_I$	$0,3K_I$	$0,3K_I$	$0,3K_I$
(14) Группа 2. Гидротехнические сооружения (капиталовложения пропорциональны отводимому водой теплу) $K_{i,2}$	$0,09K_I$	$0,066K_I$	$0,06K_I$	$0,052K_I$
(15) Группа 3. Повышающие трансформаторы, подстанция и вспомогательные компоненты, зависящие от мощности электростанции (капиталовложения пропорциональны общей мощности станции) $K_{i,3}$	$0,08K_I$	$0,097K_I$	$0,099K_I$	$0.111K_I$
(16) Группа 4. Паротурбинное оборудование (капиталовложения пропорциональны мощности паровых турбин) $K_{i,4}$	$0,53K_I$	$0,43K_I$	$0,28K_I$	$0,23K_I$
(17) Группа 5. Компрессорное оборудование (капиталовложения на 1 кВт компрессора такие же, как на 1 кВт группы 4) $K_{i,5}$.	-	-	$0,092K_I$	$0,092K_I$
(18) Группа 6. Высокотемпературный нагреватель воздуха (капиталовложения для всех групп подсчитаны по одной методике) $K_{i,6}$	-	$0,11K_I$	$0,13K_I$	$0,13K_I$
(19) Группа 7. Преобразователи постоянного тока в переменный (капиталовложения на 1 кВт преобразуемой мощности одинаковые для всех типов) $K_{i,7}$	-	$0,058K_I$	$0,105K_I$	$0,139K_I$
(20) Группа 8. МГД генератор и камера сгорания (капиталовложения по проекту ИВТАН) $K_{i,8}$	-	-	$0,25K_I$	$0,25K_I$
(21) Группа 9. Термоэмиссионные преобразователи (капиталовложения по данным [3, рис.6], но без стоимости трансформаторов) $K_{i,9}$	-	$0,425K_I$	-	$0,258K_I$
(22) Суммарные капиталовложения K_i	K_I	$1,486K_I$	$1,316K_I$	$1,562K_I$
(23) Удельные капиталовложения $k_i = K_i / N_i$	k_I	$1,25\,k_I$	$1,09\,k_I$	$1,18\,k_I$
(24) Предельные значения удельных капиталовложений [по соотношению (3)]	k_I	$(1,19-1,23)k_I$	$(1,21-1,25)k_I$	$(1,3-1,35)k_I$
(25) Предельные капиталовложения	K_I	$(1,43-1,48)K_I$	$(1,49-1,54)K_I$	$(1,78-1,85)K_I$

KEY TO THE TABLE

1--Index
2--Type
3--Energy indices
4--Steam turbine power $N_i^{ПТ}$, MW
5--MHDG power $N_i^{МГДГ}$, MW
6--TEC power $N_i^{ТЭП}$, MW
7--Total power ΣN_i, MW
8--Power of auxiliary mechanisms N_i^{BC}, MW
9--Useful power N_i, MW
10--Rated efficiency η_p, %
11--Operational efficiency η, %
12--Capital investments
13--Group 1. Components that depend on the place of construction, amount and type of fuel burned (approach tracks and roads, fuel line, flue gas stacks including ash-removal units and sulfur oxide cleaners, and certain items common to the entire plant) $K_{i,1}$
14--Group 2. Hydraulic engineering structures (capital investments are proportional to the heat carried away by water) $K_{i,2}$
15--Group 3. Step-up transformers, substation and auxiliary components that depend on the power of the electric plant (capital investments are proportional to the overall power of the plant) $K_{i,3}$
16--Group 4. Steam turbine equipment (capital investments proportional to the power of the steam turbines) $K_{i,4}$
17--Group 5. Compressor equipment (capital investments per kW of the compressor the same as per kW of group 4) $K_{i,5}$
18--Group 6. High-temperature air heater (capital investments for all groups calculated by one method) $K_{i,6}$
19--Group 7. DC-to-AC converters (capital investments per kW of converted power the same for all types) $K_{i,7}$
20--Group 8. MHD generator and combustion chamber (capital investments according to the draft of the Institute of High Temperatures, Academy of Sciences of the USSR) $K_{i,8}$
21--Group 9. Thermionic energy converters (capital investments in accordance with the data of Ref. 3 [Fig. 6] but without the cost of transformers) $K_{i,9}$
22--Total capital investments K_i
23--Specific capital investments $k_i = K_i/N_i$
24--Limiting values of specific capital investments [from relation (3)]
25--Limiting capital investments

$$k_i = K_i / N_i$$

i. e., capital investments are not divided among forms of energy conversion.

The author assumes that capital investments K_I (k_I) in electric plants type II, III, IV, as well as capital investmnents in individual components of these plants $K_{i,j}$ ($k_{i,j}$) are determined in percentages of the capital investments in the steam-turbine electric plant*

$$K_i = \xi_i K_I ; \quad K_{ij} = \xi_{ij} \cdot K_I ; \quad k_i = \mu_i \cdot k_I ; \quad K_{i,j} = \mu_{ij} \cdot K_I ,$$

where ξ and μ are quantities to be determined. Let us examine methods of determining capital investments in more detail.

Capital investments in the components of the electric power plant listed in groups 1-4 of the table are determined (according to the author's proposal) on the basis of analogous expenditures for components of steam-turbine plants. Capital investments in group 1 were taken the same in all variants since the comparison applies to power plants being constructed under identical conditions and burning an equal amount of fuel. Capital investments in groups 2-4 for electric power plants type II, III, IV were recalculated in proportion to the flowrate of the cooling water, the useful power of the electric plant and the power of the steam turbine section.

Group 4 includes components directly related to the steam-power cycle. For electric power plants of type I, capital investments in this group come to 53% of the total capital investments, and for other types of electric plants the author assumes that they can be recalculated in proportion to the power of the steam turbines

$$K_{i,4} = 0.53 K_{I,4} \frac{N_i^{\Pi T}}{N_I^{\Pi T}},$$

where $N_I^{\Pi T}$ is the power of the steam turbine on electric plants of types II, III and IV.

Group 5 includes the cost of the compressor, its steam turbine, the fraction of the cost of the steam generator that is proportional to the flowrate of steam to the compressor turbine, and other components that relate to the thermal cycle, including the cost of foundations and buildings. It can be assumed with sufficient accuracy that capital investments per kW of compressor power and per kW of turbogenerator power are identical in the recalculated equipment. This means that capital investments can be determined from the relation

*The subscript i corresponds to the type of electric power plant, and j indicates the number of the group in the table.

$$k_{i,5} = k_{I,4} \frac{N^{ком}}{N_I} = 0{,}53 K_I \frac{N^{ком}}{N_I}$$

where $N^{КОМ}$ is the power of the compressor.

The cost of high-temperature air heaters (group 6) for the TEC and MHDG was determined by a unified method, enabling comparison of the results. The following was taken into consideration in the calculations. On electric power plants with MHDG the air is compressed by the compressor to 0.5-0.6 MN/m^2 and then enters the heater with temperature of 225°C. On power plants with TEC atmospheric air is used with a temperature of 15°C. As a result, the thermal power of the heater in the second case is approximately 15% higher than in the first. At the same time, heating air with a pressure of 0.5-0.6 MN/m^2 complicates the design of the heater as compared with the design of the heater for atmospheric air. Both these factors were taken into consideration in determining capital investments in group 6.

In principle, the same method can be used for DC-to-AC conversion on electric power plants with MHDG and TEC (group 7). In the case of the MHDG the conversion device will be somewhat simpler because of lower currents and a smaller number of parallel DC sources. Nevertheless in both cases the specific capital investments (per kW of converter power are taken as the same -- 0.15k_I -- and the overall capital investments are recalculated in proportion to the power of the TEC ($N_I^{ТЭП}$) and the MHDG ($N_I^{МГДГ}$):

$$K_{i,7} = 0{,}15 k_I (N_i^{тэп} + N_i^{мгдг}) = 0{,}15 K \frac{N_i^{тэп} + N_i^{мгдг}}{N_I}.$$

Capital investments in the MHDG (group 8) include the cost of the combustion chamber, channel and superconducting magnet system with auxiliary equipment, building and foundation. The values of these elements are determined on the basis of series production technology. The cost of the TEC (group 9) is taken from data of Ref. 3 (Fig. 6), but without the cost of the transformers. The total capital investments are determined by adding all groups.

