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CENTRAL INTELLIGENCE AGENCY

# SCIENTIFIC INFORMATION REPORT



18 March 1960

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PLEASE NOTE

This report presents unevaluated information extracted from recently received publications of the USSR, Eastern Europe, and China. The information selected is intended to indicate current scientific developments and activities and is disseminated as an aid to research in the United States.

SCIENTIFIC INFORMATION REPORT

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I. BIOLOGY

1. Animal Adaptation Discussed

"On the Process of Adaptation to New Conditions of Existence in Free and Parasitic Life," by Ye. N. Pavlovskiy, Zoological Institute, Academy of Sciences USSR; Moscow, Zhurnal Obshchey Biologii, Sep/Oct 59, pp 329-343

The author of this article discusses in detail the ability of living organisms to adapt themselves to material factors and to surrounding conditions. Since the external environment can be altered and since evolutionary processes are irreversible for living organisms which become adapted to special environmental conditions, specific species become doomed to extinction.

All living things are exposed to certain factors which vary; they are adapted for a mode of life characteristic of their kind, under characteristic environmental conditions. They receive from previous generations a heritage that equips them for the mode of life to which they are born; physiological, biochemical, cytological and all other characteristics in the hereditary complex which are of use are modifiable and adaptive. The complexity and modifiability of organisms depend on the biotic and abiotic factors of their environment and habitat.

The author of this article discusses the research in cytophysiology by B. P. Ushakov, A. D. Braun, N. M. Nesvetayeva, N. V. Fizhenko and others at the new Institute of Cytology, Academy of Sciences USSR. D. N. Nasonov is the director of this institute, which formerly had the status of a Cytological Laboratory in the Zoological Institute, Academy of Sciences USSR. The experiments discussed in this article were conducted on lacustrine frogs and herbal frogs.

The author considers a new factor in the evolution of living organisms. Environmental conditions are being changed by man, who has freed nuclear energy. Pavlovskiy deplors the danger of increased radioactivity.

When atomic bombs are exploded, radioactive strontium falls into the stratosphere, but does not remain there, but slowly drops to earth, enters the water, and covers vegetation. Strontium enters the organisms of animals and people when they consume this water and vegetation. The amount of radioactive fallout increases when atomic energy is used. F. Gerchik stated that everyone's organism contains radioactive strontium.

A new science -- radiobiology -- has arisen in recognition of the fact that radiation emitted by radioactive substances merits special attention. The job of radiobiology is to investigate the effects of

ionizing radiation on human and animal organisms and on vegetation. It is important to know how radiant energy influences the cellular (protein) substrate of the organism. Radiation may be absorbed and may become an integral part of the organism, and can result in damage to the bone marrow. This, in turn, may lead to leukemia and to disruption of normal hemopoiesis; osseous tumors may develop when osseous tissues absorb increased doses of radiation. Several small doses of radiation absorbed by developing sex cells may change the pathological make-up of the progeny.

Several small doses of radiation become stored within the organism. The consequences of accumulation emerge in time in the form of general disturbances in physiological development such as a decrease in the average weight of the newborn, retardation in mental development, shortening of the average life expectancy of an individual, and malignant leukemia.

A special UN committee reported that strontium accumulates in the bone marrow in such large quantities that it may be considered a danger to health. This report is of world-wide significance.  $Sr^{90}$  and  $C^{14}$  is absorbed by plants and through them enters the human and animal organism. This, the article states, is connected with the theoretical problem of the evolution of animal organisms on earth and with the future of mankind.

## II. CHEMISTRY

### Electrochemistry

#### 2. Electrolytic Transfer in Molten Cobalt Silicates

"Electrolytic Transfer in Molten Cobalt Silicates," by O. A. Yesin and G. A. Teterin, Institute of Metallurgy, Ural Affiliate, Academy of Sciences USSR; Moscow, Zhurnal Fizicheskoy Khimii, Vol 33, No 12, Dec 59, pp 2748-2754

With the aid of the radioactive tracer method it has been shown that in  $\text{CoO} - \text{SiO}_2$  melts containing up to 60%  $\text{CoO}$  the transfer of electricity with respect to oxygen anions is accomplished mainly by cobalt rather than silicon cations. Experimentally it has been found that there is a smoother drop in the values of the cobalt transference numbers with increasing cobalt concentration than that observed by Baak. This drop has been explained as due to increase in the share of electronic conductivity.

The decrease in value of the cationic transference number in cobalt silicate melts has been found to begin at a lower  $\text{MeO}$  content than in the case of iron silicates. This is explained by the considerably lower mobility of the cobalt in comparison with the iron cations.

### Fuels and Propellants

#### 3. Combustion of Solid Fuels in Contact With Solid Oxidizers

"Limiting Cases of the Combustion of Solid Fuel-Oxidizer Mixtures," by N. N. Bakhman, Institute of Chemical Physics, Academy of Sciences USSR; Moscow, Doklady Akademii Nauk SSSR, Vol 129, No 5, 11 Dec 59, pp 1079-1081

The combustion of mechanical mixtures of a solid fuel with a solid oxidant depends on the particle size. It is important to determine the asymptotic relationships for very large and very small particle sizes. The limiting case of interaction between very large particles of fuel and oxidant is represented by a system in which half of the space is occupied by a single piece of fuel and half of the space by a single lump of oxidant.

Experiments have therefore been carried out with cylinders and flat blocks of plexiglas functioning as fuel into which oxidizers were pressed in the form of rods or plates. Potassium chlorate, potassium perchlorate, potassium permanganate, and barium peroxide were used as oxidizers. The



original thickness of the plexiglas was greater than that of the layer of this material which burned out during the course of the experiment. The charge was ignited with a nichrome spiral inserted at the boundary between the plexiglas and the oxidizer. After a short initiation period, a constant velocity of flame propagation was established. During combustion a conical hollow space usually forms which becomes larger as the flame propagates. A photo method was used for recording the velocity of the propagation of the flame. The velocity of propagation was measured along the boundary separating the fuel from the oxidant as a function of the characteristic dimension  $d$  of the layer of oxidizer, the pressure  $p$  of the inert gas (nitrogen) which was used, and the relative density  $\delta$  of the oxidizer.

It was established that with increasing magnitudes of  $d$ , the velocity of the flame approaches a limit. Experiments were also carried out in a steel cuvette which had a plexiglas front wall. When the layer of oxidizer is not too thin, a cuvette of this type may serve as a model of a system with infinitely large particles. With increasing thickness of the layer of oxidizer in the cuvette, the velocity of flame propagation  $v$  first increases (because of reduction of the quantity of heat lost by conduction into the steel) and then remains practically constant reaching a limit which corresponds to  $d \rightarrow \infty$ . The fact that  $v$  does not depend on  $d$  at sufficiently large values of  $d$  indicates that  $v$  is determined essentially by conditions existing in the vicinity of the tip of the hollow space which forms as a result of combustion.

It was established that the propagation of the flame along the boundary plexiglas-oxidizer depends on the chemical nature of the oxidizer. Not all oxidizers support combustion in the system described, although from the thermodynamic standpoint they may be capable of doing so. The dependence of  $v$  on  $p$  varies with the type of oxidizer. With  $KClO_4$  the dependence is linear; with  $KClO_3$  the rate of increase is greater than that corresponding to a linear relationship; with  $KMnO_4$ ,  $v$  practically does not depend on  $p$  in the range of 5-100 atmospheres; with  $BaO_2$  there is a maximum velocity of flame propagation (at sufficiently high values of  $p$ , no combustion takes place with this oxidizer). The dependence of  $v$  on the relative density of the oxidizer was investigated. It was established that at low pressures  $v$  does not depend on  $\delta$  for  $KClO_4$  within the range of  $\delta = 0.5-0.9$ . However, at high pressures and consequently also high velocities of the flame, the magnitude of  $v$  increases rapidly with decreasing  $\delta$ . The product  $v\delta = f(\delta)$  has a maximum. This difference can be explained by the fact that at a sufficiently high velocity of combustion the heat transfer by convection from combustion products penetrating into the depth of the oxidizer begins to play a significant role. This penetration is facilitated at small values of  $\delta$ , but at sufficiently small values of  $\delta$ , the loss of heat by conduction into the walls begins to play a part.

A limiting velocity of flame propagation is characteristic only for systems with a continuous boundary separating the reacting substances. In systems with a random distribution of particles and discontinuous boundary, combustion stops when the size of the particles exceeds a certain critical value, because contact between individual particles of the reacting substances become too difficult.

The rate of combustion increases with diminishing particle size. However, when both reacting substances are volatile, the effect in question is not very great. Reduction of the velocity of combustion with decreasing size of particles will take place only until the width of the zone in which the vapors of the reacting substances mix, i.e.,

$l_{mix} \sim u_{vapor} d^2 / D_{vapor}$  (where  $D_{vapor}$  = the coefficient of diffusion), becomes smaller than the width of the zone of heating of the corresponding homogeneous mixture of the vapors. The curve expressing the relationships between the velocity of combustion and the particle size has an S-shape for systems with a continuous boundary between the fuel and oxidizer but develops a plateau in the case of systems composed of small, randomly distributed small particles. At a sufficiently large size of particles this plateau comes to an abrupt end.

#### 4. Solidified Liquid Gas Fuel Developed in USSR

"Solidified Liquid Gases," by V. I. Losev; Moscow, Gazavaya Promyshlennost', Vol 4, No 12, Dec 59, pp 17-24

The Institute of Mineral Fuels, Academy of Sciences USSR, in collaboration with workers at the Groznyy Petroleum Cracking Plant, developed a method for the conversion of liquid fuels and liquefied gases of the propane-butane fraction into solid briquettes which can be transported over long distances and stored conveniently. The solidified fuel briquettes contain 90-95% by weight of liquid fuel or liquefied gas fuel. The solidified fuel briquettes can be wrapped in paper and transported in this state in open trucks. They can be stored in the open air both during the summer and winter. Their use affords greater safety with respect to the danger of fire. They withstand extremes of temperature encountered in the USSR from a summer heat reaching 50-60° C to the very low temperatures common in some regions of the USSR.

Fuel of this type is acquiring increased importance in the economy of the USSR. This refers particularly to solidified gasoline. A considerable economy is achieved because no containers are required for the transportation of gasoline briquettes; consequently metal used as a material for such containers is saved. Furthermore, a saving results because trucks on which solidified fuel is shipped can be used for the transportation of other goods back to the point of departure. This cannot be done

in the case of tank cars shipping liquid fuel. Thickening of liquid fuel with soaps of the aluminum stearate type was applied at one time. Procedures employing aluminum naphenates were developed in the USSR by A. P. Ionov in work done in collaboration with Academician P. A. Rebinder, who acted as a consultant. The procedures developed were perfected at the Institute of Physical Chemistry, Academy of Sciences USSR, in work done by A. A. Trapeznikov and N. A. Bakh. Information on methods for the production of thickened (gelatinized) fuels of the napalm type was published lately.

Although all of these methods proved to be applicable from the practical standpoint, other procedures which satisfy to a greater extent present-day technological requirements had to be developed. It was important to devise methods by which liquid fuels can be converted into a product which exhibits all properties of a solid, while the fuel still remains in the liquid phase. In 1949-1950, results were published on procedures for the solidification of liquid gasoline based on research done by workers at the Anglo-Iranian Petroleum Company. Work was conducted at the Seaweed Institute in Arkhangel'sk on the use of sodium alginate ( $\text{Na C}_6\text{O}_6\text{H}_7$ ) for the production of solidified foams. In 1950, results were published on the encapsulation of liquid hydrocarbon fuels within minute spheres consisting of alginate.

In 1939-1940, Tomskiy and Fayntsimer developed a procedure whereby highly concentrated emulsions of hydrocarbons containing proteins as a protective colloid are solidified by tanning with formaldehyde. This method is in many respects superior to those developed outside the USSR. In addition to being suitable for the solidification of gasoline, kerosene, and other petroleum fuels, this method can be applied for the solidification and conversion into briquettes of vegetable oils, some medicinal substances, and gases of the butane type. However, briquettes containing protein (casein) could not be stored for a long time, so that further research of suitable emulsifying agents was conducted in the USSR. Water-soluble resins such as polyvinyl alcohol and urea-formaldehyde were tried. On the basis of work conducted by the author of this article and M. A. Troyanskaya at the Academy of Sciences USSR since 1950, the simultaneous application of several emulsifying agents, including urea-formaldehyde resin, polyvinyl alcohol, and casein, was proposed. The finished briquettes, which are supplied in three sizes and have a weight of 800, 400, or 200 grams, are coated with a solution of polyvinyl alcohol. They are packed in kraft paper and then placed in light wooden crates.

Experiments on the storage of solidified petroleum products under field conditions and in storage buildings for periods of several years at different temperatures and under different atmospheric conditions were carried out. It was established that solidified gasoline buried in the ground remains unchanged for many years. Solidified fuel briquettes can be stored in the open throughout the year without significant losses of fuel. Briquettes that were not packaged or covered could be kept

submerged in sea water or river water for 4 years. On being kept under water, the briquettes underwent some deterioration; after the briquettes were dried, the fuel had to be regenerated speedily from them.

Unpacked briquettes could be kept in heated or unheated storage buildings for many years without any appreciable losses of fuel from them.

Solidified hydrocarbons were used very successfully in the Antarctic at the Pionerskaya, Sovetskaya, Komsomol'skaya, Mirnyy, and Vostok-1 stations. It was established that application of the briquettes ensures reliable operation of heating devices at temperatures of the external air temperatures down to minus 81° C. Under these conditions, a normal temperature of 20° C can be maintained in the huts and buildings. Solidified hydrocarbons are irreplaceable for the heating of fuel and oil used on tractor sled trains which operate under polar conditions at very low temperatures. This was established at Mirnyy.

[SIR Note: No technical information on the production of solidified liquid gas fuels or the recovery of the fuel from them is given in the text of the article. However, Figures 7, 11, and 12 taken from the article, which are reproduced below, give some information. In addition, there is a line drawing of a portable device for the intermittent recovery of small quantities of liquid gas from briquettes (Figure 3, p 18). This device, which is operated manually, supplies fuel for a small gas-heated plate (Figure 4, p 18). Figure 6 (p 19) represents a device for the continuous recovery from briquettes of gaseous fuel to be burned in an automotive vehicle motor. This device is stated to be an automobile regenerator of the NATI (Scientific Research Institute of the Automobile and Tractor Industry) design.]

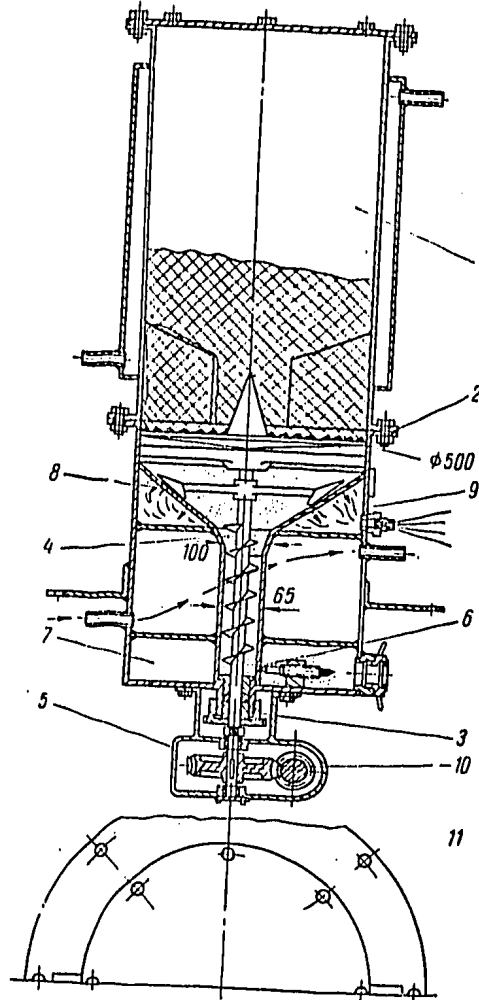


Figure 7. Equipment for the Recovery of Liquified Gas From Solidified Liquid Gas Fuel; (1) bunker for solidified gas, (2) flange connecting bunker with cutting appliance, (3) thrust bearing of shaft, (4) screw press, (5) reduction gear box, (6) outlet for solid residue, (7) space for solid residue, (8, 9) outflow of liquified gas, (10) reduction gear, (11) plan view

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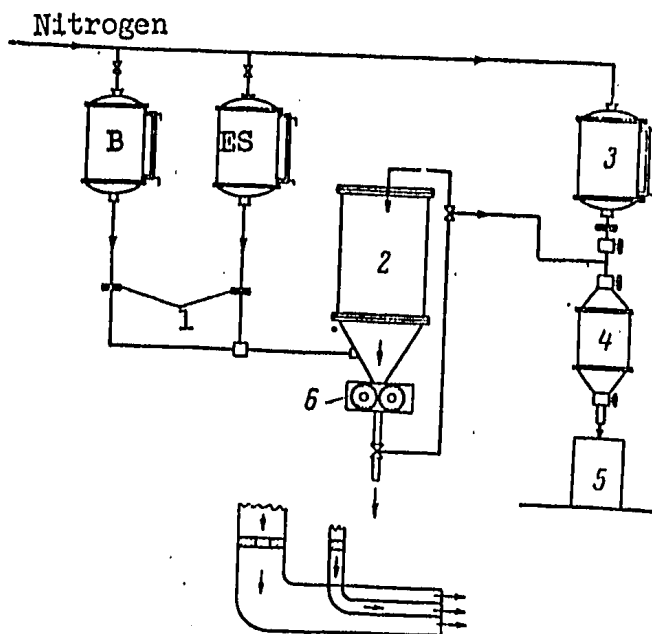


Figure 11. Flowsheet of Process for the Batch Production of Solidified Gas; (1) control of the flow of liquid ethane and emulsifiers coming from the containers B and ES, (2) intermittently operating unit with gear pump to bring about circulation of liquid, (3) vessel for  $\text{CH}_2\text{O}$  used as solidifier, (4) equipment for mixing the liquid with the solidifier, (5) mold with hermetically closing cover

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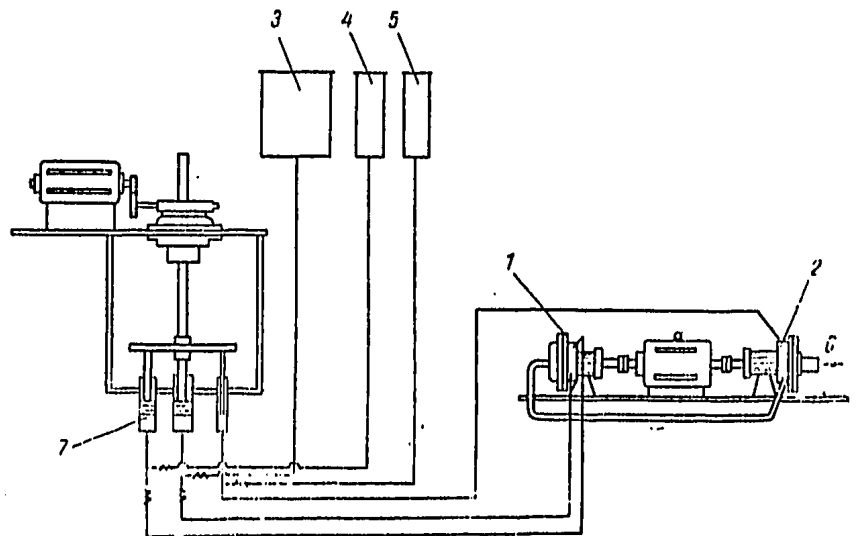


Figure 12. Flowsheet of Continuous Process for the Production of Solidified Gas; (1) disk emulsifier, (2) disk solidifier of emulsion, (3) container for liquified gas, (4) container for emulsifier, (5) container for solidifier of emulsion, (6) nipple outlet for finished product, (7) flow controllers

5. Rumanian Journal Reports New Soviet Rocket Fuels Capable of Producing Thrust Four Times Greater Than That Achieved Hitherto

"The Absolute Science of Space and Soviet Cosmic Research,"  
by Endre Weiszmann, University Instructor at Cluj; Cluj,  
Korunk, Jan 60, pp 18-27.

This article is one of three on Janos Bolyai in an issue commemorating the 100th anniversary of his death. The philosophical implications of non-Euclidean geometry are glossed over in the article, which touches on Einsteinian relativity only insofar as relativity of motion has a bearing on the problems of computing interplanetary space vehicle trajectories. The bulk of the article is devoted to a review of Soviet rocket experiments. Noting that the photographing of the back side of the moon closed the first period of space research and quoting Leonid Sedov, the author asserts that three problems must be solved to ensure

success in the second period: electronic equipment must be perfected; suitable rockets must be designed; and suitable guidance equipment must be built. Citing the success of the moon rockets, the author says that the first problem can be considered solved.

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He continues: "Nor is solution of the second problem impossible for the Soviet researchers. They have already proven how far advanced they are with respect to chemically propelled rockets. According to the most recent reports [Weissmann's article is dated 31 December 1959], Professor Anonov has successfully carried out experiments with engines operating on beryllium, aluminum, and magnesium suspensions. The use of metal suspensions, i.e., finely subdivided light metals suspended in hydrocarbons, ensures that four times the thrust achieved hitherto is produced. This makes possible the operation of maneuverable and compact high-powered rockets, which are ideal for interplanetary flights. For almost a year, dispatches have been published at frequent intervals in the Western press to the effect that work on a prototype of a rocket propelled by nuclear power is being conducted on an experimental basis in the Soviet Union. Most recently, L. Barnier, a French journalist who just returned from the Soviet Union, gave out some data on the Soviet nuclear propulsion rockets. Thus, we can assume that the second problem is solved."

In discussing the third problem, that of interplanetary navigation, the author returns to Bolyai and Einstein and includes a discussion of the red shift and the expanding or pulsating universe.

The author asserts that it is not likely that a human landing on the moon will be the next step in space research -- referring to problems of return and the "radiation prison in which we live." The author gives priority to fundamental physical research.

An editor's footnote calls attention to the 20 January 1960 Tass communique on the most recent Soviet rocket experiments as proof of the correctness of the author's statement regarding the beginning of the second period of space research.

6. Heavy Crude Suitable for Production of Oil Stable at Low Temperatures to Be Extracted From Petroliferous Sandstone

"Production of Crude Petroleum by Open-Pit Mining" (unsigned article); Moscow, Promyshlenno-Ekonomicheskaya Gazeta, Vol 14, No 12 (620), 29 Jan 60, p 4

The Ural State Institute of Mine Planning and Designing is working on a project of the first open-pit mine for the production of crude petroleum to be operated in the USSR. This gigantic open-pit mine will be located at the unique Yaregsk Oil Field in the Komi ASSR. Valuable heavy



petroleum crude is produced there which is used as raw material for the manufacture of oils that are stable at low temperatures. By using ordinary methods, one can extract only about 5% of the crude at this field. The principal part of the crude petroleum, which has penetrated into sandstone, remains in the ground. For this reason, it has been decided to mine the valuable crude together with the rock of which the ground is composed by using the open-pit mining method. The construction which has been planned is of huge dimensions. The initial depth of the pit will be 150 meters, its length 2 kilometers, and its width one kilometer. In the future the dimensions of the pit will be several times as great.