3. Comparison of Economy

Expenses per kW of generated energy

$$З_i = З_i^T + З_i^K + З_{пер} \qquad (1)$$

are made up of the expenditures for fuel

$$З_i^T = \frac{C_T}{\eta_i},$$

fixed expenses that are proportional to capital investments,

$$z_i^K = \frac{0.23 k_i}{p}$$

and personnel expenses $z_{\text{перс}}$, which are small and henceforth will be left out. Here C_T is the cost of 1 kWht of thermal energy of the fuel, p is the amount of electric energy delivered to the power system from 1 kW of installed power, 0.23 is a coefficient that accounts for all forms of expenses as a fraction of K_i.

An electric power plant with TEC or MHDG is competitive with a steam-turbine plant if

$$z_i \leq z_I \qquad (2)$$

From relations (1) and (2) we can find the so-called limiting capital investments $k_I^{\text{пр}}$ for which electric power plants with MHDG and TEC are still economically feasible in comparison with a steam-turbine power plant:

$$k_i^{\text{пр}} = \left[\varphi\left(1 - \frac{\eta_I}{\eta_i}\right) + 1\right] K_I \,, \qquad (3)$$

where $\phi = z_I^T / z_I^K$. At present in electric power plants that operate on shipped-in fuel, $\phi \approx 1$.

Since the cost of fuel is increasing more rapidly than the cost of equipment, construction and services, it can be assumed that by 1990 this quantity will increase to $\phi = 1.1$ (with consideration of a 10% reduction in p due to the increasing irregularity of daily demands for electric power). The last two lines of the table give the values of the limiting capital investments calculated from relation (1) when ϕ ranges from 1 to 1.2.

4. Discussion of the Results

As can be seen from the table, under the assumptions made the specific capital investments in an electric power plant type II are somewhat higher than the limiting values of this quantity. The discrepancies in evaluation of capital investments as compared with Ref. 3 can be attributed to the fact that only the cost of the TEC proper was considered in Ref. 3.

Among the components left out of consideration, the most expensive is the high-temperature air heater. The cost of this item is more than 25% of the cost of the TEC.

In cases where a TEC is installed on electric power plants that have an MHDG (type IV), both add-on units have a common heater, which considerably improves the indices of the power plant with TEC. According to the data of the table, specific capital investments as determined by calculation for an electric plant of type IV are 10-14% lower than the limiting values, whereas they are 1-5% higher for an electric plant of type II.

On electric plants of type III and IV the expenditures for production of electric energy are about the same on the present level of cost estimates, but the efficiency in the second case is considerably higher, and these plants promise to be somewhat more economical in the future. However, the presence of three kinds of energy converters in a single power plant involves a number of operational inconveniences, and this problem requires very careful study.

REFERENCES

1. "Topping Cycle Comparison," Report (408)734-1622, Rasor Associates, Inc.

2. W. D. Jackson, R. V. Shanklin et al., "Development of Baseline for Commercial Service," in: 15th Symposium Engineering Aspects of Magnetohydrodynamics, the University of Pennsylvania, March 24-26, 1976, p 111, 3.1-3.5.

3. E. J. Britt, G. O. Fitzpatrick, "Thermionic Topping for Central Station Power Plants," paper on the 11th Intersociety Energy Conversion Engineering Conference, September, 1976.

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ENGINEERING AND EQUIPMENT

THE SPMS-1 SUPERCONDUCTING MAGNET SYSTEM FOR AN MHD GENERATOR

Moscow SPMS-1 SVERKHPROVODYASHCHAYA MAGNITNAYA SISTEMA MGD GENERATORA in Russian 1977 signed to press 11 Apr 77 pp 1-16

[Scientific and Technical Report No A 77/2 by V. B. Zenkevich, I. A. Kir'yenin and V. A. Tovma, Institute of High Temperatures, Academy of Sciences USSR, 1977, 70 copies, 16 pp]

[Text] Progress in developing an effectively operating MHD power plant depends to a great extent on advances in the development of superconducting magnet systems (SPMS) for MHD generators.

In research and development work at the Institute of High Temperatures of the Academy of Sciences USSR a superconducting magnet system (the SPMS-1) for MHD generators has been designed, built and tested; this unit produces a magnetic field of up to 4 T in a "hot" space 300 mm in diameter and 1000 mm long (within this space the nonhomogeneity of the magnetic field is no more than ±5%) [Ref. 1, 2].

On the basis of conditions set for the magnetic system of an MHD generator, a dipole winding was selected with saddle-shaped layers and based on a tube. Such a system has the following advantages:

a) it provides fairly high uniformity of the magnetic field in the channel;

b) there is no complicated technological problem in making the base tube to which forces are transmitted through the banding and through the structural elements that shape the winding;

c) the forces developed in the winding can be transmitted to the central base tube, which enables the use of layered banding of relatively small cross section. This simplifies the technology for making the system, and does not lead to any sharp increase in the weight and overall dimensions of the magnetic system, as is the case when external banding is used.

Cooling of the windings is from the outside with access of the helium to every layer of the winding.

The SPMS was wound with 49-strand cable made up of 42 composition wires 0.3 mm in diameter, each containing six superconducting strands based on Nb-Ti alloy (diameter of the superconducting wires was 70 μm) and seven copper wires of the same diameter as the composition wires. The cable was monolithized with high-purity indium and insulated with braided Mylar filament. The diameter of the insulated cable was 3.5 mm.

The complex shape of the turns was formed and held by aluminum inserts of two types: "central" inserts around which the layers of the winding were formed, and "end" inserts placed between the single-surface layers of the winding. The inserts (4 mm thick) were made from grade AD-1M sheet aluminum. Each half of the dipole winding contained 29 layers with a number of turns that varies depending on distance from the axis of the system -- from 61 turns on the inside layer to 97 turns on the outermost layer.

Fig. 1 shows the assembly of the winding-shaper inserts.

The SPMS coil was wound from ten separate lengths of cable, the joints between lengths being led out to the end faces of the winding. The joints were soldered on copper busbars with a cross section of 10 x 12 mm; the ends of the joined lengths of cable were laid in grooves 6 mm wide and 3.5 mm deep and potted with high-purity indium.

The parts of the coil wound with single lengths of cable are separate sections tapped with current conductors -- copper tubes measuring 10 x 1.5 mm. These taps are soldered to copper plates with PSr-45 silver solder. In this way, 12 such taps are connected to the winding: the two joined to the ends of the winding are for feeding transport current to the coil, while the ten that are connected to the series tie-points of the sections are for parallel connection of 0.15 Ω protective resistors (located outside the cryostat) to each section of the winding. Shunt-connected section resistors are included in case of transition of the winding to the normal state.

The superconducting cable was laid between the coil-shaping inserts, and each layer of the winding was potted with a special dielectric material based on ED-6 epoxy resin. This was done to avoid degradation of the current in the winding caused by dsplacements of the turns under the action of electrodynamic forces.

Fig. 2 shows one of the layers of the winding.

Tangential and radial forces in the winding were compensated by layered banding with 1-mm 0Kh18N10T stainless steel wire. The wire was laid in equidistant banding "strips" in slots 1 mm deep and 50 mm wide milled into the inserts; the distance between the banding "strips" was 70 mm. To protect the insulation of the superconducting cable from damage by the banding wire, steel bands 0.1 mm thick were laid between the layers of the winding and the wire.

The axial forces in the end sections of the winding are taken up by two flanges of Kh18N10T stainless steel 20 mm thick fastened to the base tube by eight bolts, and tied together around the outside diameter by twelve longitudinal strips with cross section of 2 x 20 mm welded to the flanges.

The windings were made with provisions for cooling. Layer-by-layer cooling was provided by longitudinal channels with cross section of 1 x 10 mm milled in the inserts, and by the channels formed by the banding "strips." Helium was fed into these channels through the end faces of the windings and apertures penetrating the windings at the locations of the channels.

Preliminary tests of the SPMS-1 were done in a vertical cryostat with helium bath 700 mm in diameter.