The project worked out at the institute foresees two variants of mechanical operations at the mine. According to one variant, the excavation of the ground rock impregnated with petroleum will proceed by means of heavy rock excavators. Self-propelled 95-ton dump cars will be used for transporting the rock. According to the other variant of the project, multibucket excavators with a greatly reinforced cutting action will be applied. The excavated ground will be transported from the pit on a belt conveyor. Next to the open-pit mine a high-capacity enrichment plant will be constructed, at which petroleum will be extracted from the sandstone.

#### 7. Pressure in Hydrocarbon Gaseous Phase Oxidation

"On the Part Played by Pressure in the Gaseous Phase Oxidation of Hydrocarbons," by A. S. Badrian, N. S. Yenikolopyan, and M. S. Furman, State Institute of the Nitrogen Industry, Institute of Chemical Physics, Academy of Sciences USSR; Moscow, Zhurnal Fizicheskoy Khimii, Vol 33, No 12, Dec 59, pp 2687-2696

The effect of pressure and temperature on the oxidation of a propane-air mixture of the composition:  $C_3H_8$ -50 mole %,  $O_2$ -3 mole %, and  $N_2$ -47 mole % has been investigated. Runs were made at 5, 10, and 15 atm and 325, 350, and 375° C under flow conditions and short durations (4-8 sec) of the gaseous mixture in the reaction zone.

The relative hydroperoxide (or acetone) yield has been shown to increase linearly with the pressure of the reaction mixture and to fall with increasing temperature, the temperature coefficient amounting to about 10 kcal.

The relative alcohol yield  $\alpha$  has also been shown to increase with the pressure (or hydrocarbon concentration) and fall with rise in temperature. The dependence of  $\alpha$  on the pressure is depicted by a curve asymptotically approaching the value  $\alpha = 1$ .

The ratio of ethyl to methyl alcohol formation has been found to be practically independent of the pressure of the reacting mixture or hydrocarbon concentration. The relative fraction of ethyl alcohol grows with rise in temperature.

The relationships established are explained on the basis of competition of elementary reactions with change in pressure and temperature.

#### 8. Kinetics of Chain Reactions

"Effects of the Rate of Generation of Active Centers on the Kinetics of Chain Reactions With Degenerate Branching and Quadratic Breaking," by D. G. Knorre, V. L. Pikayeva, N. M. Emanuel', Institute of Chemical Physics, Academy of Sciences USSR; Moscow, Zhurnal Fizicheskoy Khimii, Vol 33, No 12, Dec 59, pp 2660-2667

The solution has been obtained for a system of differential equations describing the kinetics of hydroperoxide and stable product accumulation in accordance with a reaction in which linear and quadratic branching and quadratic breaking of chains takes place. The solution has been obtained without assuming steady state concentration of the radicals  $RO_2'$ .

Decrease in the rate of generation and increase in the fraction of quadratic branching have been shown to lead to clearer manifestation of the autocatalytic character of the kinetic curves.

It has been shown that already for generation rates  $W_0 \approx 10^{10}$  radicals per  $cm^3$  the assumption of steady state concentration of the radicals  $RO_2'$  leads to erroneous results. In particular in the steady state approximation it follows that at  $W_0 < 10^{10}$  the induction period ceases to be dependent upon  $W_0$ , which is not true in the semisteady state approximation.

#### 9. Calorimetric Experiment Calculation In Case of Side Processes

"On the Calculation of a Calorimetric Experiment With Side Processes With Varying Heat Evolution Rates in the Main and Final Periods of the Run," by A. F. Vorob'yev, Moscow State University; Moscow, Zhurnal Fizicheskoy Khimii, Vol 33, No 12, Dec 59, pp 2802-2804

It has been shown that when there are side heat processes in the main and final periods of a calorimetric run, causing changes in the temperature of the system in unit time proportional to the temperature rise in the run at the given time, the correction for heat exchange and for the true temperature rise may be strictly calculated by means of the usual formulas,

operating with the observed values for the temperature change without the introduction of any additional corrections. Hence the presence of such side processes is no obstacle for the completely strict fulfillment and calculation of a calorimetric experiment.

10. Thermal Explosion and Isothermal Decomposition of Explosives

"Thermal Explosion and Isothermal Decomposition of Explosives I," by A. I. Serbinov, Institute of Chemical Physics, Academy of Sciences USSR; Moscow, Zhurnal Fizicheskoy Khimii, Vol 33, No 12, Dec 59, pp 2641-2648

The paper gives the dependence of the reaction rate constant on temperature for monomolecular decomposition of explosives (8) when the value of the pre-exponent factor is normal and equal to the characteristic frequency of valence vibration of the  $\text{NO}_2$  group in nitric acid esters, and the activation energy is equal to the ruptured bond energy ( $-\text{O}-\text{NO}_2$ ).

Conforming to this dependence are both the data on thermal explosion of nitroglycerin given in the paper and published information on monomolecular isothermal decomposition and thermal explosion of nitroglycerin, which covers as wide a range of decomposition rate variation as  $10^7$  fold.

11. Kinetics of CO Conversion

"Kinetics of Carbon Monoxide Conversion in the Presence of Iron Catalysts," by Yu. B. Kagan, A. N. Bashkirov, E. V. Kamzolkina, A. Ya. Rozovskiy; Moscow, Zhurnal Fizicheskoy Khimii, Vol 33, No 12, Dec 59, pp 2706-2711

It has been shown that the maximum on the time-iron carbonization curves observed in the initial stages of the reaction in the presence of iron catalysts is due to the autocatalytic character of the reaction of carbide formation.

Decomposition of carbon monoxide with the formation of elementary carbon begins after the maximum rate of carbide formation has been attained, following which at low temperatures (up to  $370^\circ$ ) it gradually slows down or proceeds at approximately constant velocity.

The second maximum on the kinetic carbonization curves observed at temperature above  $370^\circ$  is explained as due to the pseudocatalytic course of carbon monoxide decomposition with formation of elementary carbon. In this case the autocatalytic nature of the reaction is due to degradation of the catalyst grains.

The velocity of the carbide forming reaction is satisfactorily described by the topochemical equation

$$c = 1 - e^{-k't^n}$$

The carbide formation reaction in the initial period (before the maximum rate is attained) evidently takes place in the kinetics region and then passes over to the diffusion region.

## 12. H<sub>2</sub>O<sub>2</sub> Electroconductivity and Reaction Kinetics

"A Kinetic and Electroconductivity Study of the H<sub>2</sub>O<sub>2</sub> Reaction Catalyzed by Na<sub>2</sub>WO<sub>4</sub> + SrCl<sub>2</sub>," by I. K. Prokhorova and G. A. Bogdanov; Moscow, Zhurnal Fizicheskoy Khimii, Vol 33, No 12, Dec 59, pp 2721-2728

The kinetics and electroconductivity in the catalysis of H<sub>2</sub>O<sub>2</sub> by Na<sub>2</sub>WO<sub>4</sub> + SrCl<sub>2</sub> have been investigated under varying conditions of pH and temperature. The reaction is reversible and homogeneous. The kinetic curves possess a maximum. The rate of the reaction is approximately inversely proportional to the concentration of Sr<sup>2+</sup> and directly proportional to the concentration of OH<sup>-</sup> ions. The reaction order depends upon the pH and temperature, approaching first order with increasing OH<sup>-</sup> concentration or temperature. With increase in H<sup>+</sup> ion concentration or fall in temperature the reaction tends to zero order.

The activation energy at pH=7 is a function of the existing concentration of the substrate and the temperature  $\frac{\partial E}{\partial c} < 0$  and  $\frac{dE}{dT} < 0$

However, at pH < 7,  $\frac{\partial E}{\partial c} = 0$  and  $\frac{\partial E}{\partial T} = 0$ .

In all cases excepting 45° C the ratio of the change in rate of catalysis to the change in electroconductivity is constant in the course of the reaction. For any values of pH  $dn/dH^+ = dn/dOH^- = 0$ .

Based on the shape of the rate curves, the character of the changes in electroconductivity, and the activation energy, it has been suggested that no less than three intermediate peroxide complexes are formed and the most probable mechanism of the catalytic reaction has been proposed.

Industrial Chemistry

13. Developments in Field of Organosilicon Compounds

"Progress in the Chemistry of Organosilicon Compounds," by K. A. Andrianov, Corresponding Member, Academy of Sciences USSR; Moscow, Vestnik Akademii Nauk SSSR, Vol 29, No 11, Nov 59, pp 23-27

During the past 20 years, considerable attention has been paid to the synthesis of polyorganosiloxanes (silicones). The industry producing organosilicon compounds, which originated as late as 1946, has expanded considerably.

At the present polymers are needed which can be used at temperatures from minus 60° to plus 400° and have the necessary elasticity, mechanical strength, resistance to the effects of moisture, etc. Progress in aviation, rocket technology, and other fields necessitated the development of electrical equipment which is very compact and employs strong currents. Because of this, much more heat is developed by the electrical equipment, so that insulating materials resistant to the effects of high temperatures have to be used. Polymers must withstand 200° and for short periods of time even 400° when they are applied in the construction of electrical machinery, instruments, and electronics equipment. Of no less importance is the application of heat-resistant polymers in aviation. This will be realized if one considers that during the landing of modern planes, the temperature of the tires of the landing gear may reach 320°. Heat-resistant polymers must also help in the solution of difficult problems involved in the protection of interplanetary missiles from the action of heat which develop at their surface when they pass through the atmosphere. It is known that even at velocities of only 2,000-3,000 kilometers per hour, the surface of the carrying parts (nesushchiye chasty) may heat up to 300°.

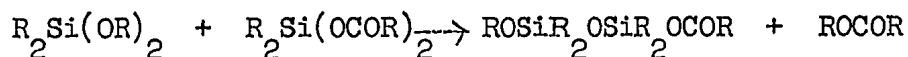
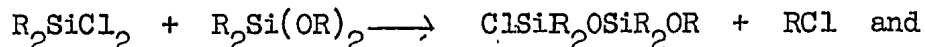
In the casting of metals, polymers are required which can stand short exposure to the action of molten metal. In the stamping of metal articles polymers used as lubricants must remain unaltered at high temperatures and exhibit a high resistance to combustion.

Until recently, polyorganosiloxanes were produced by only one method, namely by the hydrolysis of alkyl or arylhalosilanes or of substituted esters of orthosilicic acid followed by condensation or catalytic polymerization. Notwithstanding its advantages, this method has the shortcoming that as a result of the hydrolysis of monomers a considerable quantity of low-molecular cyclic compounds is formed in addition to linear high-molecular polymers.

Investigation of the chemistry of polyorganosiloxanes showed that not only the chemical composition, but also the structure of molecules exerts a pronounced effect on the properties of polymers. A low degree of polarity and weak interaction between chain molecules confer on the organosiloxanes a superior stability at low temperatures. However, the mechanical characteristics of such polymers are inferior. The change in viscosity produced by changes in the temperature is one fiftieth as great for organosiloxanes as for petroleum oils. The organosiloxanes have a compressibility of 14%, as compared with the compressibility of 6-7% exhibited by organic liquids not containing silicon. Within the region from minus 80° to 0° the modulus of elasticity of a polydimethylsiloxane elastomer changes by a factor of 1.8, while that of natural rubber changes by a factor of 100 in the temperature range from minus 64° to plus 25°. This is due not only to the chemical composition of polydimethylsiloxane, but also to the helical structure of its molecular chains. The helical structure of the molecules of polyorganosiloxanes is responsible for the high coefficient of compressibility and the small change in the viscosity of these polysiloxanes produced by changes in the temperature.

The properties of polyorganosiloxanes can be modified by replacing organic radicals bound to silicon atoms with various other groups. Thus, the energy of activation of viscous flow, which can be regarded as an index of the force acting between molecules, equals 2.1 kilocalories per mol in the case of hexamethyl-2-dimethyltrisiloxane. If the methyl radicals in the central part of the molecule are replaced with ethyl or chlorophenyl groups, the energy of activation of viscous flow increases to 6.0-7.0 kilocalories per mol.

By selecting the monomers appropriately, one can regulate the intermolecular force and in this manner control the mechanical, electrical, and other properties of polyorganosiloxanes; however, in synthesizing polymers by the hydrolysis method, one cannot always retain the polar groups at the silicon. For this reason, investigations aimed at the development of new methods for the synthesis of polymers should be conducted. This refers, above all, to the investigation of reactions by which alkyl- and arylhydroxysilanes are formed and converted into polyorganosiloxanes. An important part in this research must be played by the development of new methods for the preparations of organosilicon polymers which are by reactions of heterofunctional polycondensation. These reactions take place under the effect of heat and in the presence of different catalysts according to the equations given below.



One must conduct special research on the preparation of cyclic organosiloxanes and the mechanism of their conversion into polymers, investigate the scission of bonds of cyclic siloxanes and the transformation of these siloxanes into linear polymers under the action of catalysts, and clarify the mechanism underlying the catalytic reactions of the formation of polymers from cyclic compounds, specifically as far as the influence of organic groups bound to silicon on the process of the formation of polymers is concerned.

Of exceptional importance is the investigation of the effect of catalysts on the splitting off of organic groups. Some acids (for instance, sulfuric acid) easily rearrange cyclic siloxanes into linear compounds. This rearrangement is accompanied by the splitting off of organic groups. Organic acids, even those which are very strong and dissociate readily in aqueous solutions (for instance, perfluoroaliphatic acids), are not effective catalysts of the rearrangement of dimethylsiloxanes. Anhydrous hydrogen halide acids split siloxane bonds of polymethylcyclorosiloxanes with relative facility, so that silicon halide and silanol groups are formed. All of these reactions, notwithstanding their great practical importance, have not been investigated adequately as yet.

The packing of polymer chain molecules is affected to a considerable extent by the organic radicals which have been introduced into these molecules. By this means, the force of interaction between molecules can be regulated. Thus, polydimethylsiloxane rubber, which consists of  $(\text{CH}_3)_2\text{SiO}$  links, withstands temperatures down to approximately minus  $60^\circ$ . If 7-15% of the methyl groups in polydimethylsiloxane are replaced with phenyl groups, the elastomer is stable down to minus  $77^\circ$ . This is a result of the closer packing of polymer chains brought about by the substitution of methyl groups with phenyl groups.

The investigation of relationships pertaining to the effects which the type of organic radical and the distribution of organic radicals in the polymer chain exert on the physical properties of molecules is of great interest. Relationships of this type have a bearing on the fact that polyphenylmethyl- and polyphenylethylsiloxanes are suitable for use as heat-resistant liquids for vacuum pumps and as heat-resistant lubricants.

The development of methods for the synthesis of polymers which contain, in addition to Si-O-Si groups, silicohydrocarbon groups, such as  $-\text{SiC}_6\text{H}_4$

Si-, deserves particular attention. Polymers with siloxane hydrocarbon chains of this type ought to be of considerable interest from the standpoint of production of films with a high stability to oxidation at elevated temperatures. The synthesis of polymers of this type, which form as a

result of the hydrolysis of tetramethylphenyldichlorosilane or tetraethylphenyldichlorosilane, has not yet reached a sufficiently high state of development. It is necessary to develop new methods for the production of polyphenylenemethylsiloxanes and polyphenyleneethylsiloxanes with molecules which have a strictly linear structure and a sufficiently high molecular weight.

Great attention must be paid to the investigation of reactions for the production of block and graft polymers. In reactions of this type organosilicon polymers must be combined with purely organic polymers, such as polyesters, epoxy resins, polyurethanes, polycarbonates, polytetrafluorethylene, and other polymers containing fluorine.

An important part in the research to be conducted must be played by investigations aimed at the development of methods for the conversion of organosilicon polymers into various heat-resistant materials and materials which stand exposure to low temperatures (plastics reinforced with glass fibers, compound plastics, lacquers, enamels, elastomers, oils, lubricants, etc.).

#### 14. Use of Polysiloxanes for Deicing

"Investigation of the Effect of Polyorganosiloxane Coatings on the Adhesion of Ice to Different Surfaces," by K. A. Andrianov, B. V. Deryagin, N. N. Zakhavayeva, M. V. Sobolevskiy, and M. V. Talayev; Leningrad, Zhurnal Prikladnoy Khimii, Vol 32, No 12, Dec 59, pp 2682-2691

On the basis of the experiments which have been conducted, it is concluded that polyorganosiloxane liquids can be used to lower the adhesion of ice to different surfaces. The most suitable compounds for this purpose proved to be methylpolysiloxanes No 1 and No 15, ethylpolysiloxane No 5, and isoamylpolysiloxane No 13 (liquids with a viscosity of 300-1161 centipoises). Particularly favorable characteristics were exhibited by liquids No 5, No 13, and No 15. These liquids lowered the force necessary for chipping the ice off by factors amounting to multiples of 10. They exerted this effect at a low thickness of the layer of liquid spread on the surface ( $h = 0.1$  mm). On being applied to the surface the coating consisting of these liquids is very stable: the layer that has been applied does not wear off after repeated freezing of ice to the surface. On being removed from the surface by thorough wiping, they leave a layer sufficient to lower the adhesion of ice by a factor of 6.

Particularly good results were obtained on aluminum surfaces coated with lacquers, rubber surfaces, and plexiglas. Somewhat worse results were obtained in experiments on the adhesion of ice to an aluminum surface



which was covered with a polysiloxane liquid without being coated with lacquer prior to this and in experiments conducted with windowpanes. The low viscosity of methylpolysiloxane No 1 is a disadvantage, because this liquid readily flows off vertical surfaces.

On the basis of results obtained in investigations described in this paper, polyorganosiloxane coatings are recommended for the prevention of icing of surfaces, because the coatings in question facilitate the removal of ice formed on the surface.

15. Production of Polytetrafluorethylene Gaskets

"A Method For the Production of Ftoroplast-4 Gaskets For Industrial Chemical Equipment," by Engr M. V. Palekha; Moscow, Khimicheskoye Mashinostroyeniye, No 6, Nov-Dec 59, pp 45-46

Until recently polyvinyl chloride was used as a material for gaskets of industrial chemical equipment applied in the production of concentrated nitric acid. Polyvinyl chloride does not have a chemical resistance that is high enough for this application; it has been decided to use gaskets of ftoroplast-4 (polytetrafluoroethylene) instead. Ftoroplast-4 gaskets of sufficiently large dimensions could not be produced by the pressure molding process used hitherto. The Machine-Building Plant imeni Frunze at Sumy has developed a method whereby annular gaskets of any desired diameter up to 1,250 mm can be produced by cutting a helix from ftoroplast-4 rings 50 mm thick and molding the two ends of the helix together to form a ring.

16. Work at Institute of Chemical Physics, Academy of Sciences USSR, on Protection Against Corrosion, Corrosion-Resistant Alloys, and Semiconductors

"Corrosion Must Be Forced to Retreat," by V. Stishova; Moscow, Promyshlenno-Ekonomicheskaya Gazeta, Vol 4, No 12 (630), 29 Jan 60, p 4

Procedures for protection against corrosion cannot be based on hit-and-miss methods and reliance on practical experience only; knowledge of the theoretical aspects of corrosion is necessary. USSR scientists may claim a priority in the development of the theory of corrosion. Research conducted under the direction of Prof N. D. Tomashov at the Division of Corrosion, Institute of Physical Chemistry of the Academy of Sciences USSR, has done much to clarify the mechanism of corrosion processes.

During the Seven-Year Plan, 8 million tons of metal will be used to construct pipelines in the USSR. Without a protective coating, a metal pipe lasts for 20 years. With a protective coating it has a useful life of 40 years. The metal of which the pipes are constructed lasts indefinitely if it is protected against corrosion by electrochemical means. The quantitative aspects of the theory of corrosion were investigated on the basis of data obtained at one of the laboratories of the Division of Corrosion.

The Saratov-Moscow pipeline is protected against corrosion by metal protective devices and electric cathodic installations, which are the two variants of electrochemical protection. The application of protective devices results in a saving of 3,000 rubles per kilometer of pipeline per year.

A thorough investigation of the mechanism of underground corrosion that was conducted makes it possible to predict with a great degree of precision the course of the corrosion process and also to devise the most effective method of protection against corrosion. A manual entitled Zashchita Podzemnykh Sooruzheniy ot Korrozii (Protection of Subterranean Constructions From Corrosion), which was published this year, was compiled mainly on the basis of data and calculations that originated at the laboratory mentioned above. The same laboratory developed new insulating coatings. Sections of the Stavropol'-Moscow pipeline and of the Gur'yev-Orsk petroleum pipeline are covered with a protective coating consisting of polyvinyl chloride. This synthetic resin has a useful life three times that of the commonly used bituminous tar coating. The cost of both coatings is about the same. At a laboratory directed by Prof I. L. Rozenfel'd volatile inhibitors of corrosion are being investigated. This is the newest and most promising method of protection against corrosion. The purpose of treatment with volatile inhibitors is to protect metal articles against corrosion during storage and transportation. The application of volatile inhibitors is very simple: they can be applied by filling them in bags and suspending these bags at the construction works, or they can be applied to the surface of the metal in the form of a powder or a solution. Small metal articles of light weight are protected by wrapping them in paper impregnated with a solution of the inhibitor. The characteristics responsible for the protective effect exerted by definite compounds active as volatile inhibitors had to be investigated. The principles on the basis of which inhibitors of this type can be developed were established. Several inhibitors have been proposed for use in the industry to protect steel and some nonferrous metals against corrosion.

The development of large-scale industrial chemical production resulted in a demand for corrosion-resistant alloys for the construction of chemical equipment. A group working under the direction of V. V. Andreyeva

does research on the theory of acid-resistant alloys. New corrosion-resistant titanium alloys have been developed and tested on a laboratory scale. Titanium, which has a low specific gravity and a high tensile strength, is an effective corrosion-resistant metal. Experiments which have been carried out indicate that addition of a definite proportion of molybdenum to titanium increases the corrosion resistance of titanium toward solutions of hydrochloric acid by a factor which in some cases amounts to 1,000 and more. Alloys of titanium with zirconium also proved to be corrosion-resistant.

A group headed by Ye. N. Paleolog has conducted work on the etching of semiconductors. The etching changes the shape and dimensions of semiconductor crystals and affects the surface electric properties of these crystals. Clarification of the mechanism by which electrolytes act on semiconductors makes it possible to control the technological operations of the production of semiconductors and, what is particularly important, to solve the problem of the production of semiconductors with a surface that has the desired electrical properties. The experiments which have been carried out indicate that dissolution of semiconductors in electrolytes (i.e., the etching of semiconductors) is not a simple chemical reaction, but a complex electrochemical process. The conclusion was reached that the etching of semiconductors and the corrosion of commonly used metals are essentially similar; the same relationships underlie both processes.