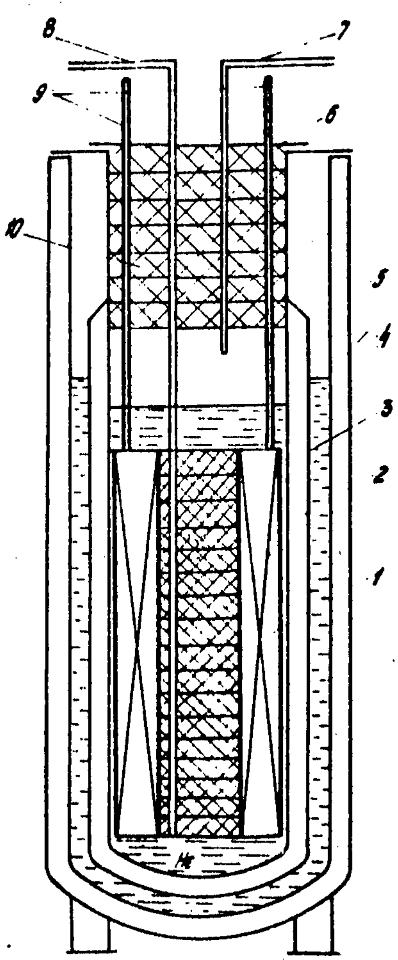

Fig. 3. Cross section of the winding with cryostat: 1--winding; 2-- helium shell; 3, 4--shells of the nitrogen vessel; 5--outer jacket; 6--cover of the cryostat; 7, 8--filler tubes; 9--current-conducting leads; 10--foam plastic plug

Shown in Fig. 3 is a diagram of the cross section of the vertical cryostat (the general appearance is shown in Fig. 4) with the magnetic system located inside. The cryostat is made with nitrogen cooling. It consists of two vessels with high-vacuum insulation. The helium vessel is made of two shells (2) and (3) with elliptical bottoms. To reduce heat flux to the liquid helium, an aluminized Mylar film is applied to the outside surface of shell (2). The nitrogen vessel also consists of two shells (4) and (5) with elliptical bottoms; heat fluxes to the liquid nitrogen are reduced by covering the outer surface of shell (4) with a multilayered screen insulation that consists of alternating layers of aluminized Mylar and fiberglass paper.

The SPMS is held in the helium space of the cryostat by using three stainless tubes to suspend the system from flange 6.

To reduce heat flows to the helium space that are caused by convection and by the thermal conductivity of the gas column and the throat of the cryostat, the upper part of the helium space of the cryostat is filled with a plug (10) of eight foam plastic disks. To reduce the amount of liquid helium required to fill the system, the inside space of the winding was also filled with foam plastic. To cool the winding of the SPMS and to fill the helium space with liquid helium, two filler tubes (7) and (8) were provided that were made from two concentric thin-walled stainless tubes with a vacuum space between them. Filler tube (8) was brought down beneath the SPMS winding and used in the process of cooling the system (to 4.2 K); tube (7) was cut off above the system and was used for filling the cryostat with liquid helium and for adding liquid helium.

To make the cooling process safe throughout the temperature range from 300 to 4.2 K, two safety valves were provided with adjustment from 0.7 to 2 kgf/cm^2.

To ensure safe transition of the winding from the superconductive to the normal state, provision was made for raising the flange (6) with attached SMPS-1 coil to allow the violently evaporating helium to escape. The flange could be raised along eighteen guide rods to a height of 80 mm set by special limiting nuts.

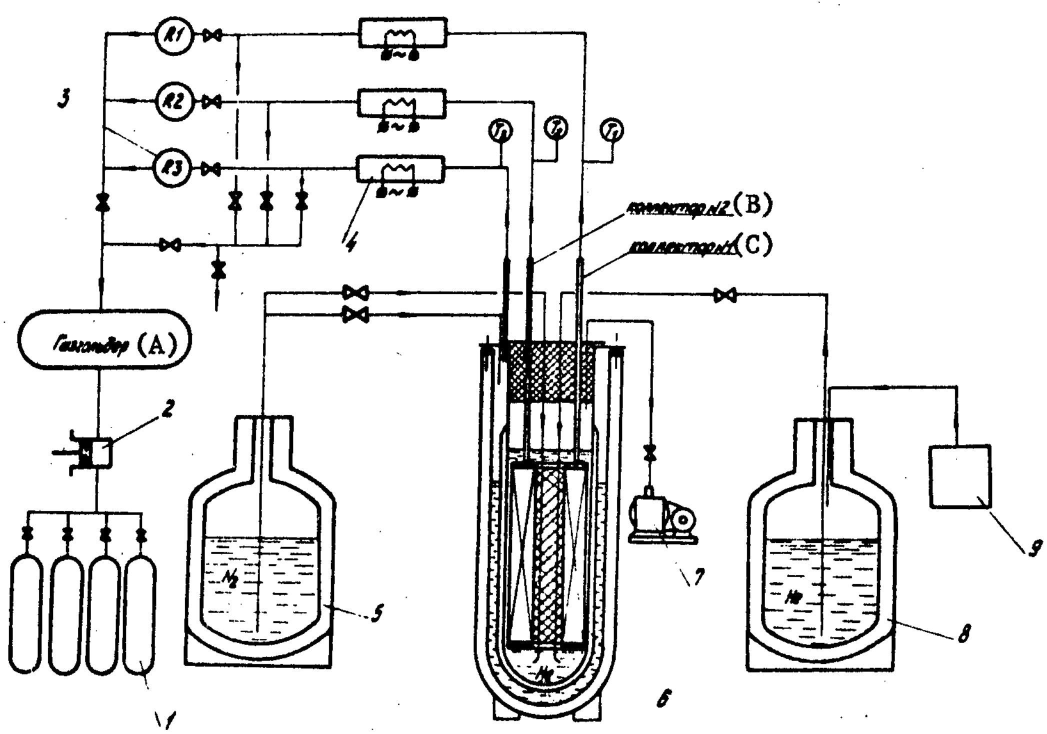

Fig. 5. Cryogenic system: 1--receiver ramp; 2--compressor; 3--rotameters; 4--heaters; 5--nitrogen Dewar vessel; 6--winding; 7--vacuum pump; 8--helium Dewar vessel; 9--helium oxidizer; A--gasholder; B, C--collectors No 2, I

The amount of liquid helium necessary for cooling rather large superconducting magnet systems is determined to a great extent by the cooling system selected. We used three-stage cooling in the SPMS-1 winding. Shown in Fig. 5 is a schematic diagram of the cryogenic system.

The SPMS-1 was cooled from 293 to 80 K by liquid nitrogen poured into the helium vessel of the cryostat (8) from nitrogen tank (5) (TRZhK-3M).

The rate at which liquid nitrogen was fed to the SPMS and the change in temperature of different sections of the shell were monitored by the change in resistances of the individual sections during cooling. As the winding was cooled, the temperature differential between the innermost and outermost walls did not exceed 5 K, ensuring the absence of any extreme temperature stresses in the winding.

In the second stage, the winding was cooled from ~30 to ~65 K by evacuating the nitrogen vapor to a residual pressure of $p \sim 0.17$ absolute atmosphere, using a type VN-1MG vacuum pump. Lowering the temperature of the winding to $T \approx 65$ K enables an approximately 5% reduction in the amount of helium necessary for cooling the winding.

Before the last stage of cooling the winding (pouring in the liquid helium), the liquid nitrogen was removed, after which the winding and the helium space were thoroughly rinsed with gaseous helium.

Liquid helium from vessel (8) type RS-100 and RS-2500 with capacities of 100 and 500 l respectively was transferred by siphon to the lower part of the cryostat. The outlet end of the siphon is fitted with a collector with 12 branch pipes ensuring uniform distribution of the helium around the perimeter of the winding. The evaporating helium passed through channels in the winding and through an annular millimeter gap of ~547 mm between the helium shell and the winding. The cold content of the spent helium vapor was used to cool the two main current conductors through which electric current was fed in the process of supplying the magnetic system, ten auxiliary conductors connecting the sections of the winding to the protective resistors, and the throat of the cryostat.

The distribution of gas flows to the main and auxiliary current leads and the throat of the cryostat was set by valves installed upstream from the rotameters R_1, R_2, R_3. The distribution of the flows was controlled in such a way that the gas temperature at the outlet from the cryostat was approximately the same in the three cooling streams. The temperature of the flows was measured by carbon thermometers T_1, T_2 and T_3 mounted directly in the lines at the outlet from the cryostat.

Each of the three streams leaving the cryostat was heated to the ambient temperature (15-20°C) in electric heaters (4) (the power of each heater was regulated over a range from 0 to 4.5 kW depending on the amount of helium flowing through and its temperature at the outlet from the heater), and then after passing through the rotameters (3) the helium was collected in a soft gasholder with capacity V = 100 cu. m. From the gasholder, the gaseous helium was pumped by three type IVUV-45/150 compressors (2) to receiver ramps (1) with a capacity of 1500 nm^3.

During cooling of the SMPS-1 system from 65 to 4.2 K, the rate of transfer of the liquid helium from the vessels to the cryostat was regulated over a range from 50 l/hr in the initial period of cooling (in the given temperature range) to 150 l/hr at the end of cooling, i. e. when the windings were practically cooled to the working temperature. The rate of helium transfer was monitored by the change in electrical resistance of the winding sections and by the gas temperature at the outlet from the cryostat; the temperature of the gas leaving the cryostat was no lower than 238 K.

Eight hours were spent on the process of cooling the system with subsequent helium filling to the working level: six hours on cooling and two hours on filling the cryostat to the working level. Cooling the SPMS-1 system and the helium bath of the cryostat took 410 l of liquid helium. Filling the cryostat to the working level (200 mm above the system) took 230 l of liquid helium.

The helium was liquefied and accumulated by an "Air-Liquide" installation (9) with capacity of 30 l/hr with subsequent transfer to Dewar vessels (8) type

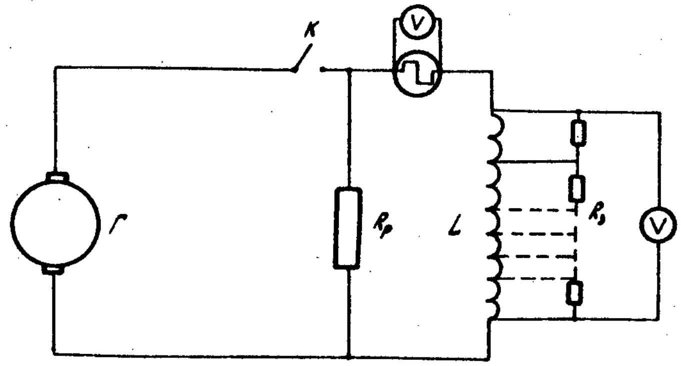

Fig. 6. Electric circuit: Г--power supply; K--commutating device; L--superconducting winding; R_p--protective resistor; R_3--protective section resistors

RS-500 and RS-100, and also to a stationary tank with capacity V = 3000 l based on an updated cryostat with helium space 1300 mm in diameter.

The preliminary tests of the SPMS were done in the vertical cryostat. A schematic diagram of the electric circuit is given in Fig. 6. The power supply was based on a low-voltage motor-generator set type AND-5000/2500. Current regulation was through the field winding of the generator with voltage fed to the winding from a type EMU-3P amplidyne. The control windings of the EMU-3P were fed in turn from rectifiers. The process of current feed to the SPMS could be controlled both manually (by an operator) and automatically (by means of the appropriate automation and control modules). The power supply provided current of up to 5000 A, output voltage up to 6 V, and current stability was within 5% of the steady-state current.

Since the superconducting cable used in the winding was partly stabilized (the ratio of the cross section of normal metal with high-conductivity Cu and In to the cross section of superconductor is equal to 7, and only ~20% of the cable surface can be washed with liquid helium), particular attention was devoted to protecting the winding against transition to the normal state. Protection was provided mainly through shunting by sections. When a normal region showed up in a section of winding, an outside resistance shunting the section dissipated a considerable portion of the energy stored in the winding. In addition, the aluminum inserts, particularly the central ones, performed protective functions. In case the system made a transition to the normal state (such a transition is inevitably accompanied by a drop of current in the system, and hence in the magnetic flux that penetrates the inserts), eddy currents were induced in the inserts with loops forming the equivalent of transformer secondaries (the primary in the given case being the SPMS winding itself). In this case a part of the energy associated with the magnetic flux penetrating the insert is dissipated in the inserts.

When a normal region shows up in a winding based on partly stabilized cable, the energy should be quickly coupled out of the magnet system. One way to do this is to discharge the winding across a resistor. The fraction of energy released across the resistor during discharge is proportional to the resistance value, which is limited by the permissible breakdown voltage of the cable insulation. Preliminary tests of the cable insulation showed that it withstands voltage up to 1000 V. On this basis, the discharge resistance in testing the SPMS was taken as 0.4 Ω. The power circuit was broken by an air contactor with an arc-quenching chamber.

the winding current was measured by a measurement resistor of $R = 0.0001\ \Omega$ and a type TR-6555 digital voltmeter combined with a printer.

The magnetic field was measured by a calibrated Hall pickup installed in the center of the magnet system. The Hall pickup was fed from batteries of the "Deviz" type; a digital voltmeter of the "Solatron" type was used for monitoring the measurement current and for measuring the Hall emf.

During raising and lowering of the current, the voltage across the ends of the winding was measured with a type TR-65 digital voltmeter.

The tests of the SPMS winding were done at different rates of current increase over the range from 0 to 0.3 A/s as the current was repeatedly raised to 550 A. The SPMS winding was discharged in both slow and fast modes across a discharge resistor. The current was damped out with a time constant of ~40 s.

The critical current of the SPMS was equal to $I_{cr} = 589$ A, and the design current density was equal to $3.77 \cdot 10^3$ A/cm^2. At the critical current the magnetic field B_0 in the center of the system is equal to 3.8 T, and the maximum calculated magnetic field on the winding is 60,000 oersteds. At the critical current, ~2.254 MJ of energy is stored in the winding of the system. The critical current of the SPMS was ~15% lower than the average level of the critical currents of short specimens of the cables from which the system was made. Shown in Fig. 7 are relations for the critical currents of cables as a function of the magnetic field, and the line of the maximum field on the winding as a function of the current feeding the winding. It is most probable that the degredation of current in the winding was due to inadequate cooling of the current leads joining the sections of the winding. When installing the SPMS winding in the horizontal cryostat, steps were taken to ensure satisfactory cooling of the contact plates on which the winding sections were connected.

The main characteristics of the SPMS-1 winding:

Diameter, mm	
inside	400
outside	690
Length, mm	1790
Weight, kg	1800
Inductance, H	13
Critical current, A	589
Design current density, A/cm^2	$3.77 \cdot 10^3$
Magnetic field in the center of the system	38

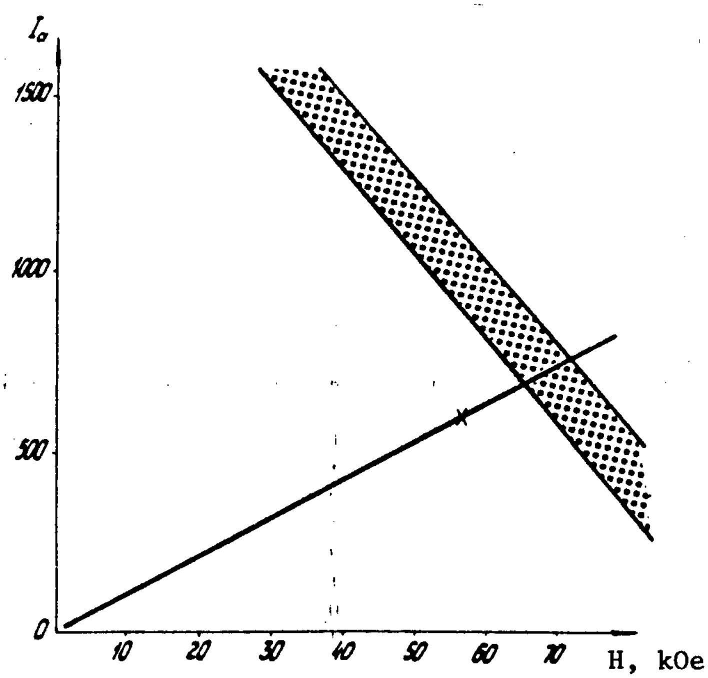

Fig. 7. Dependence of the critical current of superconducting cables on the magnetic field

Stored energy, MJ	2.25
Length of zone with uniform field (±5%), mm	1000

Horizontal cryostat with the SPMS-1 Winding

After the tests in the vertical cryostat, the SPMS-1 was placed in a horizontal cryostat.

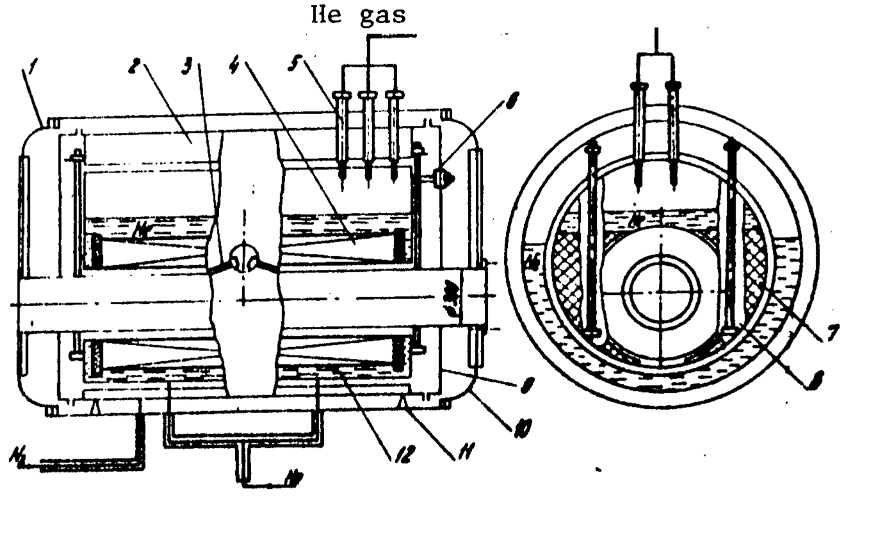

Fig. 8. Cross section of the horizontal cryostat with SPMS: 1--cryostat housing; 2--nitrogen space; 3--tie rods; 4--winding; 5--current leads; 6--stops; 7--foam plastic; 8--hangers; 9--shield; 10--housing; 11--supports; 12--helium space

A diagram is given in Fig. 8 of the cross section of the horizontal cryostat with the SPMS-1 winding placed inside, and the general appearance of the horizontal cryostat is shown in Fig. 9.