17. Kinetics of Low-Pressure Decomposition of Ammonia

"Kinetics of the Decomposition of Ammonia on Platinum at Low Pressures," by L. O. Apel'baum and M. I. Temkin, Physico-chemical Institute imeni Karpov, Moscow; Zhurnal Fizicheskoy Khimii, Vol 33, No 12, Dec 59, pp 2697-2705

The kinetics of the ammonia decomposition on platinum at low pressures (of the order  $10^{-2}$  mm Hg) have been studied in a static system. In the high-temperature range ( $900-1350^{\circ}$  C) the rate of the decomposition reaction is proportional to the ammonia pressure. The reaction is not retarded by its products and the activation energy is 5,100 cal. In the low-temperature range ( $490-560^{\circ}$  C) the decomposition is retarded by hydrogen, its rate

being proportional to  $(P_{\text{NH}_3}^2 / P_{\text{H}_2}^3)^n$ , where n changes from 0.73 to 1 with increase in the hydrogen pressure. The activation energy is 49,300 cal (for  $n = 0.73$ ).

These results show that in the low-temperature range the rate-controlling step is the desorption of nitrogen, the coverage of the surface with nitrogen decreasing with increase in  $P_{\text{H}_2}$ ; in the high-temperature range the rate of

the reaction is controlled by the decomposition of the ammonia molecules on their impact on the surface, this being the first stage of the overall reaction. This conclusion is confirmed by existing data on the rate of  $\text{NH}_3 - \text{D}_2$  exchange. A computation shows that the first step of the reaction may be the controlling one only at low pressures and high temperatures.

In the high-temperature range the rate of nitrogen formation in the decomposition of ammonia approaches that in the oxidation of ammonia.

Heating of the platinum in vacuum leads to a loss of its catalytic activity. The activity is restored after an induction period.

Some considerations concerning the mechanism of NO and  $\text{N}_2$  formation in the oxidation of  $\text{NH}_3$  on platinum are presented.

#### 18. Polydispersity of Polyisobutylene

"Investigation of the Polydispersity of Polymers by the Method of Non-stabilized Sedimentation Equilibrium I," by S. Ya. Frenkel', A. V. Topchiyev, B. A. Krentsel', Yu. Ya. Gol'dfarb, and L. M. Pyrkov, Institute of High Molecular Compounds and Institute of Petrochemical Synthesis, Academy of Sciences USSR; Moscow, Zhurnal Fizicheskoy Khimii, Vol 33, No 12, Dec 59, pp 2778-2785

A method has been described for the determination of the polydispersity of polymers, based on measuring the concentration gradient in the bottom layer of an ultracentrifuge cell, at nonstabilized sedimentation equilibrium. A discussion has been presented of the experimental conditions under which the distribution approximates the simple barometric formula of Laplace. In that case one may theoretically calculate with the aid of a quite simple graphoanalytic procedure the mean molecular weight of any order. The method was applied together with Archibald's method of calculation to determine the weight and z-average molecular weights of five polyisobutylenes obtained with the aid of a Ziegler-Natta type of catalyst. The ratio of  $M_z/M_w$  on an average proved to be of the order of 1.6, bearing evidence to relatively moderate polydispersity of the specimens. At the same time they are of relatively low molecular weights, the maximum value of  $M_z$  not exceeding 67,000.

Inorganic Chemistry

19. USSR Book on Silicides and Other Inorganic Compounds of Silicon

"Kremniy i Yego Binarnyye Sistemy" (Silicon and Its Binary Systems), by A. S. Berezhnyy, reviewed by V. B. Glushkova; Moscow, Ogneupory, Vol 24, No 11, Nov 59, pp 527-528

The chemistry of silicon and its compounds is of great interest by reason of the specific characteristics of the binary compounds of this element and elemental silicon itself from the standpoint of technical applications. Berezhnyy's book, published by the Academy of Sciences Ukrainian SSR at Kiev in 1958 under the editorship of P. P. Budnikov, Corresponding Member of the Academy of Sciences USSR, gives a critical review of data obtained in the USSR and abroad in the fields of the physical chemistry of silicon and of its binary systems. Because of the expanding application of compounds of this type, the publication of the book is regarded as timely.

The book gives detailed information on the properties of all compounds of silicon known at present. Considerable attention is paid to the description of the molecular structure of binary compounds, the crystal structure of these compounds, the constitutional diagrams of the systems considered, some physical and thermodynamical characteristics of individual compounds, and practical applications of these compounds.

The first part of the book describes methods for the production of silicon and the properties of silicon. Methods for the purification of silicon and its applications as a semiconductor material are reviewed in this part of the book. The following section of the book reviews briefly methods for the preparation of binary compounds of silicon and lists the principal characteristics of 164 silicides in a table. The preparation of individual silicon compounds and their properties are discussed in greater detail in subsequent sections of the book, where different systems are described.

The principal part of the book describes in detail the characteristics of binary systems containing silicon as affected by the position in the periodic system of the elements interacting with silicon. In the description of systems of this type, considerable attention is paid to the crystal structure of silicides, the thermodynamic characteristics of silicides, and the possibilities of applying compounds of this class in different fields of science and technology. Particular emphasis is placed on the system silicon-oxygen with special attention to silicon dioxide of its great importance in the technology of silicates.

Extensive treatment is given to silicon carbide (carborundum) and silicides of transitional metals. Of great interest are some data on ternary systems formed by silicon with transitional metals of the IV, V, and VI groups of the periodic system and also data on ternary systems formed by transitional metals of these groups with silicon, boron, carbon, nitrogen, and oxygen.

Systems formed by silicon with metals of the iron subgroup are discussed extensively. The information given on the interactions of silicon with metals of the platinum and palladium subgroups and also with lanthanides and actinides is of interest.

The book is concluded with a general discussion of the data mentioned above. It is well-illustrated, containing 120 figures in addition to 37 tables. A historical review forms a part of every subdivision. There is a bibliography consisting of 716 references.

A shortcoming of the book is that the data cited are not always subjected to critical consideration and that discrepancies between results obtained by different investigators are not always explained. Notwithstanding this, Berezhnyy's book will be of value, because it summarizes extensive and very useful material on the basis of present-day theoretical concepts and of the most recent achievements in practical work in this field.

20. New Method For Synthesis of Nickel and Cobalt Tetracarbonyls

"Preparation of Nickel and Cobalt Tetracarbonyls From the Alloys of These Metals With Aluminum," by Ya. Yu. Aliyev, I. B. Romanova, T. G. Gar'kovets, I. M. Kovina, and M. I. Monakov, Institute of Chemistry, Academy of Sciences Uzbek SSR; Tashkent, Doklady Akademii Nauk UzSSR, No 11, Nov 59, pp 36-39

A new method has been developed whereby tetracarbonyls of nickel and cobalt are prepared from Ni-Al (45:55) and Co-Al (45:55) alloys by treating them in an autoclave with carbon monoxide at 100-120° and a pressure of 200 atmospheres gauge. Before being placed in the autoclave the alloys are activated by treatment with a 25% solution of caustic. The powdered alloy that has been activated with caustic is transferred into the autoclave in a moist state to prevent spontaneous ignition. It has been established that activation of the Ni-Al alloy with potassium hydroxide rather than sodium hydroxide increases the yield of nickel tetracarbonyl and reduces the extent of the side reaction of carbon monoxide decomposition. The purpose of the work described is investigation of the possibility of

introducing carbonyl groups into tetrahydrofuran and organic compounds in general by a catalytic process employing aluminum alloys of nickel and cobalt. On being prepared, the cobalt tetracarbonyl was dissolved in tetrahydrofuran to investigate the reaction between the tetracarbonyl and this compound.

Nuclear Fuels and Reactor Construction Materials

21. Changes in Gamma-Radiation Field Produced by Radon and Their Significance From Standpoint of Practical Procedures Applied in Prospecting for Uranium

"Concerning the Theory of Gamma Prospecting" by A. N. Timofeyev, Ural Affiliate of the Academy of Sciences USSR, Institute of Geophysics; Moscow, Izvestiya Akademii Nauk SSSR--Seriya Geofizicheskaya, No 12, Dec 59, pp 1873-1875

As a result of diffusion and convection, radon may be displaced for considerable distances in the direction from the soil toward the surface, forming a gas envelope which covers uranium deposits lying more deeply. This will be equivalent to a displacement of the source of gamma radiation toward the surface, because the gamma radiation emitted by products of the decay of radon comprises 98% of the total gamma radiation emitted by the uranium radioactive series. In a radiation approximation applying to the case of radioactive rocks covered with inactive deposits, a quantitative estimate is made of the changes in the intensity of gamma radiation due to the emanation and diffusion of radon.

22. Thermodynamic Properties of Heavy Water

"The Thermodynamic Properties of Ordinary and Heavy Water," by V. A. Kirillin, Corresponding Member, Academy of Sciences USSR, and Engr S. A. Ulybin, Moscow Power Institute; Moscow, Teploenergetika, Vol 6, No 12, Dec 59, pp 77-80

Using results obtained in an experimental investigation of the density of heavy water, the thermodynamic properties of D<sub>2</sub>O are compared with those of H<sub>2</sub>O. Because detailed tables listing the properties of D<sub>2</sub>O are not available, one must calculate values for D<sub>2</sub>O using tables for H<sub>2</sub>O. On the basis of experimental determinations of saturated D<sub>2</sub>O vapor pressures and D<sub>2</sub>O specific volumes made by the authors within an extensive range of conditions (cf Teploenergetika, Vol 6, No 4, Apr 59, 1959, pp 67-72), a comparison of the thermal properties of heavy water with those of

ordinary water at different pressures and temperatures becomes possible. This includes the region adjacent to the critical (in the investigation published in April, specific volumes at temperatures of 250-500° C and pressures of 100-500 kgs/cm<sup>2</sup> were determined.

Because of the extensive experimental material that is available and agreement of the data used with those obtained by US investigators, the results arrived at concerning the dependence of  $p_g$  on  $t_g$  for heavy water up to the critical temperature must be regarded as reliable. Curves showing the interrelationships between the critical volumes of H<sub>2</sub>O and those of D<sub>2</sub>O at 380°, 400°, 450°, and 500° C have been plotted. Assuming that the molar critical volume for ordinary water is  $v_{cr} = 3.26 \text{ cm}^3/\text{g}$ , the corresponding value for heavy water must be  $v_{cr} = 2.93 \text{ cm}^3/\text{g}$ . The values of  $v_{cr}$  found by E. H. Riesenfeld and T. L. Chang (Zeitschrift fuer Physikalische Chemie, Vol 1333, 1935; Vol 1333, 1936) and H. Eck (Physikalische Zeitschrift, Vol 40, 1939) are too low; the value of  $v_{cr} = 2.955 \text{ cm}^3/\text{g}$  obtained by the authors is considerably higher and more accurate.

By plotting  $v_{\text{H}_2\text{O}}/v_{\text{D}_2\text{O}}$  (ratio of specific volumes) against pressure (cf Fig 2, p 79), a direct comparison between  $v_{\text{D}_2\text{O}}$  and  $v_{\text{H}_2\text{O}}$  at different temperatures could be made. It was established that the ratio of specific volumes does not remain constant, but changes to a considerable extent with the parameters of state. The curve corresponding to 380° is particularly significant from the point of view of an understanding of the relationships involved in these changes, because it is closest to the critical points of both heavy and ordinary water. The changes in the ratio of specific volumes at any temperature are greatest when the pressure is closest to the critical. With increasing temperatures the pressure which corresponds to the minimum of the ratio of specific volumes shifts to higher values.

The isochors of heavy water were compared with those of ordinary water in the p-t diagram (Figure 3, P 80). It was established that there is complete similarity between the isochors of D<sub>2</sub>O and H<sub>2</sub>O both in the liquid phase and vapor phase regions. The isochors of heavy water in the liquid phase are somewhat to the left of and in the vapor phase somewhat higher than those of ordinary water, indicating that the molar volume of heavy water is slightly larger than that of ordinary water at the same values of the temperature and pressure. In the region of low densities, when the properties of the vapor are close to those of an ideal gas, the differences between the molar volumes of H<sub>2</sub>O and D<sub>2</sub>O disappear, for all practical purposes.



Analysis of the p-t diagram demonstrates clearly that the thermal properties of heavy and ordinary water change in a similar manner.

23. Flow Counter Operating Under Atmospheric Pressure

"Flow Counter Operating Under Atmospheric Pressure," by E. E. Finkel' and K. V. Chmutov, Institute of Physical Chemistry, Academy of Sciences USSR, Scientific Research Institute of the Cable Industry; Moscow, Zhurnal Fizicheskoy Khimii, Vol 33, No 12, Dec 59, pp 2805-2806

The conditions of operation of an ordinary cylindrical counter to ensure good counting characteristics have been ascertained. The plateau length over the voltage range 1,900 to 2,200 v is 200 v with the slope less than 10% on 100 v, which permits one to use as power source a standard rectifier of the type VS-2500. The runs were made with a counter of the type FEM-8 in a steel housing that had a 3-4-mm hole bored in the end opposite the stem as gas outlet. The dead time of the counter determined by the two-source method was found to equal  $9.7 \cdot 10^{-6}$  as against  $2.7 \cdot 10^{-6}$  min.

The results obtained showed that under the conditions selected the flow counter may be used for measuring the radioactivity both of external (solid and liquid) and internal (gaseous, solid, and liquid) sources under atmospheric pressure.

Physical Chemistry

24. Interaction of Adsorbed Atoms Through Surface Electron Gas

"Adsorption Equilibrium and Kinetics in the Interaction of Adsorbed Atoms Through a Surface Electron Gas," by L. I. Krishtalik; Moscow, Zhurnal Fizicheskoy Khimii, Vol 33, No 12, Dec 59, pp 2729-2731

Based on the Temkin "surface electron gas" model, equations have been obtained for the equilibrium and kinetics of adsorption on metals, similar to equations for a heterogeneous surface and for repulsive forces diminishing with the distance. For this model the rate of reaction with the participation of a single adsorbed atom is independent to a first approximation of the rate of surface migration of the adsorbate. The effect of surface migration on the value of the b constant in the recombination theory of hydrogen overvoltage has been noted.

Radiation Chemistry

25. Temperature Dependence of Radiation-Chemical Oxidation of Hydrocarbons

"Temperature Dependence of the Oxidation of n-Heptane and n-Nonane Under the Effect of Radiation," by N. A. Bakh and T'ung T'ien-chen, Institute of Electrochemistry, Academy of Sciences USSR; Moscow, Doklady Akademii Nauk SSSR, Vol 129, No 3, 21 Nov 59, pp 604-606

On the basis of data obtained in the authors' laboratory, it was concluded that oxidation of hydrocarbons under the effect of radiation takes place by a radical mechanism at room temperature and that no chains are formed. On the other hand, it has been established that  $\gamma$  - radiation initiates chain oxidation processes at elevated temperatures and that radiation may initiate chain oxidation even at room temperature. Under the circumstances, it was of theoretical and practical interest to investigate the dependence of the kinetics of reactions of this type on the temperature and the degree of exposure to radiation. The formation of liquid-phase oxidation products from n-heptane and n-nonane under the action of X-ray irradiation at temperatures from minus 80° to plus 130°

and magnitudes of the dose from  $1 \times 10^{14}$  to  $8 \times 10^{15}$  electron volts per  $\text{cm}^3$  per second was investigated. It was established that in the region of temperature-independent yields of peroxides and carbonyls (this refers to determinations made at minus 80° and plus 10°, respectively) the yields do not depend on the magnitude of the radiation dose. On the other hand, in the regions where dependence on the temperature exists, the yields also depend on the temperature. On the basis of the results obtained, the conclusion is made that chain and radical reactions are superimposed during the oxidation of n-alkanes under the action of radiation. Although this combination of the two reaction mechanisms is a general property of radiation-chemical oxidations, the temperature at which chain oxidation begins depends on the chemical constitution of the compound oxidized.

26. Effect of Radiation on Hydrogen Exchange Taking Place by Reaction in Which Diffusion Forms Limiting Factor

"The Effect of  $\gamma$  - Radiation on the Velocity of Hydrogen Exchange Between Water and Isoamylthiol," by K. I. Sakodinskiy and N. M. Zhavoronkov, Corresponding Member, Academy of Sciences USSR, Physicochemical Institute imeni L. Ya. Karpov; Moscow, Doklady Akademii Nauk SSSR, Vol 129, No 2, 11 Nov 59, pp 391-393

The effect of radiation on hydrogen isotope exchange was investigated in several instances. Bardwell and P. Dyne, who investigated the isotope exchange between water and hydrogen in the gas phase under the action of

radiation, found that the rate of exchange is considerably increased as a result of the action of radiation and that the coefficient of distribution becomes equal to unity. Ya. M. Varshavskiy, G. Ya. Vasil'yev, and others (Doklady Akademii Nauk SSSR, Vol 118, 1958, p 315) established that hydrogen isotope exchange takes place under the effect of radiation in a heterogeneous system consisting of gaseous deuterium and a solid polymer. In the absence of radiation no exchange occurs in this system. In the work described in this instance, the exchange of deuterium between water enriched with deuterium to the extent of 3-5% and isoamylthiol was investigated. It was established that  $\gamma$  - radiation increases the rate of isotope exchange in this instance. Because the exchange reaction proceeds between two immiscible phases in the case studied, diffusion must be regarded as the limiting factor in it. It is concluded on the bases of the results obtained that  $\gamma$  - radiation exerts an effect on the course of diffusion processes; other radiation effects are not regarded as being of sufficient magnitude to explain the increased rate of exchange observed.

#### Radiochemistry

27. Desorption of Radiostrontium and Radiocesium From Suspended Particles in Water of Open Bodies of Water

"Desorption of Radiostrontium and Radiocesium From Particles Suspended in Water of Open Bodies of Water," by L. K. Ponomareva and V. L. Zolotavin; Leningrad, Radiokhimiya, Vol 1, No 5, Oct 59, pp 619-621

It was established that for all practical purposes, complete desorption of radiostrontium from suspended matter contained in the water of open bodies of water can be achieved when the suspended material is treated with a 0.5-1.0 N solution of hydrochloric or nitric acid. The desorption of radiocesium is considerably more difficult; extraction of this element to the extent of 98-99% can be brought about only when the precipitate is boiled with concentrated acid.

III. ELECTRONICS

Computers and Automation

28. Linear System of Automatic Course Control

"Investigation of a Linear Automatic Course-Control Analog," by N. I. Ashbel', Gor'kiy State University; Gor'kiy, Izvestiya Vysshikh Uchebnykh Zavedeniy, Radiofizika, Vol 2, No 5, 1959, pp 787-794

A linear system of automatic course control can be realized with the following direction-sensitive components: the object being controlled, two direction-sensing elements, adding unit, amplifier, servomotor, and rudder control device. The input and output orientation coordinates are expressed by values proportional to the magnitudes of deviation of the controlled object from its equilibrium state. One of the sensing elements of the system is in the form of a three-degree-of-freedom course gyro, which measures the deviation angle from the true course; the second sensing element is in the form of a rate gyro which responds in proportion to the time derivative of the deviation angle. These two deviation functions are transformed by an induction transducer into corresponding voltage pulses, which are added up and fed through a phase discriminator to an amplifier. The output voltage of the amplifier is applied to the armature winding of a reversible dc motor with an independent excitation. The servomotor controls the contact arm of an autotransformer. The voltage at the autotransformer taps is applied to the excitation winding of the motor, which serves to rotate the rudder.

This system of automatic course control is described by a linear differential equation of a fourth order. This type of analog simulates two dimensional problems, such as movement of a ship on the surface of water.

29. Amplidyne Control Systems

"Synthesis of Correcting Devices in Amplidyne Control Systems," by V. L. Ankhimuk and O. P. Il'in, Central Asian Polytechnic Institute; Tashkent, Izvestiya Akademii Nauk Uzbek SSR, Seriya Tekhnicheskikh Nauk, No 6, 1959, pp 5-18

Modern control and regulation systems are characterized by high amplification factors and negative feedback, which are often responsible for undesirable oscillations. To compensate for such undesirable oscillations, a system of automatic control should have some kind of stabilizing (correcting) devices.

This work presents an engineering method for synthesis of correcting devices that can be used in design of various control and regulation systems with one stabilizing circuit. The problem of designing stabilizing devices consists in principle in determining the amplification factor and the time constant of the stabilizing circuit, as well as the position for connection to the system.

The criteria for the precision of the regulating system are: duration of the transient processes, magnitude of overcorrection, susceptibility of the system to oscillations, magnitude of braking moment during overcorrection, and starting deflection. In design stabilizing devices, the first four enumerated criteria are taken into account.

30. Czech Differential Analyzer Solving Problems Nonlinear in Character

"Electromechanical Differential Analyzer DIANA," by Engr Jaroslav Tomasek; Prague, Slaboproudny obzor, No 1, Jan 60, pp 15-23

The article, written by a member of the Institute of the Theory of Information and Automation (Ustav theorie informace a automatizace) of the Czechoslovak Academy of Sciences in Prague, describes the principles and design of the DIANA differential analyzer, developed at the institute and scheduled for completion in early 1960. Generally, the analyzer facilitates the solution of linear differential equations, differential equations with variable coefficients, nonlinear differential equations, and differential equations of physical systems with transport delay. In addition, the machine can solve such problems as Fourier analyses, and correlation functions.

In the article, the author states that the requirement for designing such an analyzer was based on the need to provide Czechoslovak researchers with a sufficiently accurate machine for use in confirming results of theoretical research and for working out new ways of solving problems in the theory of automatic regulation. The initial design, proposed by Prof Dr Z. Trnka, originated in the former Laboratory for Automatization and Telemechanics (Laborator pro automatizaci a telemechaniku) of the Czechoslovak Academy of Sciences, which has now become the Institute for the Theory of Information and Automation. The actual work on DIANA was performed by a small group of specialists, lead by Engr Jiri Haskovec.

Originally, the author reveals, the design began taking shape in the period 1955-1956, when no similar equipment was being produced in Czechoslovakia and was unobtainable through imports. Thus, the designers

were forced to utilize component parts available at that time. They elected to proceed on the electromagnetic principle because some of the computer components, such as integrators and differentiators, were more easily available at clearance sales (vyprodej).

When the differential analyzer is finally completed, it will have one generator for independent variables, 12 integration units; 8 addition units, 8 diagramming units, and auxiliary components. The majority of the components, with the exception of the diagram units, will be located in standardized instrument panels, with the final model having seven instrument panels and two control consoles. According to the author, DIANA will take up considerably less space than similar equipment of the same nature previously used.