The cryostat is a system of horizontal eccentric cylinders with high-vacuum multilayer insulation.

The inside tube with a hot zone 300 mm in diameter accommodates the channel of the MHD generator. A distinguishing feature of this cryostat design is that the inside shell of the helium vessel acts as a support tube for the SPMS-1 winding, to which flat end caps are welded. This design not only maximizes the size of the hot zone, but reduces the horizontal size of the cryostat itself.

The helium bath (12) is suspended from the nitrogen bath (2) on four hangers (8).

To compensate the axial forces that arise both under working conditions as a result of interaction between the magnetic field and the plasma and also during transportation of the cryostat, the helium bath transmits the forces to the nitrogen bath through supports (6). The outer jacket carries the weight of both the helium and nitrogen baths through four supports (10). The relative position of the nitrogen bath and outer jacket is fixed by four tie rods (3). Between the end caps of the outside jacket and the ends of the helium bath are shields (9) that are fastened to the nitrogen bath and have a temperature close to 77 K.

To reduce the amount of liquid helium that is poured into the cryostat, the space between the SPMS-1 winding and the outer shell of the helium bath is filled with a foam plastic displacer. The evaporating helium is carried out of the cryostat through six current leads (5) made of copper tubes with diameter of 16×1.5 with perforations having a cross section of 3.5 and spacing of 25 mm. Of the six tubes, four are used as current lead-ins, and two as intermediate current lead-outs that connect the sections of the SPMS-1 winding to the protection system that operates under conditions when the system changes from the superconductive to the normal state.

The design of the cryostat provides for feeding the liquid helium into the helium bath above and below the SPMS-1 winding. The level of the liquid helium is monitored by feelers connected to display instruments and to a light-and-buzzer alarm system.

To ensure safety under conditions of transition of the SPMS-1 winding from the superconductive to the normal state, the helium bath of the cryostat is fitted with a safety valve and a breakable diaphragm.

Technical specifications of the cryostat

Overall dimensions, mm	
length	2500
outside diameter	1700
height	2400
Diameter of the hot zone, mm	300
Weight of the cryostat with the SPMS-1 winding and without coolant, kg	6000
Amount of liquid helium stored in the helium bath up to the working level, *l*	600
Time for depletion of helium to the minimum permissible level, hr	
with current	15
without current	5
Amount of liquid helium for cooling the SPMS-1 winding and the helium bath from 80 to 4.2 K, *l*	700
Volatility of the helium at I = 600 A, kg/hr	6
Volatility of liquid nitrogen, kg/hr	1.4

REFERENCES

1. "Vazhneyshyye resul'taty nauchno-issledovatel'skikh rabot 1975 goda" [The Most Important Results of Research in 1975], Moscow, Nauka, pp 74-77, 1976.

2. V. A. Al'tov et al., "Saddle-Shaped Superconductive Magnet System for an MHD Generator," ELEKTROTEKHNIKA, No 8, pp 2-4, 1976.

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RESERVOIRS CHANGE THE TEMPERATURE OF RIVERS

Moscow PRIRODA in Russian No 6, Jun 77 pp 92-95

[Article by T.V. Odrova, candidate of geographical sciences, Odessa Hydrometeorological Institute]

[Text] Every year there is an increase in hydraulic engineering construction in our country. Dams have been built and reservoirs have already been created on many of the large rivers in the European part of the USSR and Siberia. The main reason for creating reservoirs is to distribute river drainage uniformly. However, this also has the incidental side effect of changing other river regime characteristics: current speed, depth, periods of stable ice on the open water, water temperature, and so on.

To create reservoirs, GES dams alter regulated rivers into a series of lakelike sections that are of great depth and in which water exchange is retarded. In summer, therefore, the section of river below the dam receives colder water than it did before the dam was built; because of the large amount of water in the reservoir, it does not have time to warm up to the temperature that it previously attained. In fall, on the other hand, the water discharged from the reservoir is warmer than it was before the river was controlled, since a reservoir cools off more slowly than a river does.

In analyzing the effect of a reservoir on a river's regime, insufficient attention has been given to the change in the temperature conditions along the river's length. Since large reservoirs have been created mainly on rivers running from north to south (Dnepr, Volga), their temperature regimes have not exerted any substantial influence on the surrounding environment.

The situation is entirely different when a reservoir is created on a river running from south to north. The waters of the large Siberian rivers (Ob', Yenisey, Lena) carry a considerable

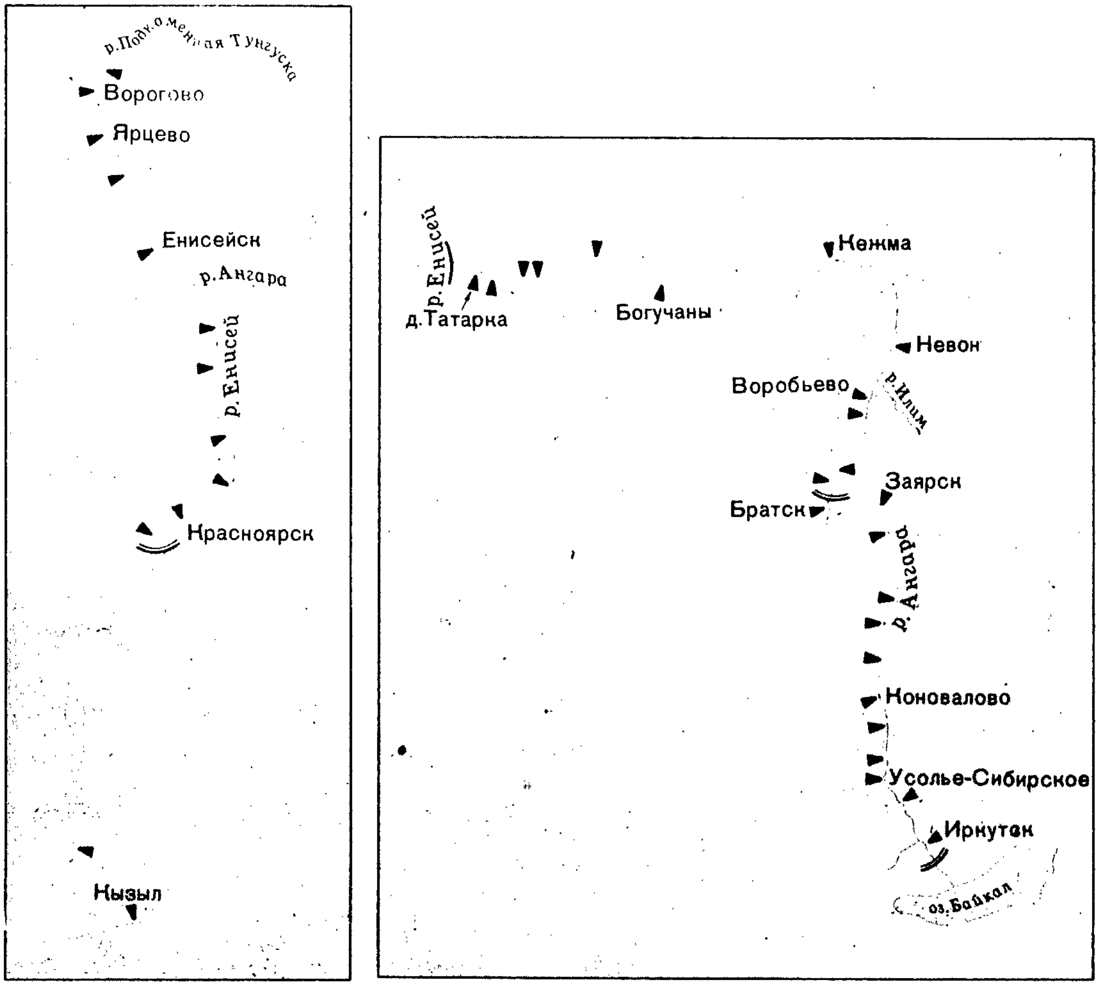
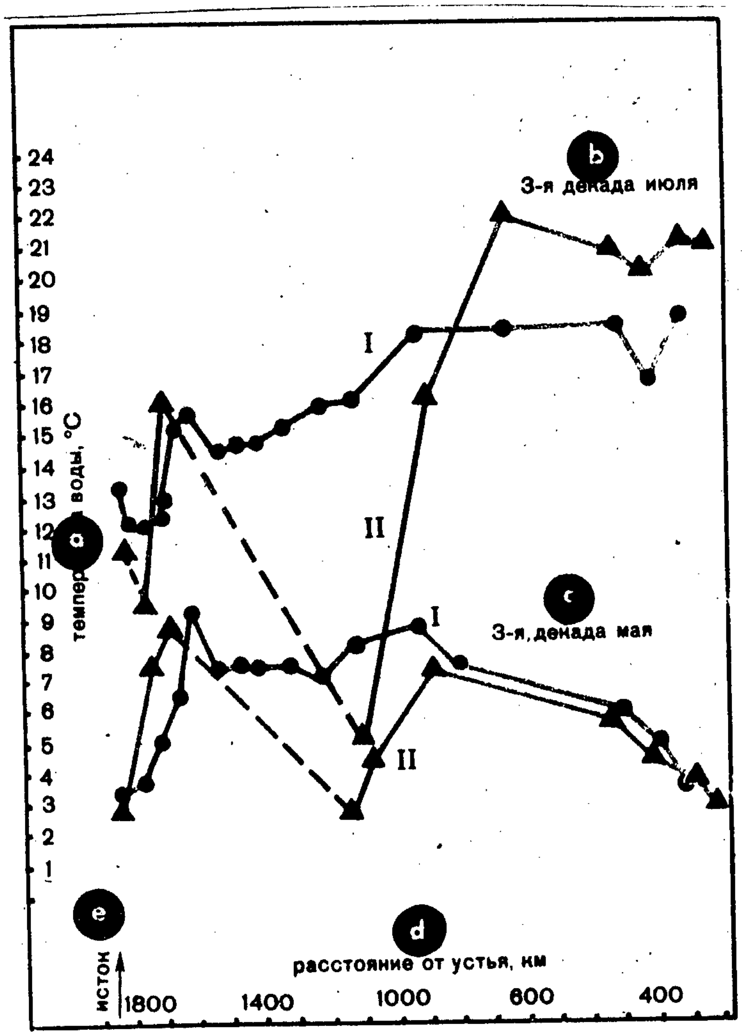


Diagram of location of water temperature observation points on the Yenisey and Angara Rivers: ► = observation points; ≋ = dams of operating GES's. Geographical features, lefthand map (from top to bottom): Podkamennaya Tunguska River, Vorogovo, Yartsevo, Yeniseysk, Angara River, Yenisey River, Krasnoyarsk, Kyzyl; righthand map (clockwise from top left): Yenisey River, Tatarka village, Boguchany, Kezhma, Nevon, Ilim River, Vorob'yevo, Zayarsk, Bratsk, Angara River, Konovalovo, Usol'ye-Sibirskoye, Irkutsk, Lake Baykal.

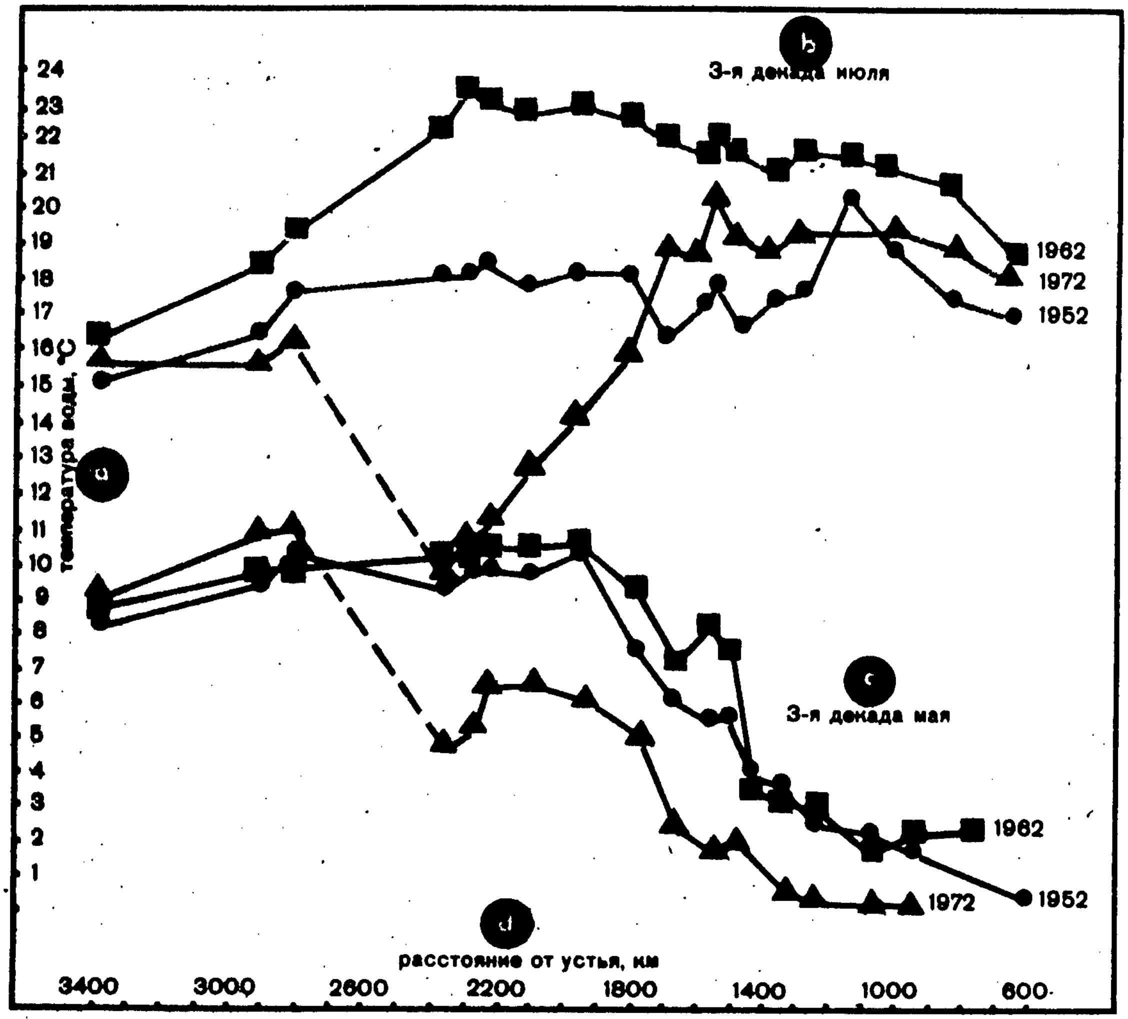
amount of heat to the north. This not only affects the microclimate of the regions along the rivers' banks, but also forms (to some extent) the ice and thermal regime of the part of the Arctic Ocean in the areas where these rivers enter it.

Right now, the most intensive hydraulic engineering construction in Siberia is being done in the Yenisey basin. The Angara



Distribution of average 10-day temperatures on the Angara in May and July: I -- before control (1952); II -- after control (1972); dotted line -- reservoir section.
Key: a. water temperature, °C; b. 21-31 July; c. 21-31 May; d. distance from mouth, km; e. source.

was spanned above Irkutsk at the end of 1956, and below Bratsk in September 1961. On the Yenisey, the Krasnoyarskaya GES has been in operation since 1967. Let us examine the changes that have taken place in the temperature regimes of these rivers in the period since the GES's have begun operating. It is necessary to mention that the conditions for the formation of the Angara's and Yenisey's temperature regimes are not identical. The temperature of the water in the Angara is the result of the



Distribution of average 10-day water temperature on the Yenisey from Kyzyl to Igarka in 1952, 1962, and 1972. Dotted line -- reservoir section.
Key: a. water temperature, °C; b. 21-31 July; c. 21-31 May; d. distance from mouth, km.

joint effect of weather conditions and the influence of the temperature of the water in Lake Baykal, which feeds the river. Lake Baykal has a permanent effect on the water temperature in the upper part of the Angara, lowering it beginning in early summer and raising it in fall and winter (in the section as far down as Bratsk).