After describing the operation and control of DIANA in some detail, including the use of diagrammatic sketches and photographs of equipment, equations, and final graphs, the author makes the statement that during the first 18 months of its operation, DIANA has, thus far (in the incomplete stage and still missing some major components), solved almost 500 differential equations and other problems, "approximately one half of which were nonlinear in character." As to DIANA's defect record, the author points out that although one breakdown defect does occur in about every 5 hours of operation, the majority of the defects are so minor as not to cause any errors in the final results. Thus far, it has apparently only rarely been necessary to re-run certain problems because of mechanical malfunctions.

The accuracy of DIANA is given as 0.2 percent per unit and within one percent for the final solution.

### Instruments and Equipment

#### 31. Infrared Detector

"Detection of Infrared Radiation by Thermal Frequency Converters," by S. I. Averkov and V. Ya. Ryadov, Scientific-Research Radiophysics Institute, Gor'kiy University; Gor'kiy, Izvestiya Vysshikh Uchebnykh Zavedeniy, Radiofizika, Vol 2, No 5, 1959, pp 697-702

On the basis of theoretical evaluations, thermal frequency converters can be utilized for investigation of the longer-wave section of the infrared spectrum. For detection of infrared radiation (10 microns or longer), a device was suggested in which a blackened film was heated on one side by the examined radiation, and secondary emission on the other side of the film was picked up by a sensitive photoresistor.

Such infrared detectors should be more resistant to mechanical vibrations than the conventional optico-acoustic elements. An approximate threshold sensitivity of such a thermal frequency converter should be about  $10^{-10}$ W, which is comparable to the sensitivity of conventional infrared radiation detectors.

32. Frequency Entrainment in Self-Oscillators

"Frequency Entrainment in a Two-Degree of Freedom Self-Oscillator," by A. M. Shauman and P. N. Zanadvorov, Leningrad State University; Gorkiy, Izvestiya Vysshikh Uchebnykh Zavedeniy, Radiofizika, Vol 2, No 2, 1959, pp 267-276

The behavior of a self-oscillator with two-branch grid circuit is examined for the condition of weak splitting of normal frequencies and a wide range of circuit detuning and coupling.

The actual experiment was conducted with a two-degree of freedom oscillator having a natural frequency of 170 kc, which was subjected to the influence of an external periodic force. On the screen of the analyzer were observed simultaneously the lines corresponding to the frequency of the oscillator and the lines corresponding to the frequency of the external field. Examination of weak splitting of normal frequencies and "double resonance" permits finding the region of stability for the case of frequency entrainment. Expressions were obtained for determination of the boundaries of these regions, which in turn permit one to observe how these regions change with the change in the degree of coupling between the circuits. For the condition of strong coupling, each region of instability coincides with boundaries as derived from the theory of strong coupling. The observed "resonance" curves were in good agreement with the calculated values.

The data obtained in this experiment can also be extended to the self-oscillator with higher than two degrees of freedom.

33. Czechs Build New Electron Microscope

"New Type of Electron Microscope" (unsigned article); Prague, Obrana Lidu, 26 Jan 60, p 1

According to a brief announcement accompanied by a photograph, the Laboratory of Electronic Optics (Laborator elektronické optiky) of the Czechoslovak Academy of Sciences in Brno has completed work on a new type of electron microscope capable of directly enlarging objects by 200,000 times. Certain objects, after proper treatment, can even be enlarged up to one million times.

Materials

34. Faraday Effect in Semiconductors

"Faraday Effect in Semiconductors on Free Carriers in a Strong Magnetic Field," by L. E. Gurevich and I. P. Ipatova, Leningrad Physicotechnical Institute, Academy of Sciences USSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1324-1329

The dielectric constant tensor is determined for an electron with an anisotropic mass in a strong magnetic field. The Faraday effect is considered in the case of hexagonal crystals with an energy minimum in the center of the Brillouin zone and also for a cubic crystal with a minimum which does not coincide with the center of the Brillouin zone. The refractive indexes calculated for various directions of the magnetic field relative to the principal crystallographic axes in the crystals are found to sharply depend on the direction of the magnetic field. This circumstance permits one to determine the components of the effective mass tensor by measuring the angle of rotation of the polarization plane.

35. Fermi Surface of Gold

"Topology of the Fermi Surface of Gold," by Yu. P. Gaidukov, Institute of Physical Problems, Academy of Sciences USSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1281-1291

The resistance anisotropy of gold single crystals in a magnetic field has been determined. It has been found that for certain directions of the magnetic field relative to the crystallographic axes of the single crystals, the resistance varies according to a quadratic law, whereas for other directions it completely saturates in fields  $H \gg H_0$ . It can thus be concluded that an open Fermi surface exists in gold. A stereographic projection of preferred directions of the magnetic field has been constructed, and an analysis of it shows that the Fermi surface in gold is a "spatial network" produced by "corrugated cylinders," the axes of which are parallel to the directions [110] and [111] of the reciprocal lattice. The resistances of gold single crystals have been averaged over the angles. The magnitude of the averaged resistance linearly depends on the magnetic field, thus explaining Kapitza's law.



36. Raman Spectra of Electromagnetic Waves

"Combination Scattering of Electromagnetic Waves in Ferromagnetic Dielectrics," by F. G. Bass and M. I. Kaganov, Institute of Radiophysics and Electronics, Academy of Sciences USSR, Physicotechnical Institute, Academy of Sciences Ukrainian SSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1390-1393

Combination scattering of electromagnetic waves by oscillations of the magnetic moment is predicted. The extinction coefficient for the scattered radiation is calculated.

37. Hall Effect in Ferrites

"Hall Effect in Ferrites Near the Curie Temperature," by K. P. Belov and Ye. P. Svirina, Moscow State University; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1212-1216

The Hall e.m.f. in nickel-zinc and manganese ferrites has been measured in the vicinity of the Curie point. A new method of determination of the "usual" Hall constant is suggested. The calculated values of the density and mobilities of the current carriers agree in order of magnitude with the values for nonferromagnetic oxide semiconductors. The Hall e.m.f. is by one order of magnitude larger in a manganese ferrite single crystal sample than in a polycrystalline sample.

38. Superconducting Alloys

"Theory of Superconducting Alloys in a Strong Magnetic Field Near the Critical Temperature," by L. P. Gorkov, Institute of Physical Problems, Academy of Sciences USSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1407-1416

The equations of the phenomenological Ginzburg-Landau theory near  $T_c$  have been deduced from the BCS theory. As in the case of pure superconductors, a double charge is encountered in the equations. The relation between  $\chi$  of the alloy and  $\chi$  of the pure superconductor has been found under the assumption that the shift in  $T_c$  is small. For a sufficiently "impure" alloy,  $\chi$  depends only on the conductivity and the coefficient in the linear law for the electron thermal capacity of the normal metal. Agreement between the theory and experiments is found to be satisfactory.

39. Superconductivity of Beryllium

"Superconductivity of Beryllium and Its Morphology at Low Temperature," by B. G. Lazarev, A. I. Sudovtsev, and Ye. Ye. Semenko, Physicotechnical Institute, Academy of Sciences, Ukrainian SSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1461-1462

It has been found that during condensation of Be vapors on a cool lining, a new modification of Be forms with properties differing from those of ordinary Be; in particular, superconductivity is present. It is possible that these modifications are the same as those revealed at plastic deformation below 20 °K (author et al. ZhETF, 35, 802 (1958)). It is assumed that bismuth exhibits the same behavior at low temperatures.

40. Dilatometric Study of Pb and Ba Titanate and Phosphate Systems

"Dilatometric Investigation of the Systems  $Pb_3(PO_4)_2 - BaTiO_3$  and  $Ba_3(PO_4)_2 - PbTiO_3$ ," by I. N. Belyaya and L. I. Polezhayeva, Rostov-on-Don State University, Moscow, Zhurnal Fizicheskoy Khimii, Vol 33, No 12, Dec 59, pp 2770-2772

The linear expansion of specimens of the systems  $Pb_3(PO_4)_2 - BaTiO_3$  and  $Ba_3(PO_4)_2 - PbTiO_3$  has been studied at 20 to 200-350° by a dilatometric method.

It has been shown that in the system  $Ba_3(PO_4)_2 - PbTiO_3$ , the coefficient of linear expansion ( $\alpha$ ) changes almost monotonously from  $\alpha$  of pure lead titanate ( $-6.3 \cdot 10^{-6}$ ) to  $\alpha$  of pure barium orthophosphate ( $14 \cdot 10^{-6}$ ). In the system  $Pb_3(PO_4)_2 - BaTiO_3$ ,  $\alpha$  remains nearly constant from pure barium titanate ( $6.6 \cdot 10^{-6}$ ) to specimens containing 70 eq. %  $Pb_3(PO_4)_2$ , following which it drops sharply to  $\alpha$  of pure lead orthophosphate ( $-15 \cdot 10^{-6}$ ).

41. Production of Ferrite Crystals by the Verneuil Method

"Production of Ferrite Single Crystals by the Verneuil Method," by G. Elbinger, Institute of Magnetic Materials, Jena; Berlin, Experimentelle Technik der Physik, Vol 7, No 5, 1959, pp 193-208

A description is given of the construction and testing of a Verneuil furnace for the production of ferrite single crystals. Results are also given of measurements made on the drawn crystals; these involved the

magnetic crystal anisotropy constant, the spontaneous magnetization, specific gravity, and lattice constant and were conducted for the purpose of determining the extent to which the crystals differed with respect to properties. Mention is also made of investigations of the Curie temperature, of the half width of the ferromagnetic resonance, and of the dependence of the magnetic crystal anisotropy constant on temperature.

Parts of the apparatus and information on the operation of the Verneuil furnace were supplied by VEB Elektrochemisches Kombinat, Bitterfeld.

[For additional information on materials, see under Chemistry, Industrial Chemistry.]

### Wave Propagation

#### 42. Radiowave Propagation Over Rough Terrain

"Fresnel Coefficient for Rough Terrain," by S. Ya. Braude, Institute of Radiophysics and Electronics, Academy of Sciences Ukrainian SSR; Gor'kiy, Izvestiya Vysshikh Uchebnykh Zavedeniy, Radiofizika, Vol 2, No 5, 1959, pp 691-696

To determine the mode of radiowave propagation and the radiation pattern of the antenna array, it is necessary to find the coefficient of reflection. In case of radiowave propagation over rough terrain, it is also necessary to take into account the effect due to scattering of electromagnetic waves, in addition to the effect due to reflection and refraction.

The article presents a method for calculation of the Fresnel reflection coefficient for uneven terrain with rather gentle slopes. The concept of effective permittivity and conductivity is introduced to facilitate the determination of radiowave propagation over uneven terrain. By replacing the real electrical parameters of the ground with its effective values, it is possible to reduce the problem to that of radiowave propagation over flat terrain.

From the calculation presented, it is seen that the Fresnel coefficient for rough terrain depends on the permittivity and conductivity of the ground, the wave length, the angle of glance, and the degree of terrain roughness.

43. Unretarded-Wave Oscillator

"Phase Interaction of Harmonically Oscillating Electrons With the Field of an Unretarded Backward Wave," by P. A. Borodovskiy, Institute of Radiophysics and Electronics, Siberian Branch of Academy of Sciences USSR; Novosibirsk, Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR, No 11, 1959, pp 3-10

The article discusses the approximation theory of interaction between harmonically oscillating electrons with the unretarded backward wave, which propagates in a waveguide with transverse hyperbolic field. The accelerating and reflecting electrodes of the oscillator have such a shape as to form a hyperbolic electric field. In the presence of a sufficiently strong uniform magnetic field, the electrons emitted from the cathode will harmonically oscillate with respect to the axis X and at the same time propagate in forward direction along the Z axis at a definite velocity. A matched load is capacitively coupled to the waveguide system. An effective energy exchange and electron bunching take place when an electromagnetic wave travels along the line with a velocity equal to the phase velocity of the charge. The electrons accelerated by the wave field arrive at the reflector and are removed from further interaction. The electrons transmitting their energy to the wave field pass through the interaction space and are caught by the collector.

The transverse dimensions of the device and intensity of magnetic field are selected in such a manner as to prevent the electrons from reaching the accelerating electrode, which has a high positive potential with respect to the cathode. The frequency of the oscillator can be controlled within a certain limit by changing the negative potential of the reflector.

44. Methods for Decreasing Attenuation in Circular Wave Guides

"The Effect of Periodic Annular Slots and a Thin Layer of Dielectric on Attenuation of Waves in a Circular Wave Guide," by V. P. Shestopalov and A. I. Adoniana, Khar'kov State University; Moscow, Zhurnal Tekhnicheskoy Fiziki, No 12, Dec 59, pp 1457-1461

The article explains how attenuation losses in a continuous circular wave guide, cause by the degeneration of the mode  $H_{01}$  wave into mode  $E_{11}$ , can be substantially reduced by introducing periodic or helical slots. A mathematical analysis is given of wave guides with a thin layer of dielectric and with annular and helical slots.

45. Trochoidal-Beam Amplifier

"Interaction of Electron Beam and Electromagnetic Waves in Wave Guide Systems With Removal of Accelerated Electrons," by V. M. Bkov, Scientific-Research Radiophysics Institute, Gor'kiy University; Gor'kiy, Izvestiya Vysshikh Uchebnykh Zavedeniy, Radiofizika, Vol 2, No 5, 1959, pp 730-740

Interaction of a trochoidal electron beam with a fast electromagnetic wave moving in a crossed electric and magnetic field is examined for the condition when the improperly phased electrons are removed from the system. The described amplifying system utilizes "forced" bunching, which is accomplished by means of attracting the particles accelerated by the ac field to one of the electrodes of the system. If the trochoidal trajectories of the electrons touch one of the wave-guide walls ("slender" beam), a complete bunching will occur in the first period if a high-frequency field is superimposed over the system. The electrons accelerated by the field will be attracted to the wave-guide walls, while the electrons retarded in the wave field will transfer energy to the high-frequency field. Thus, the energy increase of the electromagnetic wave is due to the work done by particles moving in the retarding field.

Interaction of such a nature is more effective than that encountered in the conventional traveling-wave devices in which self-phasing is due to density modulation of the particles. The traveling-wave amplification in this type of device is achieved through the mechanism of removal of accelerated electrons, which is accomplished with the aid of an absorption electrode located close to the modulated trajectory and by appropriate polarization of the high-frequency electric field.

46. Experimental Data on Trochoidal-Beam Amplifier

"Experimental Investigation of Amplifier With Traveling Wave and Trochoidal Electron Beam in Which Accelerated Electrons Are Removed," by I. I. Antakov and R. P. Vasil'yev, Scientific-Research Radiophysics Institute, Gor'kiy University; Gor'kiy, Izvestiya Vysshikh Uchebnykh Zavedeniy, Radiofizika, Vol 2, No 5, 1959, pp 741-747

The article describes experimental investigation of an amplifier with traveling wave and trochoidal electron beam controlled by crossed electric and magnetic fields, in which the amplification is obtained by interaction of the traveling wave and space harmonics of the current. To attain the desired interaction of centimeter waves with fast current harmonics, a magnetic field of the order of several thousand oersteds is required.

The experimental test with a trochoidal-beam amplifier has proven its usefulness as an amplifier for medium and large power output.

47. Decelerating Dielectrics

"Study of Decelerating Systems of the Type Helix-Anisotropic Dielectric and Helix-Rib Structure," by V. P. Shepalov and V. A. Slyusarskiy, Kharkov State University imeni Gor'kiy; Moscow, Zhurnal Tekhnicheskoy Fiziki, Vol 29, No 11, Nov 59, pp 1317-1329

Dispersion equations for a helix located in an anisotropic dielectric were obtained, as well as the dispersion of the power flux in such a system. The limit of transition from a decelerating system helix-anisotropic dielectric to the system helix-rib structure was obtained. The possibilities of using a helical wave guide with uniform pitch of the helix in traveling-wave tubes have been studied.

IV. ENGINEERING

48. Trends in Research on Heat Transfer

"The Present-Day Status and Prospects of Work in the Field of Heat Transfer," by B. S. Petukhov, Doctor of Technical Sciences, Moscow, Power Institute; Moscow, Teploenergetika, No 12, Dec 59, pp 3-13

Fundamental problems of heat transfer are discussed, with particular attention to developments in this field in the USSR. Heat conductivity, heat transfer by convection in a single-phase medium, heat transfer during boiling and condensation, and heat transfer by radiation are reviewed in some detail under appropriate subject headings. The importance of heat transfer in nuclear technology, aviation, and the design of rockets and rocket engines, and in connection with the passage of ballistic missiles through the atmosphere is pointed out. It is stated that systematic investigation of heat transfer phenomena began both in the USSR and outside of the USSR in the 1920s. Because of the development of nuclear technology after World War II and the emphasis placed on rockets and space missiles in recent years, increased attention has been paid to research on heat transfer during the past 10-15 years. Problems pertaining to heat transfer arise in connection with the work on controlled thermonuclear reactions that is being done at present.

In the section on heat transfer by convection in single-phase media, the problems pertaining to the evaluation of heat transfer and friction at very high temperatures (above  $2,500^{\circ}\text{K}$ ) under conditions arising during the motion of objects through the atmosphere at supersonic velocities are considered. The chemical aspects of the thermal dissociation of molecules in the external stream (behind a shock wave or in the boundary layer) and the recombination of atoms in the colder parts of the boundary layer are discussed. It is pointed out that at still higher temperatures (in the vicinity of  $10,000^{\circ}\text{K}$ ), the gas becomes ionized and, consequently, subject to the action of a magnetic field. Under these conditions, the motion of the gas is described by equations of magnetic hydrodynamics. The effects of turbulence on heat transfer are discussed in some detail.

The problem of heat transfer and friction under conditions of interaction of the boundary layer with the compressor shock is formulated and defined. It is stated that a values of  $M \sim 10$  and higher, the temperatures which arise behind the front of the shock wave and in the boundary layer are so high that one must consider, in estimating the heat transfer, not only the compressibility and the change in the physical parameters of the gas, but also the phenomena of dissociation into ions and recombination into molecules (as has already been pointed out above) under consideration of the catalytic action exerted by the wall.

Because of the great complexity of the problem, theoretical analysis of heat transfer has been carried out principally under consideration of conditions encountered in limiting cases, namely, at an infinitely great velocity of the reaction in the gas phase (thermodynamic equilibrium) or at an infinitely small velocity (the condition encountered when a chemically "frozen" flow exists). As far as the catalytic action of the wall is concerned, one assumes that the wall is either a perfect ("ideal") catalyst or exerts no catalytic action at all. In the investigations being published, heat exchange in the laminar boundary layer adjacent to the front part of bodies with a blunt tip ("nose") is considered principally because the mathematical relationships are greatly simplified thereby. As far as conditions existing in cases when the boundary layer is turbulent are concerned, the treatment given to the subject must involve a very great amount of approximation.

The special problem involved in flight in the upper reaches of the atmosphere and beyond the confines of the atmosphere involves consideration of heat transfer and air resistance in a stream of rarefied gas of very high velocity. A specific characteristic of this problem is the fact that the medium cannot be regarded as continuous.

The region of high degrees of rarefaction (free molecular flow) has been subjected to thorough investigation on the basis of the latest results of the molecular kinetic theory. The region of gliding flow, which lies between the free molecular and the continuous medium regions, does not lend itself readily to a theoretical treatment. For this reason, only approximate theoretical results have been obtained in studies of this field. Very few experimental data are available either on the region of rarefied gas or the continuous medium region. For this reason, experimental work must be carried out in a wide range of degrees of rarefaction at high values of  $M$ .

49. New Testing Rules Effective April 1960

"New Rules for Conducting Tests of Measures and Measuring Instruments," by L. M. Zaks, N. M. Karelin, and N. I. Tyurin; Moscow, Izmeritel'naya Tekhnika, No 12, Dec 59, pp 3-5

The Committee on Standards, Measures, and Measuring Instruments of the Council of Ministers has prepared rules "2-59" for conducting, on a nationwide basis, the testing of measures and measuring instruments. These rules will be applied to the newly designed, as well as the presently manufactured, instruments in the USSR and will become effective on 1 April 1960, superseding the present rules "2-56."



The new rules are compiled in accordance with the requirements set up by the 21st Congress of the Communist Party of the Soviet Union and the July Plenum of the Central Committee of the Communist Party, are for the purpose of accelerating the general tempo of technical progress, and will assist faster assimilation of modern technology by industry. These new rules are in line with the increasing complexity of control equipment used in automation of various industrial processes.

50. Standardization of Miniature Motors

"Standardized Characteristics for a Series of DC Miniature Motors," by G. A. Stambulyan; Moscow, Vestnik Elektropro-myshlennosti, No 12, Dec 59, pp 36-39

At present, USSR industry manufactures dc miniature motors for voltages from 4 to 36 v and for rated speeds of 2,000 to 10,000 rpm. Planned Automation and mechanization in all fields of the Soviet national economy during the current Seven-Year Plan will greatly increase the demand for miniature motors. Therefore, the problem of creating a unified series of dc miniature motors becomes of great urgency. A unified series of these motors, satisfying the needs of all fields of technology, should have any required combination of voltages and speeds within the indicated limits, i.e., for a comparatively restricted number of basic motor designs, there should be a rather large number of motor winding combinations.

The design principles of such a unified series of standardized dc miniature motors is given in this article.

71. 800,000 KW Steam Turbine in Process of Design

"Giant Steam Turbine" (unsigned article); Moscow, Sovetskaya Aviatsiya, 11 Feb 1960

The article claims that for the first time in electrical machine building practice, the design of a 800,000-kw turbine has been undertaken at the Khar'kov Plant imeni Kirov. The rough model of this unit has already been completed, and detailed design of the components of the giant turbine has just begun. This 800,000-kw steam turbine will be of two-shaft, seven-cylinder design and will incorporate the design experience of the single-shaft 300,000-kw steam turbine which is now in the production stage at the same plant. This turbine will operate at 3,000 rpm and steam parameters of 240 atmospheres pressure at 580°C.

It is expected that the first 800,000-kw turbine will be completed at the Khar'kov Plant sometime between 1963 and 1964.

The chief designer of the Khar'kov plant, L. A. Shubenko-Shubin, stated that the plant will be in a position to build single-unit steam turbines with generating capacity of one million kw and 1.2 million kw within the next few years.

52. Ultrasonic Survey of River Bed Deposits

"Survey for Thickness of the Gravel-Pebble Deposits by a Sounding Method," by V. I. Savel'yev; Moscow, Gidrotekhnicheskoye Stroitel'stvo, No 12, Dec 59, pp 43-44

In 1957-1958, investigations were conducted on the Yenisey River at the sites of Yeniseyskaya and Krasnoyarskaya hydroelectric stations to evaluate the feasibility of the sounding method in determining the thickness of the gravel deposit in river beds. The sounding survey with a 21-kc sound wave conducted at the site of the Yeniseyskaya hydroelectric station has proven the usefulness of the method if the pebbles do not exceed 5 cm in diameter. Other sounding tests were conducted at sound-wave frequencies of 30, 21, 15, and 10 kc.