The construction of the Irkutskaya GES had practically no effect on the Angara's temperature regime in the section from its source to Irkutsk, in which Lake Baykal's influence is extremely heavily felt. At Irkutsk, below the Irkutskaya GES's dam, the water temperature drops somewhat in May and then increases in June and July, because at the comparatively shallow depths in the reservoir, the slowly moving water has time to warm up more than it would in the Angara's natural channel, where the current is quite fast. Farther downstream, the Irkutskaya GES does not cause any changes in the temperature regime.

The construction of the Bratskaya GES, at the point on the Angara where Lake Baykal's influence ends and the river enters a colder region, caused a substantial change in the water temperature. Earlier, warmer water entered the Bratsk region along the river from the south. Now the water heating conditions have changed -- in summer, only the surface layer of the Bratskoye Reservoir can warm up. In the deeper part of the reservoir (its depth in the section just above the dam is more than 100 m) a temperature on the order of 4° or less is maintained. Therefore, cold water flows down the river from the reservoir, and the average 10-day water temperatures have dropped by $5\text{-}10^{\circ}$. The water temperature has dropped the most in the middle of the summer. The highest average daily temperatures in the period before the reservoir was created exceeded $20\text{-}22^{\circ}$ at Bratsk and during the filling period they still reached $15\text{-}16^{\circ}$, but after the reservoir's regime was settled they did not exceed 10°. In fall, when the water in the riverbed begins to cool off and water heated during the summer is released from the reservoir, the reduction in temperature is not great in comparison with the period before the dam was built -- it is only $2\text{-}4^{\circ}$ -- but in October the temperature is even higher than it was before the river was controlled.

The length of the section that is under the cooling influence of the Bratskoye Reservoir is 200-250 km. As the distance from Bratsk increases the water gradually warms up and in the area of Vorob'yevo village and Nevon settlement the water temperature is the same as it was before the erection of the GES.

At the present time, construction of the Ust'-Ilimskaya GES is being completed, near the settlement of Nevon. Its reservoir will receive water from the Bratskoye Reservoir with average monthly temperatures of 8° or lower that will have had no chance to warm up because the distance it travels between the reservoirs is too short. It is difficult to believe that the water heating conditions in the Ust'-Ilimskoye Reservoir, with depths near the dam of up to 90 m and a location that is even farther north, will be favorable. Below the Ust'-Ilimskoye Reservoir, therefore, the (average monthly) water temperature will hardly be higher than 8°. By analogy with the Bratskoye Reservoir, the length of the section falling under the reservoir's cooling influence can be on the order of 200 km. It is

Average Monthly Angara Water Temperatures

Май (1)	Июнь (2)	Июль (3)	Август (4)	Сентябрь (5)	Октябрь (6)
Иркутск, до сооружения плотины (1945 — 1956) (7)					
3,4	5,6	7,1	10,9	9,4	6,5
после сооружения плотины (1957 — 1973) (8)					
2,9	7,2	8,4	10,7	10,0	6,4
Братск, до сооружения плотины (1952 — 1959) (9)					
нет данных (10)	15,3	18,7	17,2	11,0	3,1
после сооружения плотины (1965 — 1973) (11)					
2,3	3,8	4,8	5,7	7,8	5,8

Key:
1. May
2. June
3. July
4. August
5. September
6. October
7. Irkutsk, before construction of dam (1954-1956)
8. After construction of dam (1957-1973)
9. Bratsk, before construction of dam (1952-1959)
10. No data
11. After construction of dam (1965-1973)

necessary to mention that this is the part of the Angara in which the temperature had previously increased. Thus, water with a lower temperature than is now the case will reach the Angara's mouth.

The future construction of the Boguchanskaya GES, with a somewhat shallower reservoir but which is located in a colder region, will cause the heating conditions for the Angara's water to deteriorate even further, and the Yenisey will be deprived of the considerable amount of heat that it now receives along with the Angara's water. This can be reflected unfavorably not only in the temperature of the Angara's and Yenisey's water and their ice regimes, but also in the microclimate of the surrounding territory.

The conditions for the formation of the Yenisey's temperature regime are somewhat simpler than those for the Angara: the direction of its flow -- almost strictly south to north -- means that it carries warmer waters to colder regions and that there is a smooth and gradual change in water temperature along the length of the river.

Before the Yenisey was controlled, the water temperature increased from its headwaters (in a mountainous area) to its middle reaches. The water warmed up most of all in the section between Krasnoyarsk and Yeniseysk (2,462-2,054 km from the mouth). Downstream, the water temperature was almost constant for some distance, but near Igarka (697 km from the mouth) it fell because of the river's entry into a colder region. This type of water temperature change is maintained along the length of the Yenisey throughout the warm period, with only the temperature difference changing. It was highest during the heating period (8-10°) and less during the cooling period (5-6°).

After the river was controlled, the water temperature dropped abruptly (especially during the spring and fall) in the section directly below the Krasnoyarskaya GES (near the city of Krasnoyarsk). While the maximum water temperature at Krasnoyarsk reached 23.8-24.8° before the construction of the GES, now it does not exceed 14.8°.

As the distance from the reservoir increases the water warms up, and in the area of Yartsevo and Vorogovo settlements (1,774-1,660 km from the mouth), the reservoir's cooling effect is almost unfelt during the period of maximum heating. In spring, however, when cold winter water flows from the reservoir into a colder region, it warms up more slowly than it did before the river was controlled. During the fall, water warmed during the summer that has not yet had time to cool off is discharged from the Krasnoyarskoye Reservoir, so that the natural temperature pattern is not disrupted as much.

Thus, the Krasnoyarskoye Reservoir's effect changed the Yenisey's temperature regime in the section from the dam to the confluence with the Podkamennaya Tunguska River. The Angara enters the Yenisey at about the middle of this section and approximately doubles the Yenisey's size when they converge. As was mentioned above, after the completion of the chain of GES's on the Angara, there should be a reduction in the temperature of the water that it contributes to the Yenisey. All of this will unfavorably affect the Yenisey's water temperature and reduce the amount of heat that it carries to its mouth.

The changes in the Yenisey's and Angara's thermal regimes make it possible to assume that the final completion of the hydraulic engineering construction projects on the Yenisey will sharply reduce the magnitude of its heat discharge and change the Yenisey valley's microclimate.

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

ACADEMICIAN ADYSHEV DISCUSSES DEVELOPMENT OF SCIENCE IN KIRGHIZ SSR SINCE THE REVOLUTION

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 24 May 77 p 3

[Article by Musa Adyshev, vice president of the USSR Academy of Sciences: "Stages of Growth"]

[Text] Vice president of the Academy of Sciences, academician of the Kirghiz SSR AS Musa Adyshev answers questions of the correspondents of SOTSIALISTICHESKAYA INDUSTRIYA.

The starting mechanism clicked, and a ghastly pale light struck the aperture of the plasmotron's casing. Even through the glass of the protective goggles two streams of unendurably bright flames are visible. Flowing together, they form a plasma flow with a temperature of 15-20 thousand degrees.

The double-stream plasmotron DGP-50 was constructed and developed by a collective of the atomic spectroscopy laboratory of the Kirghiz SSR AS Institude of Physics and Mathematics under the direction of doctor of physical and mathematical sciences, professor Zh. Zheyenbayev and candidate of physical and mathematical sciences V. Engel'sht. His original construction advantageously differs from analogous apparatus in many ways. It has a prolonged lifetime of uninterrupted performance, it is easy to operate, and it is probably useful for welding in the medium of gas envelopes, in plasmochemistry, in plasma metallurgy, the cutting of metals and so on. But, very likely, the most predominant advantage of the plasmotron under consideration consists in the fact that one can quickly and with high precision conduct a spectral analysis of any material on it. Until now, for example, in order to detect the low concentration of an alloy in any substance in industrial conditions, sometimes it was necessary to process the specimen 25-50 times. With the aid of the plasmotron DGP-50 this is done many times more quickly and precisely. Even a one hundred-thousandth fraction of a percent of any alien alloy does not evade the apparatus. The creation of plasmotrons is the unquestionable success of young Kirghiz science.

How was that science developed? What were the stages of its development during the years of Soviet power?

I will begin from the present day said Musa Mirzapayazovich. In the Kirghiz SSR there are 65 scientific institutes, in which around 8 thousand scientists work. Of these 2,400 are doctors and candidates of the sciences. In a friendly, unified family representatives of 50 nationalities of our native country solve the important problems of the development of science. And all of this is the fruits of Great October, since prior to the revolution there was not a single scientific institute. For 60 years with the fraternal aid of other peoples of the country our republic made an unprecedented leap from a patriarchal-feudal way of life to progressive science.