From the results of the experiment, it was concluded that the sounding method is a valuable auxiliary means in determining the thickness of the gravel deposit in the river bed during surveying for projected power dams.

## V. MATHEMATICS

53. Eigenfunction Expansions for Operators

"Eigenfunction Expansions for a Difference Operator With Operator Coefficients " by I. N. Senchikhina; Kiev, Ukrainskiy Matematicheskiy Zhurnal, Vol 11, No 2, Apr-Jun 59, pp 183-191

A difference operator of the form

$$L(u_j) = a_{j-1} u_{j-1} + b_j u_j + a_j u_{j+1} \quad (j=0, 1, 2, \dots)$$

is considered where  $u_j$  are elements of a certain Hilbert space and  $a_j$ ,  $b_j$  are bounded operators acting in this space. The operator is considered on a Hilbert space of the sequences

$$u = (u_0, u_1, \dots) \quad (\sum_j \|u_j\|^2 < \infty)$$

with a scalar product  $\langle u, v \rangle = \sum (u_j, v_j)$ .

The fundamental result of the paper is the construction of eigenfunction expansions for this operator.

54. Rational Solutions of Painleve's Equation

"Concerning Rational Solutions of the Second Equation of Painleve," by A. I. Yablonskiy; Minsk, Izvestiya Akademii Nauk Belorusskoy SSR seriya Fiziko-Tekhnicheskikh Nauk, No 3, Jul-Sep 59, pp 30-35

It is known (H. Schubart, Zur Wertverteilung der Painleveschen Transcendenten [On the Distribution of Values of Painleve Transcendentals], Arch. Math., No 7, 1956) that for  $\alpha = 0$ ,  $\alpha = 1$ ,  $\alpha = -1$ , the equation

$$w'' = 2w^3 + zw + \alpha \quad (1)$$

has the corresponding solutions  $w = 0$ ,  $w = -\frac{1}{z}$  and  $w = \frac{1}{z}$ .

In the above-mentioned work, it is proven that the equation (1) cannot have rational solutions, except the ones indicated, for any  $\alpha$ . However, there is an error in the proof, and this assertion is not correct.

In the present work, it is proved that rational solutions other than the ones indicated exist for the equation (1). It is also proved that for  $\alpha$  not equal to a whole number, equation (1) has no rational solutions. In addition, it is proved that if a rational solution exists, it is unique for the given  $\alpha$ . The initial conditions for the latter are also presented. It is proved that all rational solutions, different from the ones mentioned in the above-mentioned source, have poles with residues equal to 1 and -1.

#### 55. Spectral Equivalence of Operators

"Concerning the Spectral Equivalence of Two Operators," by G. V. Virabyan, Moscow State University; Moscow, Doklady Akademii Nauk SSSR, Vol 128, No 1, Sep 59, pp 13-16

Equations for the small oscillations of a rotating fluid have been considered by a number of authors. S. L. Sobolev (Izv. AN SSSR, ser. matem., Vol 18, No 1, 1954) established that a system of these equations reduces to an equation of the fourth order, namely,

$$\frac{\partial^2 \Delta \Phi}{\partial t^2} + \frac{\partial^2 \Phi}{\partial z^2} = 0,$$

or, in operator form,

$$\frac{\partial^2 \Phi}{\partial t^2} = -B\Phi \quad (B = \Delta^{-1} \frac{\partial^2}{\partial z^2}), \text{ by introducing}$$

the corresponding potential.

The problem concerning the spectral properties of the operator B of the fourth order and the operator C expressing the derivative of the velocity of oscillations of the rotating fluid is interesting.

In the present work, the spectral equivalence of these two operators is established in a certain sense.

56. Fundamental Theorem of Shannon Formulated

"General Formulation of the Fundamental Theorem of Shannon in Information Theory," by R. L. Dobrushin; Moscow, Uspekhi Matematicheskikh Nauk, Vol 14, No 6(90), Nov/Dec 59, pp 3-104

The article is divided into the following parts:

Part 1 Introduction

Part 2 The Fundamental Properties of Information

Part 3 Feinstein's Lemma Concerning a Transmitting Device

Part 4 The Fundamental Lemma Concerning Communication

Part 5 Proof of the Fundamental Theorems

Part 6 A transmitting Device Without Memory and Communication With Independent Components.

A translation of the first two sections of the introduction is presented below. Bracketed numbers refer to sources mentioned in original paper and appended to this translation.

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Section 1.1 Historical and Introductory Remarks. In the materially rich book of Shannon and Weaver [ 1 ], the fundamental concepts of information theory were presented and the fundamental theorem of the theory rigorously obtained at the physical level. Thereafter, the works of B. MacMillan [ 2 ] and A. Ya. Khinchin [ 3 ], [ 4 ] appeared, in which a rigorous interpretation of Shannon's theorem was given in the case of a discrete stationary source and channel with the requirement of exact coincidence of the received communication and the transmitted. For this, A. Ya. Khinchin substantially built on the notion contained in the work of Feinstein [ 5 ]. The works of Khinchin were developed in application to processes with a continuous set of conditions by M. Rozenblat-Rot [ 6 ], [ 7 ], and in particular by A. Perez [ 8 ], [ 9 ], and [ 10 ], Rozenblat-Rot also proved the possibility of extending the theory to non-stationary processes. The recent works of J. Wolfowitz [ 11 ], [ 12 ] and the work of D. Blackwell, L. Breiman, and A. J. Thomasian [ 13 ] are also interesting.

A. N. Kolmogorov [ 11 ] proved the theorem of Shannon stated in an extremely general form using a mathematically rigorous treatment. The purpose of the present is work to prove Shannon's theorem in the interpretation of Kolmogorov for sufficiently general conditions. These general conditions are formulated with the help of the concept of information density, introduced in mathematical literature by I. M. Gel'fand and A. M. Yaglom (see [ 14 ] and [ 15 ] and A. Perez [ 8 ]). The commonly used general concept of information stability discussed below was induced by several ideas orally expressed by the first two authors.

We note at once that justification of our conditions for concrete classes of processes in a nontrivial and fundamentally (still unsolved) problem.

In this work, the author endeavors to limit exposition to the widest natural boundaries of generality and to conduct the argument in a mathematically rigorous manner. In view of this, although no particular assumptions are made concerning the reader's knowledge of information theory, a solid training in the regions of measure theory is assumed, for example, the contents of the book [ 16 ]. This article is not recommended for a reader first becoming acquainted with the subject inasmuch as it will appear too bulky and abstract. Among the list of papers and books sufficing the beginner are the works of A. Ya. Khinchin [ 3 ], S. Goldman [ 17 ], C. E. Shannon and W. Weaver [ 1 ], and J. Wolfowitz [ 12 ]. In particular, we mention the work of Kolmogorov [ 11 ], the notion of which is developed in this paper and excellently described in the book of Feinstein [ 18 ]. A short report of that work was published by P. L. Dobrushin, in 1958 [ 19 ]. More detailed fundamental results were formulated in the work of R. L. Dobrushin [ 20 ].

Section 1.2 Information. We shall recall several general definitions in order to make our use of terminology more exact. We will call the set  $X$  together with the  $\sigma$ -algebra  $S_X$  of the subsets of the set  $X$  the measurable space  $(X, S_X)$ . Sometimes, when it cannot lead to misunderstandings, we will denote the measurable set by the one letter  $X$ . We will define the measurable space  $(\Omega, \beta)$  together with the  $\sigma$ -algebra  $\beta$  of the probability measure  $P[ \ ]$  as the probability space  $(\Omega, \beta, P)$ . We will define a measurable function  $\xi(\omega), \omega \in \Omega$ , with values in the space  $X$ , to be a random variable with values in the space  $X$ . We will define the probability measure  $p(\cdot)$  on  $(X, S_X)$ , defined by the equality

$$p_{\xi}(A) = P[\xi(\omega) \in A], A \in S_X,$$

to be the distribution of probabilities  $p_{\xi}(\cdot)$  of the random variable  $\xi$ . We will define any finite system of nonintersecting sets, entering in  $S_X$  and by the union giving the entire space  $X$ , as a partition of the measurable space  $X$ .

If  $(X, S_X)$  and  $(Y, S_Y)$  are two measurable spaces, then we will define the product of these spaces to be the measurable space  $(X \times Y, S_X \times S_Y)$  formed by the set  $X \times Y$  of pairs having the form  $(x, y)$ ,  $x \in S_X$ ,  $y \in S_Y$  and the  $\sigma$ -algebra  $S_X \times S_Y$ , generated by the sets  $A \times B$  of pairs  $(x, y)$ , defined by  $x \in A$ ,  $y \in B$ , where  $A \in S_X$ ,  $B \in S_Y$ . We may, in a natural manner, interpret the pair of random variables  $\xi$  and  $\eta$  as one random variable with values in the product space  $X \times Y$ . We will designate

this new random variable by  $(\xi, \eta)$ . We will define the joint distribution of the quantities  $\xi$  and  $\eta$  to be the distribution of the pair  $p_{\xi, \eta}(\cdot, \cdot)$ , having the measure in  $X \times Y$ , and denote the lower parentheses by  $p_{\xi, \eta}(\cdot)$ . If the respective probability measures  $p_1(\cdot)$  and  $p_2(\cdot)$  are given on the measurable spaces  $X$  and  $Y$ , we will define their measure product to be  $p_1 \times p_2(\cdot)$  on  $S_X \times S_Y$  such that for a set of the form  $A \times B$ , where  $A \in S_X, B \in S_Y, p_1 \times p_2(A \times B) = p_1(A) p_2(B)$  and for the remaining sets from  $S_X \times S_Y$ , it is extended in the natural manner (see P. Halmos [16], section 35 for the proof of the existence and uniqueness of this extension). If the joint distribution  $p_{\xi, \eta}(\cdot)$  coincides with the product  $p_{\xi} \times p_{\eta}$ , then the quantities  $\xi$  and  $\eta$  are defined as independent.

We now let two random variables  $\xi$  and  $\eta$  be given which assume values in the measurable spaces  $(X, S_X)$  and  $(Y, S_Y)$ . We define the number

$$\begin{aligned}
 I(\xi, \eta) &= \sup_{i, j} \sum P[\xi \in A_i, \eta \in B_j] \log \frac{P[\xi \in A_i, \eta \in B_j]}{P[\xi \in A_i] P[\eta \in B_j]} = \\
 &= \sup_{i, j} \sum p_{\xi, \eta}(A_i \times B_j) \log \frac{p_{\xi, \eta}(A_i \times B_j)}{p_{\xi}(A_i) p_{\eta}(B_j)} \quad (2)
 \end{aligned}$$

to be the information of these random variables where the upper bound is chosen with respect to all possible partitions  $\{A_i\}$  of the space  $X$  and all possible partitions  $\{B_j\}$  of the space  $Y$ . The number  $I(\xi, \eta)$  is defined as the entropy of the random variable  $\xi, \eta$ . Here, as in the future, the logarithm to the base 2 is employed. We will always consider that  $0 \log \frac{0}{a} = 0$  for  $a \geq 0$ , that  $a \log \frac{a}{0} = +\infty$ , and that  $+\infty \pm a = +\infty$ . It is not difficult to prove (see section 2.1) that the information is nonnegative. It may assume the value  $+\infty$ . In view of the fact that until now the complete choice of the fundamental properties of information was not published, we cite the formulation and proof of part 2 [of this paper].

We will not indicate the fact quickly following from definition (2). If the quantities  $\xi$  and  $\eta$  are independent, then  $I(\xi, \eta) = 0$ .

We proceed to formulate the independence obtained by I. M. Gel'fand [14], A. M. Yaglom [15], and A. Perez [8], which is particularly important for our purpose. We consider two probability measures on the measurable space  $(X \times Y, S_X \times S_Y)$ : the joint distribution  $p_{\xi, \eta}(\cdot)$  and the product distribution  $p_{\xi} \times p_{\eta}(\cdot)$ . It is known that the following alternatives hold (see [16], section 30-31):

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(1) The Case of Nonabsolute Continuity. For this case, there exists a set  $B \in S_X \times S_Y$  such that  $p_{\xi} \times p_{\eta}(B) = 0$ , but  $p_{\xi\eta}(B) > 0$ .

(2) The Case of Absolute Continuity. In this case, for any  $B \in S_X \times S_Y$  such that  $p_{\xi} \times p_{\eta}(B) = 0$ , it follows that  $p_{\xi\eta}(B) = 0$ . Then (by the theorem of Radon-Nikodim), there exist functions  $a_{\xi\eta}(x, y)$ ,  $(x, y) \in X \times Y$ , assuming finite nonnegative values and measurable with respect to the  $\sigma$ -algebra of  $S_X \times S_Y$ , such that for any  $B \in S_X \times S_Y$  the probability  $p_{\xi\eta}(B)$  is given by the integral of  $a_{\xi\eta}(x, y)$  and the measure  $p_{\xi} \times p_{\eta}(\cdot)$  over  $B$ , namely,

$$p_{\xi\eta}(B) = \int_B a_{\xi\eta}(x, y) p_{\xi} \times p_{\eta}(dx, dy). \quad (3)$$

We will define the quantity  $a_{\xi\eta}(x, y)$  as the density of the measure  $p_{\xi\eta}(\cdot)$  relative to the measure  $p_{\xi} \times p_{\eta}(\cdot)$  and designate the condition by

$$a_{\xi\eta}(\cdot, \cdot) = \frac{dp_{\xi\eta}(\cdot)}{dp_{\xi} \times p_{\eta}(\cdot)}.$$

In case (1), the information is infinite, and in case (2), it is given by

$$I(\xi, \eta) = \int_{X \times Y} \log a_{\xi\eta}(x, y) p_{\xi\eta}(dx, dy) = \quad (4)$$

$$= \int_{X \times Y} a_{\xi\eta}(x, y) \log a_{\xi\eta}(x, y) p_{\xi} \times p_{\eta}(dx, dy),$$

where the integrals in (4) exist in that sense that the integrals of the negative portions of the integrand functions converge. The derivation of the formula (3), which we will define as the integral formula for the information, is presented in section 2.4. In accordance with what was written above, we will define the function

$$i_{\xi\eta}(x, y) = \log a_{\xi\eta}(x, y)$$

to be the information density of the variables  $\xi$  and  $\eta$ . It is now possible to write the relation (4) in the form

$I(\xi, \eta) = M i_{\xi\eta} \{ \xi, \eta \}$ . Here, as in the future, we will designate the mathematical expectation by  $M \{ \cdot \}$ . We will say that if  $p_{\xi\eta}$  is nonabsolutely continuous with respect to  $p_{\xi} \times p_{\eta}$ , then the information density of the variables  $\xi$  and  $\eta$  does not exist.



In the simpler cases, it is possible to give expressions for  $i_{\xi\eta}(x, y)$  not based on the theorem of Radon-Nikodim. For example, let the  $\sigma$ -finite measures  $\mu_X \{.\}$  and  $\mu_Y \{.\}$  be given corresponding to  $S_X$  and  $S_Y$ . It is natural to choose the ordinary measure of Lebesgue in the role of  $\mu_X \{.\}$  and  $\mu_Y \{.\}$  if  $X$  and  $Y$  are finite-measurable Euclidean spaces. Further, let one-dimensional distribution  $p_\xi(.)$  and  $p_\eta(.)$  of the quantities  $\eta, \xi$  and the joint distribution  $p_{\xi\eta}(.)$  of these variables be given by densities, that is by functions  $\pi_\xi(x), \pi_\eta(y)$  and  $\pi_{\xi\eta}(x, y)$ , corresponding respectively to  $S_X, S_Y$ , and  $S_X \times S_Y$ , such that

$$p_\xi(A) = \int_A \pi_\xi(x) \mu_X \{dx\} \quad A \in S_X,$$

$$p_\eta(B) = \int_B \pi_\eta(y) \mu_Y \{dy\} \quad B \in S_Y,$$

$$p_{\xi\eta}(C) = \int_C \pi_{\xi\eta}(x, y) \mu_X \times \mu_Y \{dx, dy\}, \quad C \in S_X \times S_Y.$$

Then it is not difficult to see that the information density almost-everywhere on  $X \times Y$  in the sense of the distribution  $p \times p(.)$  is

(5)  $i_{\xi\eta}(x, y) = \log \frac{\pi_{\xi\eta}(x, y)}{\pi_\xi(x) \pi_\eta(y)}$ . This follows for example from theorem 1, section 32 of [16]. Analogously, if  $X$  consists of a countable number of points  $E_1, E_2, \dots$ ,  $Y$ , from a countable number of points  $\bar{E}_1, \bar{E}_2, \dots$ , and  $S_X$  and  $S_Y$  consist respectively of all the subsets of the sets  $X$  and  $Y$ , then it is natural to give the distributions  $p_\xi, p_\eta$ , and  $p_{\xi\eta}$  by the probabilities

$$\begin{aligned} p_\xi^{(i)} &= p_\xi(E_i), \\ p_\eta^{(j)} &= p_\eta(\bar{E}_j), \\ p_{\xi\eta}^{(i, j)} &= p_{\xi\eta}(E_i, \bar{E}_j). \end{aligned}$$

Then

(6)  $i_{\xi\eta}(E, \bar{E}_j) = \log \frac{p_{\xi\eta}^{(i, j)}}{p_\xi^{(i)} p_\eta^{(j)}}$ , and the definition (4) converges

to the general formula of Shannon

$$I(\xi, \eta) = \sum_{i, j} p_{\xi\eta}^{(i, j)} \log \frac{p_{\xi\eta}^{(i, j)}}{p_\xi^{(i)} p_\eta^{(j)}}.$$

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It is possible to transform the expressions for information density (5) and (6) to  $i_{\xi\eta}(x, y) = \log \frac{p_{\xi\eta}(x, y)}{\prod_{\xi} p_{\xi}(x)}$  and  $i_{\xi\eta}(E_i, \bar{E}_j) = \log \frac{p_{\xi\eta}(E_i/\bar{E}_j)}{p_{\xi}(E_i)}$  by employing conditional probabilities and conditional densities.

Goldman [17] used information density in this form, defining with its help, the concept of information.

The portion of the 34 sources mentioned in the original paper and included in the present extract are as follows:

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- [18] A. Feinstein. Foundations of Information Theory, McGraw-Hill Book Company, Inc., New York, Toronto, London, 1958.
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57. Solutions of the Equation  $Au + V \cdot u = 0$  Discussed

"On Positive Solutions of the Equation  $Au + V \cdot u = 0$ ," by R. Z. Khas'minskiy; Moscow, Teoriya Veroyatnostey i yeye Primeneniya, Vol 4, No 3, Jul-Sep, pp 332-341

Let  $X_t$  be the path of a continuous Markov process in the domain  $D$  with boundary  $\Gamma$  in a metric space. Let  $\tau$  be the moment of reaching  $\Gamma$ , let  $A$  be the extended infinitesimal operator of the process, and let  $V$  be a continuous nonnegative function defined in  $D$ .

The theorem proved in the work is as follows:

Let  $\Gamma$  be regular for the process  $X$  in the sense  $P_x \{ X_\tau \in U_{x_0} \} \rightarrow 1$  for  $x \rightarrow x_0$  for any neighborhood  $U_{x_0}$  and for all  $x_0 \in \Gamma$ . Let  $X_t$  be a strong Feller process; then  $M_x \exp \left\{ \int_0^\tau V(X_t) dt \right\} < +\infty$  if and only if the equation  $Au + V \cdot u = 0$  has a solution positive and continuous in the union  $D \cup \Gamma$ .

This theorem is applied for different conditions which guarantee the existence of a unique solution of the first boundary value problem for the equation  $Au + V \cdot u = 0$ . Stability of the maximum eigenvalue of the operator  $Au + Vu(u|_\Gamma = 0)$  is also proved by some global changes of domain.

58. Trends of Mathematical Statistics Discussed

"Investigations According to the Theory of Probability and Mathematical Statistics in the System of the Academy of Sciences of the Ukrainian SSR," by B. V. Gnedenko; Kiev, Ukrainskiy Matematicheskiy Zhurnal, Vol 11, No 2, Apr-Jun 59, pp 123-136

A brief review is presented of the trends of investigations in the theory of probability and mathematical statistics performed in the Academy of Sciences Ukrainian SSR.

59. Differentiation With Respect to a Parameter

"Application of the Method of Differentiation With Respect to a Parameter to the Solution of Nonlinear Equations in Banach Spaces," by N. A. Shidlovskaya; Leningrad, Uchenyye Zapiski Leningradskogo Ordena Lenina Gosudarstvennogo Universiteta imeni A. A. Zhdanova, Seriya Matematicheskikh Nauk, No 271, 1958, pp 3-17

The method of differentiation with respect to a parameter was presented in the works of D. F. Davidenko, "Concerning a New Method for the Numerical Solution of Systems of Nonlinear Equations," DAN, Vol 88, No 4, 1953, pp 601-604 and "Concerning the Approximate Solution of Systems

of Nonlinear Equations," Ukr. matem. zhurnal, Vol 5, No 2, 1953, pp 196-206, for the numerical solution of systems of nonlinear equations, depending on a parameter. The possibility of applying the method for the solution of algebraic, transcendental, and nonlinear integral equations was proven. A particular case of the method is also encountered in the work of V. A. Fok, "Diffraction of Radio Waves Around the Earth's Surface," Izd. AN SSSR, Moscow-Leningrad, 1946.

In the present work, a method of differentiation with respect to a parameter is presented for nonlinear equations in linear, normalized spaces. This method may be applied, in particular, to nonlinear integral equations and to boundary value problems for nonlinear differential equations in partial derivatives.

#### 60. Nonlinear Elliptic and Parabolic Equations

"Boundary Value Problems for Nonlinear Parabolic Equations," by Ch'ou Yee ling; Peiping; Matematicheskii Sbornik, Vol 47 (89), No 4, Apr 59, pp 431-434

Several boundary value problems for a quasilinear parabolic equation of two independent unknowns and having nonlinear boundary conditions, as well as a second boundary value problem for a quasilinear parabolic equation of many unknowns, are discussed. The solution of the second boundary value problem for several quasilinear elliptic equations is obtained as a limit considering the corresponding problem for a parabolic equation as  $t$  approaches  $\infty$ .

In addition, a priori estimates for the derivatives of the solutions for quasilinear elliptic and parabolic equations are obtained analogous to the estimates of S. N. Bernshteyn (see "Bounds for the Moduli of Successive Derivatives of Solutions for Equations of the Parabolic Type," DAN SSSR Vol 18, No 7, 1938, pp 385-388 and "Concerning Equations of the Calculus of Variations," Uspekhi matem. nauk, No 8, 1940, pp 32-74).

#### 61. Nonlinear Operators

"Nonlinear Operators and Hammerstein's Equations in the Orlich Spaces," by M. M. Vaynberg and I. V. Shragin, Moscow Oblast Pedagogical Institute imeni N. K. Krupskaya, Kostroma State Pedagogical Institute imeni N. A. Nekrasov; Moscow, Doklady Akademii Nauk SSSR, Vol 128, No 1, Sep 59, pp 9-12

New theorems concerning the uniqueness and existence of a solution for the nonlinear equation

$$u(x) = \int_B K(x, y) g[u(y), y] dy \equiv \Gamma u,$$

as well as theorems concerning the existence of eigenfunctions of the Hammerstein operator  $\Gamma$ , are proved in the Orlich spaces.

The fundamental difference between the methods and assumptions here and those of earlier theorems is included in the fact that in the present work the complete continuity of the linear integral operator

$$Av = \int_B K(x, y) v(y) dy \text{ is not assumed.}$$

62. One-Dimensional Scheme of Random Wandering

"Asymptotic Analysis of the Probability of Absorption in a One-Dimensional Scheme of Random Wandering With a Lattice Distribution of Crossing Probabilities," by V. S. Korolyuk, Mathematics Institute, Academy of Sciences Ukrainian SSR; Kiev, Dopovidi Akademii Nauk Ukrainskoy RSR, No 7, Jul 59, pp 702-707

An asymptotic representation is given for the probability  $u_\epsilon(x)$  of reaching the region  $x \leq 0$  when starting from point  $x$ , without entering the region  $x \geq 1$  in a one-dimensional scheme of random wandering having a lattice distribution of crossing probabilities. The representation is in the form of a series involving powers of  $\epsilon$  where  $\epsilon$  is the maximum step of distribution of the crossing probability.

63. Mean in Stationary Processes Estimated

"On the Estimation of the Mean in Stationary Processes," by S. Ya. Vilenkin; Moscow, Teoriya Veroyatnostey i yeye Primeneniya, Vol 4, No 4, Oct-Dec 59, pp 451-453

The variance of the estimate

$$\sigma_{N+1}^2 = \frac{1}{N+1} \sum_{i=0}^N \xi \left( \frac{i}{N} - T \right)$$

for the mean of a stationary process  $\xi(t)$  is shown to attain its minimum value for some finite  $N$ .

64. Analytic Random Processes Investigated

"Analytic Random Processes," by Yu. K. Belyayev; Moscow, Teoriya Veroyatnostey i yeye Primeneniya, Vol 4, No 4, Oct-Dec 59, pp 437-444

The paper is devoted to investigating analytic random processes. A random process  $\xi(t)$  is called analytic in a region D if almost all of its sample functions are analytic and possess an analytic continuation in the region D. Analyticity of the covariant function  $B(t,s) = M \xi(t)\xi(s)$  in the neighborhood of  $(t_0, t_0)$  is a sufficient condition for analyticity of  $\xi(t)$  in the neighborhood of  $t_0$ . This condition is also necessary for Gaussian processes.

Other problems connected with analytic processes are also investigated.

VI. MEDICINE

Aviation Medicine

65. Progress in Space Research

"So Begins the Assault on Space," by A. Yerebin and V. Smirnov; Moscow, Meditzinskiy Rabotnik, No 89, (1837), 7 Nov 59, p 4

This brief item asserts that the launching of the first artificial earth satellite by the USSR inaugurated a new era in man's conquest of space. Soon, says the article, earth-bound man will be able to travel to other planets. Before this dream can become a reality, it is pointed out, scientists must solve the problem of re-entry.

Soviet scientists have been conducting experiments on animals under laboratory conditions and have launched rockets containing animals. The spectacular launching of the second Soviet artificial earth satellite with a dog, Layka, is now well known.

Soviet scientists are developing special altitude equipment for high-altitude emergency conditions and are conducting laboratory tests under simulated conditions. All vital functions of the human organism are being investigated, and research on methods of training humans for life and activity under unusual conditions is in progress.

66. Soviets Develop New Prosthetic Device

"Artificial Hand for Astronauts" (unsigned article); Sofia, Rabotnichesko Delo, 7 Feb 60, p 5

According to this brief announcement, the Central Institute for Prosthetic Devices in Moscow has developed a model of a "much improved artificial hand." Controlled directly by muscular currents, the "artificial hand" can, according to Soviet specialists, render great service to astronauts of the future.

The article contends that it will be sufficient for the pilot of an interplanetary rocket to merely think of executing one or another action in operating the rocket and the "artificial hand" will immediately and unerringly perform this activity.



Bacteriology

67. Chinese Progress in Lyophilized Cultures

"Studies of an Improved Method of Lyophilization for Preservation of Microorganisms," by Hsieh Cheng-yang (謝正昉), Chair of Microbiology, Second Military Medical University; Peiping, Wei-sheng-wu Hsueh-pao (Acta Microbiologica Sinica), Vol 7, No 4, Dec 59, pp 375

The author describes the parts and complete assembly of an "improved" lyophilization apparatus and the simplified procedure followed in using it to preserve cultures of microorganisms. The apparatus reportedly was constructed by the author and his colleagues and has been in use by "fraternal units" [military medical establishments?] since 1954. Its 1/4-horsepower vacuum pump and vacuum gauge were manufactured in China.

According to the article, more than 150 strains of bacteria, fungi, and influenza viruses have been successfully preserved in a lyophilized state since 1954 by the method described. The article presents three plates showing the structure of the apparatus and also several charts indicating that no significant changes in cultural and physiological characteristics, morphology, antigenicity, virulence, etc. had occurred in various microorganisms after 2-3 years in a lyophilized state. Listed are: staphylococci, streptococci, tetragenic streptococcus [sic], pneumococcus, and meningococcus; Vibrio cholerae; pathogenic and non-pathogenic enterobacteria; bacilli [sic] which cause anthrax, tuberculosis, brucellosis, bubonic plague, tetanus, pertussis, diphtheria, and influenza; standard strains of influenza viruses (PR8, FM, and Lee), and new variants of influenza viruses which were isolated in 1957 and designated as A<sub>1</sub>, A<sub>5</sub>, A<sub>19</sub>, 112, 113, 312, and 313.

Immunology and Therapy

68. Therapy of Pulmonary Plague Discussed

"The Immunology of Plague (Report 27); Results of and Prospects for Therapy of Primary Pulmonary Plague," by N. N. Zhukov-Verezhnikov and N. K. Zav'yalova, Institute of Experimental Biology and State Scientific Research Antiplague Institute; Moscow, Klinicheskaya Meditsina, Vol 37, No 12, Dec 59, pp 33-37

This article is a survey of Soviet and foreign research on the treatment of plague from 1900 to the present. Several case histories of patients with primary pulmonary plague, which was considered an incurable disease until 1945, are reviewed. One recovery, reported in 1925, was attributed to the administration of a large dose of antiplague serum; it is pointed out, however, that Friedlander's pneumonia was sometimes accepted as pulmonary plague before the isolation of a pure culture was required for positive diagnosis of the disease. Many early reports of convalescence have therefore been evaluated as doubtful.

In 1934, Zhukov-Verezhnikov et al reported the recovery of a patient who was given antiplague serum and bacteriophage immediately after exposure to pulmonary plague. Since 1939, the following antibiotics have been used to treat demonstrated cases of this disease: sulfanilamide preparations, sulfidine, sulfadiazine, sulfathiazole, sulfapyridine, thiazamide, streptomycin, sulfamerazine, chloramphenicol, terramycin, and aureomycin. These antibiotics have been administered in combination with methylene blue, antiplague serum, and live antiplague vaccine at various stages of the disease. The authors state that according to their own observations and the literature, the problem of primary pulmonary plague therapy has been resolved in principle by modern methods.

The average doses for a course of therapy with these antibiotics are given. The manner in which they should be administered (separately or in combination) is now a widely discussed issue. The authors advance the opinion that therapy of primary pulmonary plague should be complex because of the unknown resistance of the pathogen to separate preparations.

The use of immunological preparations is discussed. The indications and the most advantageous time for immunization with live vaccine are noted. It is the authors' opinion that antiplague serum should be used to relieve intoxication, but only strictly according to indications.

In conclusion, further study of hormonal preparations and vitamins, particularly vitamin B<sub>12</sub>, is recommended. Vitamin B<sub>12</sub> is especially indicated when the hemopoietic system has been seriously impaired. The prevention and therapy of complications merits special attention and will be discussed in a subsequent report, the authors note.

69. Prevention of Tick-Borne Encephalitis

"Serum Prophylaxis of Tick-Borne Encephalitis," by A. R. Tav'ya, Tomsk Scientific Research Institute of Vaccines and Sera; Moscow, Voprosy Virusologii, Vol 4, No 6, Nov/Dec 59, pp 686-689

Following references to the work of M. P. Ciunakov and others on serum prophylaxis of tick-borne encephalitis, the author reports on the prophylactic administration of serum to 3,541 persons exposed to ticks in Tomskaya Oblast from 1954 to 1958. The data collected were analyzed to determine the effectiveness of the method. Natural anti-encephalitis serum, anti-encephalitis serum purified by the Diatherm-3 method, and anti-encephalitis gamma globulin were used. The following conclusions are given:

CPYRGH "1. Serum prophylaxis at an early period after exposure to ticks decreased the incidence of tick-borne encephalitis (natural serum, to one third the previous level, and purified preparations, to one fourth the previous level), and prevented the development of a severe form in persons already infected.

"2. Serum sickness among inoculated persons developed only one fourth to half as frequently when anti-encephalitis serum purified by the Diatherm-3 method and anti-encephalitis gamma globulin were administered than when natural serum was given."

A table is included to show results of serum prophylaxis with natural anti-encephalitis serum for 4 years, 1954-1957.

70. X Rays Affect Immunological Reactivity of White Mice

"The Effect of X-Irradiation on the Immunological Reactivity of White Mice to MM Virus," by O. P. Peterson and Ye. I. Sklyanskaya, Institute of Virology imeni D. I. Ivanovskiy, Moscow, Voprosy Virusologii, Vol 4, No 6, Nov/Dec 59, pp 737-740

The effect of sublethal doses of X rays (300 r) on immunogenesis in white mice before and after immunization with live MM virus (of the encephalomyocarditis group) was studied. The animals were vaccinated twice subcutaneously (with a 7-day interval) with 0.5 ml of a live virus suspension in a dilution of  $10^{-8}$  (the  $LD_{50}$  was  $10^{-6}$ ). The intensity of immunity was determined 7 days after the first immunization and 10-15 days after the second immunization by subcutaneous infection of the mice with a series of increasingly diluted virus suspensions. Blood was taken from the hearts of some of the mice for determination of the presence of virus-neutralizing antibodies in the serum.

The neutralization reaction was performed with a mixture of sera from four mice and mouse brain suspensions containing 100, 1,000, 10,000 and 100,000  $LD_{50}$  of MM virus. Control groups consisting of mice which had been irradiated but not infected and mice which had been infected but not irradiated were used in all experiments.

Results of the experiments are discussed in two parts: the effect of preliminary irradiation on resistance and antibody formation in white mice; and the effect of irradiation during immunization and after its completion on the development of increased resistance. The following conclusions are given.

CPYRGHT "1. A change in the immunological reactivity of white mice to MM virus under the effect of total irradiation by a sublethal dose of 300 r depends on the interval between irradiation and the beginning of immunization.

"2. A high mortality rate among irradiated mice in the process of immunization with live MM virus, especially if immunization was begun more than 2 days before or 2 days after irradiation, was noted.

"3. Preliminary irradiation of white mice with a 300 r dose suppresses the development of increased resistance and virus-neutralizing antibodies to MM virus for the entire period of acute radiation sickness (2 weeks in these experiments). Normal immunological reactivity is also restored in proportion to the development of restoration processes toward the end of the second week.

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"4. Irradiation of mice during immunization with MM virus and after its termination reinforces still more the development of increased resistance, and decreases the immunity already formed."

The authors point out that the effect of irradiation on the immunological reaction of living organisms to viral infections is analogous to its effect on immunogenesis to various bacterial infections and bacterial toxins.

71. Soviets Use Sea Water to Treat Color Blindness and Myopia

"Useful Sea Water" (unsigned article); Prague, Obrana Lidu, 21 Jan 60, p 2

A brief announcement in a column devoted to reporting news from the world of technology contains the statement that Soviet researchers in Odessa are successfully utilizing a sea water derivative to treat myopia and color blindness. The derivative, which is not further identified, is injected in the patient and results in "sudden changes for the better following the very first injection." The entire course of the treatment is said to require ten injections.

Pharmacology and Toxicology

72. Tear Gas as Lethal Agent

"Lethal Intoxication by Tear Gas," by Dr Tadeus Praglowski; Warsaw, Polski Tygodnik Lekarski (Poland), No 1, 4 Jan 60,

CPYRGHT pp 24-25

"A case of lethal intoxication by tear gas is described by the author. A very small room was filled with chloroacetophenone. The gas concentration was so high that it caused the death of 32-year-old man who developed pneumonia and pseudomembraneous inflammation of the respiratory tract. In using tear gas it is necessary to observe considerable caution, and in no case should it be used in closed quarters."

73. Exhaustion Inhibitors

"Effect of Medinal, Barbamyl, Cocaine, Bromine, Caffeine, and the Mixture of Bromine and Caffeine on the Processes of Exhaustion and Restoration of the Organism," by S. P. Zakrividoroga, L. N. Zamanskiy, A. I. Lopushanskiy, P. I. Lyubovskaya, T. L. Nevskaya, G. F. Red'ko, P. Ya. Siver, and M. L. Tarakhovskiy, Sirkhom ykhak, Experm. Meditsina (Korea), 1958, 2, No 4, 10-13 (from Referativnyy Zhurnal--Biologiya, No 21, 10 Nov 59, Abstract No 95191, by the authors)

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"Experiments carried out on 300 rabbits revealed that medinal, barbamyl, cocaine, sodium bromide (I), caffeine (II), and the mixture of sodium bromide and caffeine when administered in average doses inhibited exhaustion of the organism induced by starvation and prolonged the life of the animals. Sodium bromide and caffeine were the most effective drugs. Medinal, and barbamyl in particular, inhibited weight restoration when the animals exhausted by starvation were fed, while the other drugs, and particularly sodium bromide and the mixture of sodium bromide and caffeine, hastened weight restoration."

74. Effect of Rhodanine and Its Derivatives on the Organism

"Pharmacology and Toxicology of Rhodanine and its Derivatives," by Wieslawa Zlakowska, Acta polon. pharmac. (Poland) 1958, 15, No 6, 471-480 (from Referativnyy Zhurnal--Khimiya, Biologicheskaya Khimiya, No 22, 25 Nov 59, Abstract No 30384, by R. Khaunina)

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"Twelve derivatives of rhodanine were investigated. In acute experiments carried out on mice it was found that rhodanine itself, and its ethyl and methyl derivatives -- its closest analogues -- possessed greatest toxicity (LD<sub>50</sub> 162-228 milligrams per kilogram of body weight); its phenol and acetate derivatives are considerably less toxic (LD<sub>50</sub> 3,520 - 1,853 milligrams per kilogram of body weight). Most of the compounds which were investigated produced functional and histological changes in the liver and kidneys. Some of the preparations induced hyperglycemia."

75. Effect of Aminazine and Mepazine on the Organism

"Effect of Aminazine and Mepazine on Carbohydrate Metabolism and the Activity of Some of the Hormonal Preparations," by Ye. L. Pravotorova and A. V. Smirnova; Uch. zap. In-t Farmakol. i Khimoterapii AMN SSSR (Scientific Notes of the Institute of Pharmacology and Chemotherapy, Academy of Medical Sciences USSR), 1958, 1, 153-160 (from Referativnyy Zhurnal Khimiyi--Biologicheskaya Khimiya, No 23, 10 Dec 59, Abstract No 31441, I. El'man)

CPYRGHT

"In experiments on rabbits it was found that aminazine and mepazine (administered intravenously) caused no essential changes in the sugar content in the blood. Aminazine in a dose of 5 milligrams per kilogram of body weight produced a slight rise in the glycogen content in the liver, without changing its content in the heart and skeletal muscles. A considerable rise in the glycogen content in the liver, heart, and skeletal muscles was noted following the administration of mepazine. Aminazine administered 30 minutes before the application of adrenalin, sharply intensified the hyperglycemic reaction of the adrenalin, while mepazine decreased it. A decrease in the hyperglycemic reaction (the sugar content in the blood decreased by only 11.7 milligram percent, and without aminazine, by 27 milligram percent) when insulin was administered (0.3 unit per kilogram of body weight) on a background on aminazine was noticed. Mepazine depressed the activity of insulin to a lesser degree. The hyperglycemic curve, following the administration of adrenalin on a background of I aminazine, not only failed to drop, but rose to a higher level; mepazine, to the contrary, somewhat reduced the hyperglycemic effect of adrenalin. It is assumed that aminazine inhibits the process of phosphorylation of glucose, while mepazine does not possess this property. In animals which were administered thyroidin in conjunction with aminazine, the cholesterol concentration in the blood was not reduced (as occurred under the effect of thyroidin alone) but increased."

76. Two Antileukemic Compounds Recommended for Clinical Testing

"The Antileukemic Activity of Ethyleneimine Derivatives and Certain other Chemical Agents," by V. A. Chernov and L. S. Lytkina, Laboratory of Experimental Chemotherapy of Tumors, Division of Chemotherapy, All-Union Scientific Research Chemico-pharmaceutical Institute imeni S. Ordzhonikidze; Moscow, Problemy Gematologii i Ferelivaniya Krovi, Vol 4, No 12, Dec 59, pp 14-23

This report presents the results of a comparative study of the toxicity and antileukemic and antitumor activities of 43 compounds, which may be divided into three groups according to their chemical constitution.

The first group consists of 18 compounds which are ethyleneimine derivatives, and include the following substances: (a) phosphoric acid amides and thiophosphoric acid amides with the general formula (I) given below, where R<sup>-</sup> is a piperazine ring with different substituents at the nitrogen atom (compounds No 3, 4, and 5 in the list below); a residue of an amino acid ester (such as glycine in DEFA-1, phenylalanine in DEFA-2, glutamic acid in DEFA-3, and leucine in DEFA-11), or an aromatic radical (such as Kr-50) with various substituents in the ring (compounds designated Kr-50, Kr-49, and Kr-54); (b) derivatives of the trimer (formula (II) below) (compounds designated KrP-10, and KrP-12) or the tetramer (formula (III) below; compound designated KrP-15) phosphonitrile; (c) compounds in which the "carrier" of the ethyleneimine groups is a triazine ring (formula (IV) below), and where R<sup>-</sup> represents a residue of an amino acid ester such as alanine in the compound designated LS-90 and phenylalanine in the compound designated LS-98). The activity of these compounds was compared with the activity of triethyleneimino-S-triazine (TET, TEM) and with the activity of triethyleneimide of phosphoric acid (TEF), the efficacy of which has been verified clinically in the treatment of chronic leukosis.

All the above-mentioned derivatives of ethyleneimine were synthesized by A. A. Kropacheva, V. A. Parshina, and L. Ye. Svetsitskaya at the Laboratory of Synthesis of Anticancer Drugs of the All-Union Scientific Research Chemicopharmaceutical Institute imeni S. Ordzhonikidze (VNIKhFI).

The second group consists of nine compounds which represent derivatives and analogs of  $\beta$ -tyrosine (synthesized at VNIKhFI by N. N. Suvorov and coworkers) (compounds No 20-28 in the list below). The structural formulas of these compounds were given in a previous article by V. A. Chernov, and L. G. Lytkina, 1958.

The third group consists of 16 compounds which belong to very different chemical types and were synthesized at VNIKhFI by N. N. Suvorov and coworkers (compounds designated by NS...) and by T. S. Safonova (compound TS-68 in the list below), Ye. G. Popova (compound designated MO-203), Yuan Ch'eng-e (Yu-14-27), and P. M. Kochergin (compound designated K-1001); the other compounds were synthesized at the Institute of Chemistry of the Academy of Sciences Latvian SSR, by Prof G. Ya. Vanag and L. S. Geyta in 1954 (compounds No 39-43 in the list below).

Tests were conducted chiefly on 2,500 mice (of which 1,076 had leukosis) and on 1,560 rats. Detailed discussions are presented on the methodology, dosage, and the explanation of the experimental results.

The authors present the following conclusions:



The results of these experiments show that the majority of the ethyleneimine derivatives that were studied possess marked antileukemic activity which is expressed in a delayed increase of immature elements in the peripheral blood of treated animals, and a substantial prolongation of their lives as compared with the controls. The greatest antileukemic activity was observed following the use of thiodipine, dipine, KrP-11, KrP-10, and KrP-15, which are not inferior in this respect to the known compounds TET and TEF; besides they are less toxic.

Dipine and thiodipine merit special interest since besides having a high antileukemic activity and low toxicity, they have a broad-spectrum-of therapeutic effect, i.e., they inhibit the growth of various transplanted tumors of mice and rats. Furthermore, thiodipine is effective when administered orally.

Dipine and thiodipine can be recommended for clinical assay in cases of chronic lympholeukosis, the authors declare.