Looking back on the path covered, we with gratitude remember those who stood at the outflows of the development of science in Kirghiziya: first of all the most prominent Russian scientist-academicians Komarov, Skryabin, Shcherbakov, Smirnov; member-correspondents of the USSR Academy of Sciences Saukov, Nikolayev; professors Shcherbin, Vol'fson and many others. They made an invaluable contribution to the preparation of the national scientific framework and to the determination of the chief direction of the development of science in the republic.

In 1932 the Academy of Sciences of the country chanelled into Kirghiziya 250 prominent scientists who formed part of a complex expedition in the study of the productive forces of the republic. Thus began the assimilation of the natural wealth of Kirghizstan. Later, more than 300 expeditions were organized which detected and brought into industrial use deposits of mercury, antimony, rare and non-ferrous metals. During the terrible war years the Kirghiz branch of the USSR AS was created, which was later reorganized into the Academy of Sciences of the Kirghiz SSR. At present the system of the Kirghiz academy includes 16 scientific-research institutes.

Along what basic directions does the science of Kirghiziya develop, to what problems is the main attention concentrated?

The circle of scientific interests is vast. In the field of mathematics--it is the integral-differential equations; in physics--the physics of solid matter, the physics of plasma, crystal physics, several questions of astrophysics and astronomy, the development of physical methods for the analysis of matter; in the field of mining sciences--development of theoretical bases and creation of fundamentally new mining equipment, study of the conditions of mountain rocks in regions of construction of large-scaled hydraulic engineering structures, new methods for the recovery of deposits of useful minerals.

Calculating the needs of the republic's industry and agriculture, scientists actively work on the operational automation of industrial processes, conduct extensive research in the automation of irrigation systems. Scientists of the institute of geology are occupied with the study of the earth's core in the Tyan'-Shan'skiy region and with the research into the regularity of formation and concentration of various types of useful minerals in the territory of Kirghizstan.

Biologists study the animal and plant world, the possibilities of improving livestock thoroughbreeding and the yields of agricultural cultivation, and they create new kinds of diverse cultivation. These are only the basic directions of the work of our academy's institutes. Furthermore, scholars of other scientific institutes of the republic are occupied with the extremely urgent research of the history, philosophy, law, language and literature, economics and disposition of the productive forces of Kirghiziya.

There probably are scientific directions, the study of which is conducted jointly by scientists of fraternal republics and the USSR Academy of Sciences?

Our Soviet science is strong by nature of the fact that it is international, that the most diverse scientists have strong creative ties and constant business contacts. I will take up a series of examples.

It is known that the Mid-Asian region is seismically dangerous. So, all the necessary research in that direction is conducted according to a unified program by the scientists of Uzbekistan, Kirghizstan, Tadzhikistan, Moscow. The Kirghiz SSR AS Institute of Geology conducts its thematic labors in conjunction with the scientists of the USSR AS Geological Institute, geographers study all the objects of Tyan'-Shan' in collaboration with the USSR AS Institute of Geography and the geographical faculty of Moscow State University.

According to a unified program in conjunction with the academies of sciences of all central-Asian republics several large-scale regional problems are being worked out, for example the study of deserts, mountains and the plant world.

Many of the labors of Kirghiz scientists have received widespread publicity in our country and abroad. This has predetermined for them links and contacts with scientists of the member-countries of CEMA as well as with a number of capitalist governments. So, the experiment of automating irrigation facilities, which was accumulated by our scientists and widely used in Azerbaydzhan, Kazakhstan, Uzbekistan and other republics, is studied by specialists of Hungary, Bulgaria, Poland, GDR and the U.S.A.

To what extent does the science of the republic exert an influence on production?

The development of fundamental science in the most intimate manner is connected with the national economy of Kirghiziya and its productive forces. One can isolate several trends which are called into being by the specifics of the national economy and the requirements of production. There is research in the field of the mining industry which is directed to the study and introduction of new methods of technology for the development of layers of useful minerals as well as for their rational use; the creation and construction of more complete mining techniques with various functions; the creation of automated systems of operation for production.

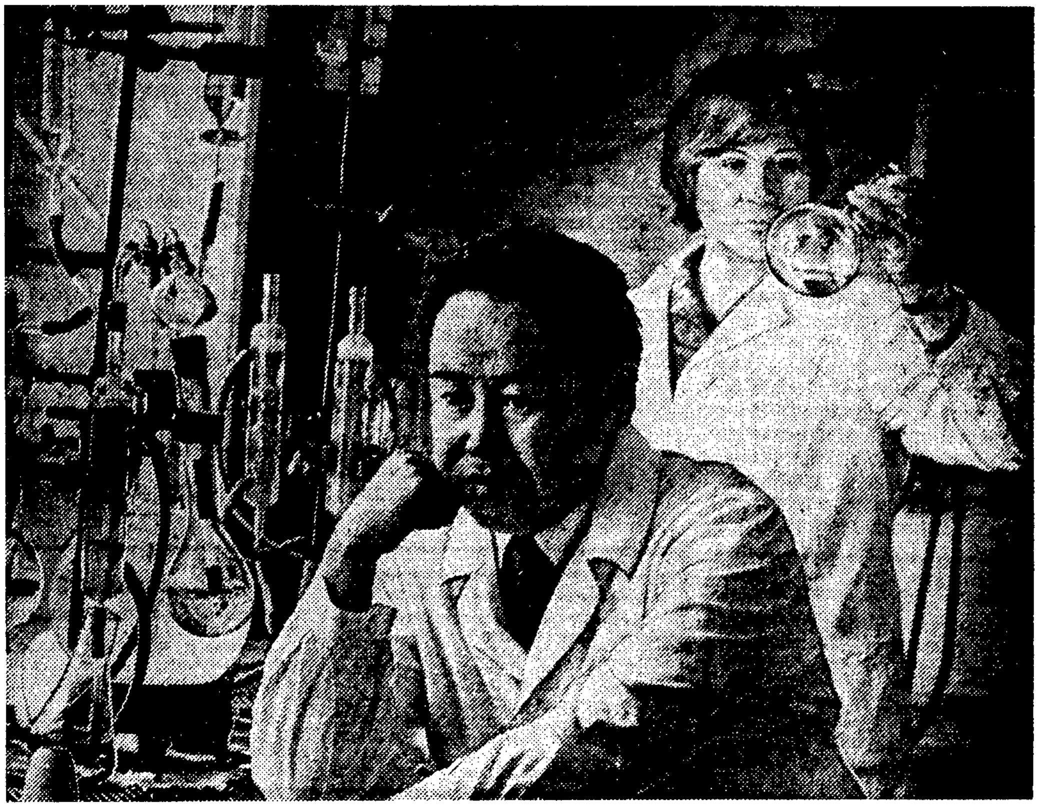
More than 160 proposals developed by the best scientists of Kirghiziya were realized in the national economy from 1971 to 1976 alone. By way of illustration, the balance of the earth's rare elements is compiled by the Institude of Geology for the Kirghiz mining-metallurgical combine. This made it possible to increase the extraction of useful components from ore by 15 percent. The annual economic effect of this amounts to 350-400 thousand rubles. The realization of the recommendations of scientists on the use of felsite-prophyric rocks in the capacity of mineral additive during the production of cement gives daily an economic effect of 450 thousand rubles with respect only to one Kantskiy cement-slate combine. To this figure one can add one more of 288 thousand rubles--this is the effect from the introduction into operation of the first phase of ASUP out of seven sybsystems worked out by co-workers of the Institute of Automation in collaboration with specialists of the combine.

The collective of the Institute of Physics and Mathematics have conducted interesting work on the automation of a control system for the harvesting of sugar beets. The application of economic-mathematical methods made it possible to reduce the loss of sugar per season approximately by 18 thousand hundredweight through the preservation and treatment of the beet.

Even these few examples graphically demonstrate the contribution of our scientists to the economics of the republic.

The principles of harmonious development of science and the national economy, which originated from the decisions of the 25th Union of the CPSU, lie at the base of the scientific research of the Kirghiz Academy of Sciences.

The scientists of the republic are prepared to greet the 60th anniversary of Great October in the proper manner.



Member-correspondent of the Kirghiz SSR AS, doctor of chemical sciences, professor Kakin Sulaymankulov manages the chemistry laboratory of nitrous compounds of the Institute of Inorganic and Physical Chemistry of the republic's Academy of Sciences.

In the photo: K. Sulaymankulov and a younger scientific co-worker N. Kipkalova.

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