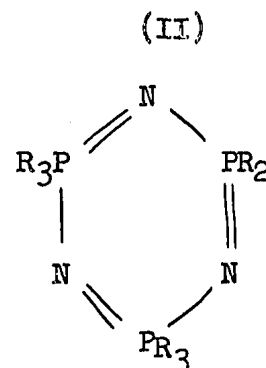
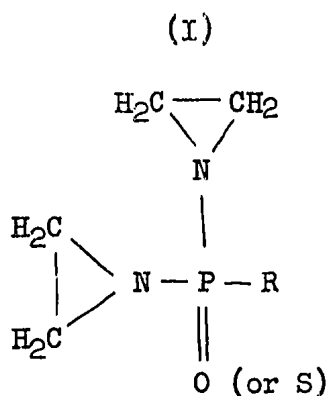
The following is the list of the 43 chemical compounds tested:

1. 2, 4, 6-triethyleneimino-S-triazine (TET, TEM)
2. Triethyleneimide of phosphoric acid (TEF)
3. Tetra-(ethyleneimide)-1, 4-piperazine of diphosphoric acid (dipine)
4. Tetra-(ethyleneimide)-1, 4-piperazine of dithiophosphoric acid (thiodipine)
5. Diethyleneimide-1, 4-(diethylcarbonyl)-piperazine of thiophosphoric acid (KrP-11)
6. Hexaethyleneiminetriphosphonitrile (KrP-10)
7. Tetraethyleneimine-( $\alpha$ -carbomethoxyethylamine- $\beta$ )-triphosphonitrile (KrP-12)
8. Octaethyleneiminotetraphosphonitrile (KrP-15)
9. Di-(ethyleneimide) (carbethoxymethyl) amide of phosphoric acid (DEFA-1)

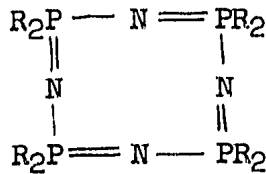
10. Di-(ethyleneimide) (  $\alpha$  -carbethoxy-  $\beta$  -phenylethyl-  $\beta$  )-amide of phosphoric acid (DEFA-2)
11. Di-(ethyleneimide) (  $\alpha$  -,  $\gamma$  -dicarbethoxypropyl-  $\alpha$  )-amide of phosphoric acid (DEFA-3)
12. Di-(ethyleneimide) (  $\alpha$  -carbethoxyisoamyl-  $\alpha$  )-amide of phosphoric acid (DEFA-11)
13. Di-(ethyleneimide)-p-iodophenylamide of phosphoric acid (Kr-50)
14. Di-(ethyleneimide)-p-methoxyphenylamide of phosphoric acid (Kr-49)
15. Di-(ethyleneimide)-phenylamide of phosphoric acid (Kr-52)
16. [Di-(ethyleneimide) (m-benzoylethyleneimide)] -amide of phosphoric acid (Kr-54)
17. Methyl ester of N-diethyleneimino-S-triazine-  $\alpha$  -aminopropionic acid (LS-90)
18. Ethyl ester of N-diethyleneimino-S-triazine-  $\beta$  -phenylaminopropionic acid (LS-98)
19. 6-Mercaptopurine
20.  $\beta$  -(4-hydroxyphenyl)- $\beta$  -alanine (  $\beta$  -tyrosine)
21.  $\beta$  -(4-hydroxy-3, 5-diiodophenyl)- $\beta$  -alanine (betazine)
22.  $\beta$  -(3-amino-4, 6-diiodophenyl)- $\beta$  -alanine, dihydrochloride (betamine)
23.  $\beta$  -(4-hydroxy-3-fluorophenyl)- $\beta$  -alanine (  $\beta$  -fluorotyrosine)
24. Disodium salt of  $\beta$  -(3-oxy-2, 4, 6-triiodophenyl) propionic acid (NS-97)
25.  $\beta$  -(3-aminophenyl)- $\beta$  -alanine (NS-96)
26.  $\beta$  -(4-amino-3, 5-diiodophenyl)- $\beta$  -alanine hydrochloride (NS-104)
27.  $\beta$  -(4-hydroxy-3, 5-diiodophenyl) propionic acid (NS-94)
28.  $\beta$  -(3-hydroxy-4, 6-diiodophenyl)- $\beta$  -alanine (NS-92)
29.  $\beta$  -(2, 4, 6-tribromophenoxy)-ethyl dimethylbenzyl ammonium bromide (NS-70)

30. N-21-(3 d, 17 d-dioxy-11, 20-diketopregnanylpyridine bromide (NS-86)
31. Monohydrochloride of O-glycyl-d, l-serine (KrP-5)
32. 5-Methyluracil (thymine)
33. Hydrochloride of N-(3-dimethylaminopropyl)-2-chlorophenothiazine (aminazine, largactyl)
34. Sodium salt of diphosphoric ester of diethylstilbesterol ("Khonvan")
35.  $\gamma$ -Phenyl- $\gamma$ -oxy-butyryl- $\beta$ -alanine (TS-68)
36. 2-Methyl-2-n-propyl-1, 3-propanediol-dicarbamate (MO-203)
37. Sodium salt of  $\alpha$ -ethylmercaptocaproic acid (Yu-14-27)
38. 2-Mercaptoimidazole (K-1001)
39. Phenanthrenone (10)-spiro-[9:4'] -2', 3'-(10), 6', 5' -(10)-dibenzoylenepyran (IF-1)
40. Phenanthrenone-spiro-dibenzoylenediphenyldihydropyridine (IF-2)
41. Condensation product of anhydrobis-indandione ("bindone") with triphenylchloromethane (BT)
42. Sodium salt of IF-1 (I-11)
43. Sodium salt of acenaphthenone-spiro-dibenzoylenepyran (I-12)

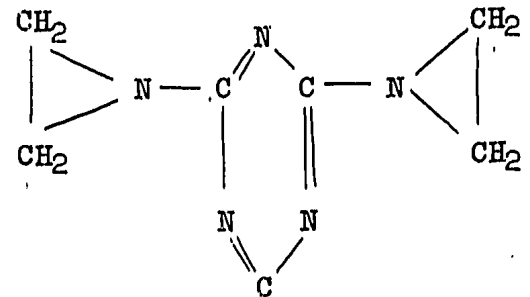
Formulas



(III)



(IV)



77. Typhus abdominalis Bacteria Resistant to Levomycetin

"Development of Levomycetin Resistant Variants of Typhus abdominalis Bacteria in Experiments in vitro," by V. M. Shubik, Vopr. Bacteriol., Immunol., i Khimterapii pro Kishech. Infektsiakh (Problems of Bacteriology, Immunology, and Chemotherapy in Intestinal Infections), L, 1958, 166-170 (from Referativnyy Zhurnal--Khimiya, Biologicheskaya Khimiya, No 23, 10 Dec 59, Abstract No 30788, by the author)

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"Typhus abdominalis bacteria, after acquiring resistance to levomycetin, lose their ability to agglutinate with specific sera, and become only one third to one half as virulent."

78. Effect of Some Antibiotics on Typhus Bacteria (Report 1)

"Combined Effect of Some Antibiotics on Typhus Abdominalis Bacteria in Experiments. Report 1. The Investigation of the Development of Typhus abdominalis Bacteria Forms Resistant to Synthomycin, Biomycin, Streptomycin, and Sanazine Individually or in Combinations, by O. O. Ovcharenko, Tr. Kharkovsk. n-i In-ta Vaktsin i Syvorotok (Works of the Khar'kov Scientific Research Institute of Vaccines and Sera), 1957 (1958), 25, 65-73 (from Referativnyy Zhurnal--Khimiya, Biologicheskaya Khimiya, No 22, 25 Nov 59, Abstract No 29601, by N. Pevzner)

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"The rise in the resistance of the Typhus abdominalis bacteria to streptomycin began with the first passages and progressively increased during the succeeding passages; its resistance to the synthomycin, biomycin, and sanazine increased only during the first ten passages, and during the succeeding passages failed to attain the indexes of streptomycin. Eleven combinations of the antibiotics were tested: six combinations of two

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antibiotics, four combinations of three antibiotics, and one combination of the four antibiotics under investigation. The combined application of the antibiotics did not prevent the development of Typhus abdominalis bacteria resistant to the antibiotics. The bacteria adapted themselves to each of the components in the mixture as well as to the combinations of the preparations. The process of bacteria adaptation to the combinations of antibiotics, however, proceeded at a considerably slower pace."

79. Effect of Some Antibiotics on Typhus Bacteria (Report II)

"Combined Effect of Some Antibiotics on Typhus abdominalis Bacteria in Experiments. Report II. Combined Effect of Synthomycin, Biomycin, Streptomycin, and Sanazine on Typhus abdominalis Bacteria in Experiments in vitro," by O. I. Ovcharenko, Tr. Kharkovsk. n-i In-ta Vaktsin i Syvorotk (Works of the Khar'kov Scientific Research Institute of Vaccines and Sera), 1957 (1958), 25, 65-73 (from Referativnyy Zhurnal--Khimiya, Biologicheskaya Khimiya, No 23, 10 Dec 59, Abstract No 30795, by N. Fevzner)

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"Biomycin and sanazine in inactive concentrations increased the bacteriostatic action of synthomycin by 2-4 times and its bactericidal action by 4-16 times. The addition of a subbacteriostatic dose of streptomycin to a solution of synthomycin had almost no effect on the bacteriostatic concentration of synthomycin, but considerably increased its bactericidal action. The antibacterial action of other investigated antibiotics when used in combinations against Typhus abdominalis bacteria was also enhanced. In testing the simultaneous effect on the microbes of mixtures consisting of three antibiotics, the best results were obtained when combinations of synthomycin, biomycin, and streptomycin, combinations of sanazine with synthomycin and biomycin, and combinations of sanazine with biomycin and streptomycin were used. When mixtures consisting of four antibiotics were used against Typhus abdominalis bacteria, the antibacterial effect of the antibiotics was intensified, particularly that of synthomycin. The combined effect of antibiotics on Typhus abdominalis bacteria with acquired resistance to synthomycin and other antibiotics was found to be greater than that when each preparation was separately administered."

80. Effect of Some Antibiotics on Typhus Bacteria (Report III)

"Combined Action of Some Antibiotics on Typhus abdominalis Bacteria in Experiments. Report III. Combined Action of Synthomycin, Biomycin, Streptomycin, and Sanazine on Typhus abdominalis Bacteria in Experiments in vivo," by O. I. Ovcharenko, Tr. Kharkovskovo n-i In-ta Vaktsin i Syvorotok (Works of the Khar'kov Scientific Research Institute of Vaccines and Sera), 1957, (1958), 25, 85-97 (from Referativnyy Zhurnal--Khimiya, Biologicheskaya Khimiya, No 23, 10 Dec 59,

CPYRGHT Abstract No 31551, by N. Pevzner)

"Of six combinations, each consisting of two antibiotics, the best therapeutic effects were obtained from a mixture of synthomycin (I) and streptomycin (II). A mixture of (I) with biomycin (III), or with sanazine prevented the death of 85-95 percent of the infected mice. The mixture of (I), (II), and (III) was found the most effective of the mixtures when three antibiotics were simultaneously administered. A combined application of four antibiotics was found to be more effective than when each of the antibiotics was administered separately. A combined therapeutic effect was noted in all cases. In a study of the combined action of the above-mentioned antibiotics on an infection induced by Typhus abdominalis bacteria resistant to (I), it was found that the best therapeutic results were obtained by the administration of the mixtures of (II), (III), and sanazine, or of (II) and sanazine. In determining the bacterial content in the spleen of the cured animals, it was found that the antibiotics, whether used separately or in combinations, have only a bacteriostatic action."

81. New Bulgarian Drug Against Heart Disease

"Snow Drops as a Cure" (unsigned article); Prague, Obrana Lidu, 28 Jan 60, p 2

According to this brief item, D. S. Paskov, a Bulgarian researcher, has extracted a substance from snow drops (*Galanthus nivalis*) which he calls "nivelin" and which allegedly has a very strong effect on the central nervous system; it is also being considered as an effective drug in heart disease.

Public Health, Hygiene, and Sanitation

82. Water Contamination

"Conference on the Protection of Water Reservoirs From Contamination" (unsigned article); Moscow, Vodostabzheniye i Sanitarnaya Tekhnika, No 1, Jan 60, pp 39-40

A conference of the City Executive Committee and the Novosibirskiy Sovnarkhoz was held during summer 1959 which considered the problem of "The State of the Sewage and Waster Water Purification System in Novosibirsk." It was pointed out that because of the absence of a unified sewage systems for waste materials from plant and city installations, the water reservoirs of the city are unsanitary. Particularly harmful are the waste materials from the leather footwear combinat, the meat-canning combinat, the fat-processing combinat, and the chemical, metallurgical, and tin-processing plants. Industrial waste water is also harmful to the fishing industry which has acquired considerable importance since the construction of the dam for the Novosibirsk Hydroelectrical Station on the Ob River. A resolution was adopted calling for the installation of waste purification equipment at the plants and the construction of waste purification plants on both banks of the river.

83. Position of Antibiotics in Seven-Year Plan

"The Strategy and Tactics of the Administration of Antibiotics," by Prof G. Gauze, deputy director of Institute for Search for New Antibiotics, Academy of Medical Sciences USSR; Moscow, Meditsinskiy Rabotnik, No 6 (1858), 19 Jan 60, p 3

The author of this article states that the Seven-Year Plan for the development of the national economy calls for an increase in the production of antibiotics by 4 1/2 times. By the end of that period the amount of antibiotics available per person in the USSR will exceed the amount available per person in the US. Rational utilization of antibiotics must take into consideration the effect of antibiotics on organisms causing disease, the interaction between the pathogen and the host macroorganism, and the epidemiological mechanisms of propagation of pathogenic microorganisms.

Antibiotic-resistant bacteria present a serious problem, especially in the case of staphylococci, which readily resist the action of penicillin, and the tubercle bacilli, which become resistant to streptomycin. Resistance to certain antibiotics is a natural property of many bacteria, but when resistance is acquired in the course of treatment, it is usually

because the dosage of antibiotic administered is insufficient to deal with the entire force of microorganisms. Adequate dosage and the use of the most effective available antibiotic are the two fundamental factors involved in successful antibiotic therapy.

It can be seen, therefore, that the strategy involved in the administration of antibiotics is not of abstract, theoretical interest; it has a direct relationship to clinical practice and to the production of antibiotics. Investigation of the dynamics of the formation of bacterial forms resistant to antibiotics, the regularity of their distribution, and the ecology of resistant and sensitive forms of bacteria is part of the over-all strategy.

After erythromycin became widely used in therapeutic establishments abroad, the number of forms of staphylococci resistant to this antibiotic increased rapidly to 80% and higher. After a number of therapeutic establishments stopped administering this antibiotic as a standard preparation for the treatment of staphylococcal infections and used it only in some infections, the percentage of erythromycin-resistant forms of staphylococci gradually dropped. In some countries, therefore, the use of erythromycin in mass treatment was discontinued, but was held (together with some other antibiotics) in "strategic reserve."

To overcome the development of resistance, one antibiotic may be used in combination with some other antibiotic.

In searching for new antibiotics, the strategy and tactics of their utilization must be considered. It is necessary to foresee the possibility of utilizing them as a "strategic reserve" during the very early stages of their development. Antibiotics, which seem particularly effective against staphylococci should not be widely used in medical practice for the treatment of commonplace infections that readily yield to the action of other antibiotics; they must be used against pathogens which are resistant to other antibiotics. In connection with this, new preparations developed in the Institute for the Search for New Antibiotics, Academy of Medical Sciences USSR, are of interest. Some antibiotics developed in this institute are being widely used in medical practice; the development of others is still in an experimental stage.

Albomycin is now being manufactured by the medical industry in the form of pure preparations free from inert substances. Clinical tests made in 1959 in a number of hospitals showed that albomycin is quite effective in the treatment of pneumonia and otitis, which accompany various infections. It is necessary to utilize more widely the ability of albomycin to suppress the growth of streptomycin and penicillin-resistant staphylococci.



Colimycin, an antibiotic belonging to the neomycin group, is a broad-spectrum antibiotic: it has found wide application in the treatment of colienteritis in children, peritonitis, and in surgery and dermatology. Colimycin and other neomycins (mycerin and framycetin) cause secondary effects on the auditory nerve and therefore cannot be recommended for the treatment of septic processes of a general nature caused by resistant forms of staphylococci. For this reason, an intensive search is being conducted to find preparations which have the same powerful therapeutic action as colimycin, but which are less toxic. A new antibiotic, canamycin, was discovered abroad. A new antibiotic, monomycin, was discovered in the Institute for the Search for New Antibiotics which possesses certain chemical properties that are common to canamycin. However, a comparative chromatographic study of products of hydrolysis of these two new preparations, conducted by Prof M. G. Brazhnikova, showed that they are related but are not identical. According to Prof V. A. Shorin and Prof S. D. Yudintsev, monomycin is less toxic than antibiotics of the neomycin group. Results of experiments showed that monomycin is very effective in the treatment of various infections in animals. It seems possible to make use of this antibiotic in the treatment of septic diseases caused by antibiotic-resistant forms of staphylococci and other microorganisms. It is currently undergoing clinical testing.

Antibiotics which are related to the ristocetin group should be used as a "strategic reserve." A new antibacterial antibiotic, actinoidin, was discovered recently in the Institute for the Search for New Antibiotics. Actinoidin belongs to the ristocetin group, but is not identical to them. Actinoidin is formed by "proactinomycin" and chemically is a very complicated substance consisting of a number of related variants containing peptides and carbohydrate components.

Inasmuch as the ristocetin group of substances can be administered intravenously only, because of their physicochemical properties, it is not expedient to use them in cases of commonplace infections; they should be held in reserve and used in the treatment of diseases caused by antibiotic-resistant forms of staphylococci and other microorganisms.

It is important, therefore, to intensify the search for new antibacterial antibiotics which can be kept in "strategic reserve" and can be used to combat forms of microorganisms which are resistant to other antibiotics.

84. New Method of Preserving Dairy Products

"News of the Day" (unsigned article); Riga, Sovetskaya Latviya, 4 Jan 60, p 4

According to the article, Candidate of Biological Sciences G. G. Blok, head of the Chair of Chemistry, Krasnoyarsk Agricultural Institute, has developed an original method of keeping butter from spoiling for a long time. This is done by injecting a pure culture of "yeast No 304," which destroys bacteria and mold. The dairy industry of Siberia is now using this new method.

A photograph which shows G. G. Blok and G. I. Blok taking a picture of the yeast by microphotography accompanies the news item.

85. Chinese Study Aerial Disinfection for Viral Influenza

"Experimental Studies on the Rate and Duration of Aerial Disinfection With Triethylene Glycol and Calcium Hypochlorite in Case of Air-Borne Influenza Virus," by Liu Yuan-yuan, (柳元元), Li Han-t'ang (李翰唐), and Wang Chih-lun (王植崙), Department of Virology, Chinese Academy of Medical Sciences; Peiping, Wei-sheng-wu Hsueh-pao (Acta Microbiologica Sinica), Vol 7, No 4, Dec 59, pp 313-318

The authors note that the use of calcium hypochlorite as an aerial disinfectant against influenza virus and the use of triethylene glycol to inactivate air-borne microorganisms (such as hemolytic streptococcus, pneumococcus, Staphylococcus pyogenes albus, as well as meningopneumonitis, psittacosis, and influenza viruses) have been reported in the literature. However, experimental results vary with the authors.

This paper reports the details of experiments undertaken to determine the conditions required for effective use of triethylene glycol and calcium hypochlorite as aerial disinfectants for air-borne influenza virus, and also to observe the rate and duration of aerial disinfection resulting from different concentrations of each agent.

The PR<sub>8</sub> strain of influenza virus was used in the experiments. A Soviet health unit donated the triethylene glycol, and the crude calcium hypochlorite was purchased in the form of commercial bleaching powder. White mice, bred at the Chinese Academy of Medical Sciences, and 10-day-old chick embryos were used as the subjects.

The procedure followed in artificially infecting the subjects is described. Some of the experiments were conducted in an experimental air-borne infection tank. Other experiments were conducted in a large chamber 4.13 by 3.7 by 2.94 meters. The air in the large chamber was infected by spraying an aerosol containing the virus. Wind, generated by a fan set at low speed, distributed the virus about the chamber. Batches of chick embryos were introduced and exposed to the infected air for 20 minutes. After 48 hours in the incubator, the allantoic fluid was subjected to the hemagglutination test to determine infection.

To test the effectiveness of the disinfecting agents, known quantities were evaporated into infected atmosphere of the chambers before the animals were exposed. The experimental results are tabulated and discussed.

### Radiology

#### 86. Radioactive Bandages Used in Radiation Therapy

"The Role of Alpha-Radiation in the Action of Radioactive Bandages Applied to the Skin," by S. N. Ardashnikov, F. L. Leytes, and M. L. Rayt, Laboratory of Radiology, Central Institute of Health Resorts; Moscow, Vestnik Dermatologii i Venerologii, No 1, Jan 60, pp 29-35

In recent years, the Central Institute of Health Resorts has tested and introduced into general practice a new form of radiation therapy -- the radioactive bandage. The bandages consist of two layers; the surface of one is coated with a radioactive deposit formed from the decay products of thoron (thorium B, thorium C, thorium C', and thorium C''). This active deposit is a mixture of alpha, beta, and gamma radiation.

Tests to explain the role of each component of the radioactive bandages which causes the macro- and micro-changes in the skin were conducted on four groups of rabbits.

Results of these experiments show that the alpha radiations play the major role in the clinicomorphological changes occurring in the abdominal skin of rabbits which have been subjected to the effects of mixed alpha, beta, and gamma radiations of a thoron deposit.

87. Combined Radiation Effects From Radon and Radioactive Bandages on Bioelectric Activity of the Cortex

"Changes in the Bioelectric Activity of the Cortex of Rabbits Subjected to Radon Inhalation and the Application of Radioactive Bandages," by S. N. Ardashnikov and M. L. Rayt, Laboratory of Radiology, Scientific Research Institute of Health Resorts and Physiotherapy; Moscow, Meditzinskaya Radiologiya, Vol 5, No 1, Jan 60, pp 18-23

The purpose of this research was to study the changes in the bioelectric action of the brain in rabbits subjected to irradiation by the inhalation of radon and the application of radioactive bandages to the abdominal area.

The authors present the following conclusions:

1. The irradiation of rabbits by the inhalation of an air-radon mixture (a radon concentration of 13-17 millicuries/l, and approximately 90% alpha radiation) through a tracheotomy for 3-4 hours leads to the intensification of external inhibition, which arises immediately during the process of actual irradiation and is diffused throughout the cortex. This effect is verified by a drop in the intensity of the bioelectric current and a decrease in the functional lability of the cortex and by a rise in the threshold of excitation (sound) in different animals.

2. No changes in the electrical activity of the cerebral cortex of rabbits subjected to irradiation by radioactive bandages (containing 0.4-2.0 microcuries of alpha-radiation isotopes thorium C and C<sup>0</sup>) were noted.

88. Radiation Effects on Healing Process of Eye Wounds

"Wound Process of the Eyes of Guinea Pigs Irradiated by Mild X-Ray Doses," by V. T. Paramey, Chair of Eye Diseases and Chair of Microbiology, Stanislav Medical Institute; Moscow, Vestnik Oftalmologii, No 1, Jan/Feb 60, pp 36-38

This article reports the author's research on guinea pigs subjected to wounds in the corneo-scleral region of the eye, and then to the whole-body irradiation by 100-600 r X-ray doses.

Results of these observations showed that the irradiation of guinea pigs by mild doses of X rays visibly delays the healing of the perforating corneo-scleral wounds of the eyes.

Significantly more microorganisms are present in the conjunctival region of both healthy and wounded eyes of irradiated pigs.

89. Radiation Effects on Animal Lactation

"The State of Lactation After General X Irradiation of Animals," by V. P. Baskakov; Chair of Obstetrics and Gynecology, Military Medical Academy imeni S.M. Kirov; Moscow, Akusherstvo i Ginekologiya, No 1, Jan 60, pp 65-66

The effect of ionizing radiations on the mammary gland and lactation was studied. Three goats were subjected to a single total X irradiation by 350 r.

Results of these studies showed that the milk yield decreased 1.5-6 times, and the fat content, by one fifth (i.e., 0.8%); changes in the pH, mineral and salt content, and in the specific gravity of milk occurred.

Surgery

90. Production of Surgical Equipment

"Within the Institute of Experimental Surgical Equipment" (unsigned article); Moscow, Meditsinskiy Rabotnik, No 6 (1858), 19 Jan 60, p 2

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"The medical industry of our country produces over 2,000 different kinds of surgical instruments, devices, and appliances. Almost one fifth of all these manufactured articles originated within the Scientific Research Institute of Experimental Surgical Equipment and Instruments, Ministry of Health USSR. Articles manufactured at the institute are well known not only in our country, but also abroad; some of those articles were displayed at the World's Fair in Brussels.

"The entire line of products of the institute was shown to the representatives of mercantile establishments of foreign countries. These representatives visited the laboratory of the institute and familiarized themselves with its work. The following people were in Moscow and visited the institute: Gombojav, the commercial representative of the Mongolian People's Republic, Bitner, deputy commercial representative of the German Democratic Republic; and Bak-behiyskiy, commercial counselor of the embassy of the People's Republic of Bulgaria. Members of the staff of commercial attaches of embassies of the following countries also visited the institute: People's Republic of China, Polish People's Republic, Rumanian People's Republic, Czechoslovak People's Republic, Democratic People's Republic of Korea, and Democratic Republic of Vietnam. Kim Che-sung, head of the Korean delegation, who is the Deputy Minister of Foreign Trade of that country, also visited the institute. His delegation is now staying in Moscow.

"M. G. Anan'yev, director of the institute, explained to the visitors how the automatic and semiautomatic instruments for suturing tissues are used; these instruments were designed at the institute. Visitors became acquainted with special instruments used in surgery on the heart, large blood vessels, stomach, intestines, lungs, and other organs. They were also shown other instruments which help make the surgeon's work easier and help him to perform many complicated operations successfully.

"An improved model of 'artificial heart-lungs' attracted great interest. A collection of surgical instruments developed by the institute's staff and used in various operations also attracted great interest.

"The guests were shown scientific films made at the institute. The visitors then watched operations on animals. Surgical instruments and devices designed at the institute by its employees were used in these operations."

#### Veterinary Medicine

91. Chinese Recover Glanders Bacillus From Artificially Infected Cattle for Studies in Bacterial Variation

"Studies on Experimental Infection of Cattle, Sheep, and Goats with *Malleomyces mallei*," by Hu Hsiang-pi (胡祥璧), Kung Ch'eng-chang (龍成章), and Ou Paō-heng (區竇珩), Harbin Veterinary Biologicals Control Institute; Peiping, Chu'u-mu Shou-i Hsueh-pao (*Acta Veterinaria et Zootechnica Sinica*), Vol 3, No 1, May 59, pp 37-42

This paper reports the author's observations of experimental glanders in 10 cattle, 12 sheep, and 7 goats. The animals were inoculated subcutaneously, intravenously, or intratestically with mallein prepared from virulent strains (R<sub>3</sub>, M<sub>7</sub>, and M<sub>224</sub>) of *Malleomyces mallei* grown in glycerol broth. Data on the manifestations of experimental infection, morbid changes, and organs from which the bacillus was recovered are presented.

On the purpose of these experiments, the authors learned from the literature that cattle, sheep, and goats having low susceptibility to glanders can be artificially infected. They perceived the value of using such ruminants in the study of glanders bacillus variation and, therefore, undertook the present experiments to find the most reliable route of artificial infection, to observe the progress of experimental glanders in the animals, and to recover the bacillus from the infected

animals for further study in bacterial variations. Their findings, particularly the fact that *Malleomyces mallei* was recovered from the testicles of cattle as long as a year after inoculation with the organism, facilitate studies on glanders bacillus variation, they say.

Citing "unpublished data of the Harbin Veterinary Research Institute," the authors mention their success in producing experimental glanders in rabbits and white rats by intratesticular inoculation when the intravenous route often failed.

### Virology

#### 92. Detection of Sublethal Doses of Tick-Borne Encephalitis

"The Use of Tissue Cultures for the Indication of Sublethal Doses of Tick-Borne Encephalitis Virus," by S.Ya. Gaydamovich and V. R. Obukhova, Institute of Virology imeni D. I. Ivanovskiy; Moscow, Voprosy Virusologii, Vol 4, No 6, Nov/Dec 59, pp 678-683

The authors of this article attempted to detect small doses of tick-borne encephalitis virus, strain Ix<sub>10</sub>, by the use of tissue cultures; the data obtained were subsequently compared with the results of the infection of white mice. Virus concentrations which do not regularly infect mice were used. The preparation of two types of tissue culture, cutaneous-muscular tissue from chick embryos and HeLa cells, is described. The cultures were infected at the same time the cells were seeded or 48-96 hours after the beginning of growth.

Dilutions of dried virus ( $10^{-6}$  to  $10^{-9}$ ) were prepared in titers close to the maximum for mice and somewhat higher, but still not pathogenic for mice. The brains of white mice and the tissue cultures were infected with each dilution. Culture fluid was collected 96 hours after infection, and the presence of virus and its titer were determined by infection of white mice.

The results of the experiments are discussed and shown in tables and graphs. The authors conclude that a culture of chick embryo fibroblasts is a sensitive indicator for observing small doses of tick-borne encephalitis virus and is superior in sensitivity to the method of infecting mice. A quantity of virus which amounted to 1/10 to 1/100 of the LD<sub>50</sub> for mice was collected in tissue culture. This method saves time and is recommended for biological detection of the tick-borne encephalitis virus in diagnosis and in control of the harmfulness of vaccines.

93. Ornithosis Virus Studied by Fluorescence Microscopy

"Calculation of the Number of Ornithosis Virus Elementary Bodies by the Fluorescence Microscopy Method," by V. D. Neustroyev, Ts. Ts. Khanduyev, and V.N. Milyutin; Moscow, Voprosy Virusologii, Vol 4, No 6, Nov/Dec 59, pp 734-737

The results of experiments on determining the number of elementary particles of the ornithosis virus in yolk culture and in brain suspensions from infected mice with subsequent comparison of the amount with the biological titer are given in this article. A luminescence microscope with OI-17 and OI-18 condensers was used; the virus titer was calculated by intranasal infection of white mice. There was found to be no direct and stable relationship between the number of particles in a visual field and the biological virus titer in the same material.

The indirect method of calculating particles in relation to a previously known quantity of bacterial cells and chicken erythrocytes was used for a more precise determination of the number of bodies in the experimental material. B. coli and B. subtilis were employed as indicator particles. Further details of the experimental procedure are given. As shown in a table, the number of elementary particles of ornithosis virus in one LD<sub>50</sub> fluctuated from 10 to 67, depending on many factors which require additional study.

CPYRGHT The following conclusions are given:

"1. The luminescence microscopy method permits calculation of the absolute number of ornithosis virus particles in a unit of volume of material being examined.

"2. The most satisfactory results were obtained by means of comparative determination of the number of virus particles in relation to a known quantity of bacterial cells and chicken erythrocytes.

"3. The method used affords the possibility of rapid preliminary determination of the quantity of virus particles in diagnostic preparations (antigens, etc.)."



Miscellaneous

94. New Medical Instruments and Apparatus

"New Instruments and Apparatuses" (unsigned article); Moscow, Meditsinskiy Rabotnik, No 10 (1862), 2 Feb 60, p 4

Several new medical instruments and apparatuses were displayed at an exhibition held at the All-Union Scientific Research Institute of Medical Instruments and Equipment, 15-31 January 1960. Among them were an instrument for artificial respiration while under anesthesia which automatically regulates inhalation and exhalation; a new anesthesia apparatus which permits the simultaneous administration of oxygen and nitrous oxide, and oxygen and ether; an ion spectrometer which permits the measurement of ions in the air when therapy with ionized air or electro-aerosols is applied; a new surgical light "Svet-15" which provides shadowless light and is equipped with a photo camera; two ultraviolet lamps equipped with filters which pass ultraviolet light harmless to the eyes; an otorhynoscope for the examination of the outer and middle chambers of the ear; a scintillating detector of beta radiation which can register radioactivity to 0.0003 microcurie per square centimeter, making possible the early diagnosis of cancer of the uterus, throat, and other cavities when very small doses of radioactive phosphorus are applied. More than 1,000 physicians, scientists, and engineers visited the exhibition.

95. New Institute of Urology Opens at Tbilisi

"The Opening of the Institute of Urology, Academy of Sciences, Georgian SSR," (unsigned article); Moscow, Urologiya, No 1, Jan/ Feb 60, p 95

A new Institute of Urology was opened on 1 October 1959 in Tbilisi through the initiative of Prof A. P. Tsulukidze, Academician at the Academy of Sciences Georgian SSR and Corresponding Member of the Academy of Medical Sciences USSR, who was elected director.

The Institute of Urology is beginning its activity by studying the following problems: urolithic disease, tumors of the urogenital system, and the search for tissue substitutes for surgery on the urogenital organs. The scientific research to be conducted at the institute will utilize the newest scientific achievements, including atomic energy.

96. Microbiology Facility at Polish Medical Academy

"Directive of the Minister of Health, Dated 27 November 1959, Concerning Organizational Changes at the Medical Academy in Krakow," R. Baranski; Warsaw, Monitor Polski, No 102, 28 Dec 59

According to a ministerial directive, a Chair of Microbiology (Katedra Mikrobiologii) and a research laboratory in the Pharmaceutical Faculty (Wydział Farmaceutyczny) have been created at the Medical Academy in Krakow.

VII. METALLURGY

97. Hot Pressing Of Titanium Silicides

"Concerning the Ductility of Titanium Silicides," by V. S. Neshpor and G. V. Samsonov, Institute of Powder Metallurgy and Special Alloys, Academy of Sciences Ukrainian SSR; Moscow, Izvestiya Akademii Nauk SSSR, Otdeleniye Tekhnicheskikh Nauk, Metallurgiya i Toplivo, No 4, Jul/Aug 59, pp 202-204

Results of investigations to determine the character of shrinkage during hot pressing of  $Ti_5Si_3$ ,  $TiSi$ , and  $TiSi_2$  are presented. Shrinkage curves show an increase in the temperature of points of inflection with increase of silicon content. The considerably lower temperature of this point for  $Ti_5Si_3$  as compared to those for  $TiSi$  and  $TiSi_2$  is attributed to the more favorable effect of the hexagonal structure of  $Ti_5Si_3$  on the appearance of ductility than the rhombic structures of the mono- and disilicides. Temperatures of points of inflection for the latter two are less differentiated. Shrinkage and plastic flow of titanium disilicide occur at higher corresponding temperatures than for the silicides  $Ti_5Si_3$  and  $TiSi$  and is believed to be conditioned by the greater number of covalent bonds in  $TiSi_2$ . Increasing pressing temperatures above the fusion points of the silicides showed no sharp change in shrinkage. Recommended pressing temperatures for compact and easily extractable specimens are  $1,450^{\circ}C$  for  $Ti_5Si_3$  and  $TiSi$  and  $1,350^{\circ}C$  for  $TiSi_2$ .

98. Viscosity and Fusibility of High-Titanium Slags

"Effect of Low Oxides of Titanium and Ferrous Oxide on the Properties of High-Titanium Slags," by I.P. Bardin, I. A. Karyazin, and V.A. Reznichenko; Moscow, Izvestiya Akademii Nauk SSSR, Otdeleniye Tekhnicheskikh Nauk, Metallurgiya i Toplivo, No 5, Sep/Oct 59, pp 35-41

Slags synthesized from chemically pure  $Al_2O_3$ ,  $CaO$ ,  $MgO$ ,  $TiO_2$ ,  $SiO_2$ ,  $FeC_2O_4 \cdot 2H_2O$  and  $Ti_2O_3$  were investigated to obtain data on the quantitative effect of low oxides of titanium and ferrous oxide on the properties of high-titanium slags. It was established that low oxides of titanium in a 0.75 ratio of  $Ti_2O_3$  to  $TiO_2$  decrease the fusibility and viscosity of slags whereas a higher ratio produces the reverse effect with the ferrous oxide content not exceeding 10%. With ferrous oxide

content above 10% the low oxides of titanium show no substantial effect on slag properties. Stable slags in a wide interval of concentration ( $Ti_2O_3$  from 0 to 45%,  $TiO_2$  from 47 to 82%) form if the ferrous oxide content is maintained below 5%.

99. Effect of Cyclic Stresses on Cold-Worked Aluminum and Nickel

"Concerning the Effect of Cyclic Loading on the Structure of Deformed Pure Metals," by M. Ya. Gal'perin, Ye. P. Kostyukova, and B. M. Rovinskiy; Moscow, Izvestiya Akademii Nauk SSSR, Otdeleniye Tekhnicheskikh Nauk, Metallurgiya i Toplivo, No 4, Jul/Aug 59, pp 82-87

X-ray studies of structural changes in pre-deformed pure aluminum (99.99%) and electrolytic nickel during cyclic loading showed a partial recovery of crystal structure in aluminum but not in nickel. It is established that recovery increases with decrease of preliminary deformation and at a given magnitude of preliminary deformation the degree of recovery after a given number of cycles is directly proportional to the amplitude of cyclic stresses.

100. Mechanisms in Hot Pressing of High-Melting Compounds

"Certain Mechanisms in the Sintering of Powders of High-Melting Compounds by Hot Pressing," by M. S. Koval'chenko and G. V. Samsonov, Institute of Powder Metallurgy and Special Alloys, Academy of Sciences Ukrainian SSR; Moscow, Izvestiya Akademii Nauk SSSR, Otdeleniye Tekhnicheskikh Nauk, Metallurgiya i Toplivo, No 4, Jul/Aug 59, pp 143-147

Results of investigations on the sintering mechanism in hot pressing of powders of carbides of titanium and tungsten and borides of titanium, zirconium and molybdenum show that this mechanism may be described as the result of the establishment of an equilibrium between the forces of surface tension and the strength of particles at each given temperature with consideration of the supplementary action of forces of external pressure which combine additively with the forces of surface tension. These concepts are applicable to the first stage of compacting during hot pressing. In the following stage of slow compacting the mechanism of diffusion creep enters into the shrinkage process. Transition of these materials into an elastic-plastic state is confirmed by a range of temperatures at which an expansion of the sintered specimens occurs upon removal of external pressure.

[For additional information on metallurgy, see Chemistry, Industrial Chemistry, and Inorganic Chemistry.]

VIII. PHYSICS

Atomic and Molecular Physics

101. Variation of Hg Isotope

"Effect of Temperature on the Variation of the Isotopic Compound of Liquid Mercury in the Electric Field of a Constant Current," by I. V. Bogoyavlenskiy, V. N. Grigor'yev, N. S. Rudenko, Physicotechnical Institute, Academy of Sciences Ukrainian SSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1241-1246

An experimental study was made of the temperature dependence of the change in the concentration of liquid mercury isotopes upon passage of a constant electric current through the liquid. In the stationary case the change in the concentrations was found to be independent of temperature. Some possible mechanisms of the phenomenon are discussed.

Low Temperature Physics

102. Charges in Liquid Helium

"Motion of Charges in Liquid Helium," by R. G. Arkhipov and A. I. Shel'nikov, Institute of Physical Problems, Academy of Sciences USSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1247-1251

A study was made of the behavior of the electric charges produced in liquid helium by a  $\beta$ -source. An attempt was made to observe how the charges are "blown away" by the heat flow. It is suggested that the observed hysteresis phenomena are due to suspended impurity particles in liquid helium.

Mechanics

103. Solution for Hydrodynamic Problem

"Symmetrical Flow About a Circular Cylinder With Two Vortices After It. Trajectories of the Vortices and Resistance of the Cylinder," by Bl. Dolapchiyev and Bl. Sendov, Mathematics Institute, Sofia University, Bulgaria; Moscow, Doklady Akademii Nauk SSSR, Vol 128, No 1, Sep 59, pp 53-56

An exact solution for the hydrodynamic problem of a cylinder and two vortices in an ideal liquid is given.

The same problem was considered and approximately solved by L. Foepppl and H. Rubach in Sitzber. d. Bayer. Akad. d. Wiss., 1913, and Fortsch, Arb. aus d. Gebiet des Ingenieurwesens, Vol 185, 1916.

104. Magnetohydrodynamics of Fluids

"The Magnetohydrodynamics of Conducting Fluids," by S. I. Braginskiy; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1417-1430

The approximate form of magnetohydrodynamic equations has been derived for a fluid possessing a small electrical conductivity (small magnetic Reynold numbers) and located in an external magnetic field. Some characteristic problems are considered which describe the physical nature of the behavior of such fluids in a strong magnetic field.

105. Role of Bending Strength in Increased Strength of Pressurized Hollow Cylinder

"The Effect of a High Pressure Which Reinforces a Hollow Cylinder," by A. A. Il'yushin and P. M. Ogibalov, Moscow, Izvestiya Akademii Nauk SSSR, Otdeleniye Tekhnicheskikh Nauk, Mekhanika i Mashinostroyeniye, No 6, Nov/Dec 59, pp 110-112

An estimate is made of the effects of a high pressure on the strength of hollow cylinders, assuming that the function of the degree of "strengthening" of the material under the effect of the high pressure and creep are constant in the pressure range under study.

The negative effect of an omnidirectional stress is considered first in the case of elastic deformation of a tube under the effect of a high internal pressure, and expressions are given for the maximum yield point and bending constant. Since the bending constant does not depend on the radius, the yield point of the material of a uniform tube will be constant with respect to thickness, and creep will begin at the internal surface when the maximum yield point is reached. The equation for the zero condition is derived. The coefficient of "strengthening" of the tube at the stage of elastic deformation resulting from omnidirectional pressure is found to be less than unity when increased bending strength is not taken into account.

A two-dimensional plastic deformation of a tube under the effect of an internal pressure is then considered, assuming that the entire thickness of the tube has entered the stage of plastic deformation. From expressions for the maximum tangential pressure and mean normal pressure, the boundary conditions are determined and the equation of equilibrium of the element of the tube is solved. The stress distribution and the limiting pressure which the cylinder can withstand are determined, with increased bending strength as a result of the pressure taken into account. The strengthening coefficient in this case is found to be greater than unity, showing increased strength of the tube as a result of the high pressure. On the basis of the assumptions made here, the coefficient of strengthening is equal to 2.27, indicating a considerable strengthening effect as a result of the high pressure.

106. Fusion of Plates in Supersonic or High-Temperature Gas Flow

"The Fusion of Plates Around Which a Supersonic or High-Temperature Gas Flows," by A. B. Batazhin, Moscow: Moscow, Izvestiya Akademii Nauk SSSR, Otdeleniye Tekhnicheskikh Nauk, Mekhanika i Mashinostroyeniye, No 6, Nov/Dec 59, pp 7-13

In the problem of protecting bodies from disintegration as a result of aerodynamic heating, great interest has been attracted to the possibility of phase transformations in a solid body when a supersonic or high-temperature gas flows around it. The solution of such problems involves the equations of motion in the boundary-layer region and in the region occupied by the liquid phase, as well as the equation of heat conductivity in the solid body. However, when the body has a rather high heat of fusion (sublimation) and low coefficient of heat conductivity (when the greater part of the heat entering the body is expended in the change of state), the thermal conductivity of the solid body can be neglected. For such a case, a study is made here of the problem of the fusion of a half-infinite plate, under the assumption that the ratio of density to dynamic viscosity in the liquid phase and in the gas is very high. The obtained solution is then generalized for the case where part of the heat flow is deflected into the body close to the fusion boundary.

107. Gas Lubricants and Two-Dimensional Problem of Hydrodynamics

"Two-Dimensional Problem of the Hydrodynamic Theory of Gas Lubricants," by A. I. Snopov, Moscow State University; Moscow, Izvestiya Akademii Nauk SSSR, Otdeleniye Tekhnicheskikh Nauk, Mekhanika i Mashinostroyeniye, No 6, Nov/Dec 59, pp 14-20

The primary difficulty involved in the two-dimensional linearized problem of gas lubricants is the nonlinearity of the equation of continuity of the gas. For particular cases, this problem has been solved (Konstantinesku, V. N., "On the Theory of Gas Lubricants," Zh. prikladn. mekh., AN RNR, Vol 1, No 1, 1956), but a rigorous solution of the problem has not been presented for the case of noncoaxial cylindrical surfaces.

The method employed in this article affords the possibility of solving the problem with any accuracy, and the simple formulas introduced are of practical use for a calculation of bearings with arbitrary eccentricities.

It is assumed that, with increased rotational velocity and eccentricity, the direction of loading is close to the center line, and that the load angle is almost independent of the composition of the gas.

Although the load capacity of a bearing cannot be increased ad infinitum at the expense of increased rotational velocity (Sheynberg, S. A., "Gas Lubrication of Sliding Bearings (Theory and Calculation)," Sb. Treniye i iznos v mashinakh, VIII, 1953), the load capacity of bearings can effectively be increased at the expense of increased relative eccentricity, bearing diameter, and quantity of lubricant. When the state of the gas is adiabatic, the load-carrying capacity of a bearing is higher than when the state of the gas is isothermal.

Nuclear Physics

108. Zone Energy Spectrum

"The Zone Energy Spectrum in the Presence of a Magnetic Field," by G. Ye. Zilberman, Kharkov Higher Aviation Engineering School; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1452-1454

Eigenfunctions (in the k-representation) are derived which describe the motion of an electron with an arbitrary dispersion law in a magnetic field, account being made of two zones (and in particular of overlapping ones). The condition of applicability of the one-zone approximation is deduced.

109. Vibrational Levels in Nuclei

"Excitation of Vibrational Levels in Nuclei by Charged Particles," by A. D. Piliya, Leningrad Physicotechnical Institute, Academy of Sciences USSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1434-1440

Excitation of the first vibrational level of an even-even nucleus by charged particles possessing energies close to the height of the Coulomb barrier is considered.

110. Forces in Hyper-Nuclei

"Contribution of Three-Particle Forces to the Binding Energy of Hyper-Nuclei," by V. A. Lulka and V. A. Filimov, Moscow State University, Institute of Nuclear Physics, Electronics and Automatics, Tomsk Polytechnic Institute; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1431-1433

The three-article  $\Lambda$ -nucleon potential is computed in the lowest order in meson theory. It is shown that in hyper-nuclei the contribution of the calculated potential to the  $\Lambda$ -particle energy is positive and insignificant in magnitude. The estimates thus obtained do not confirm Spitzer's conclusion that three-particle forces play a large role in hyper-nuclei.



111. Setting a System of Particles

"A Certain Possibility of Setting up a System of Elementary Particles," by I. V. Chuvilo, Joint Institute for Nuclear Research; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1401-1406

The possibility of setting up a system of baryons and mesons based on the requirements of existence of a single "elementary" baryon and a single "elementary" meson and of a strong interaction between them is considered. The "elementary" particles chosen are the singlet baryon  $\Omega$  - with a strangeness of - 3 and the isotopic doublet of  $K$ ,  $K^0$  - mesons with a strangeness + 1. Some of the conclusions qualitatively agree with well-known experimental data on processes involving "strange particles." Some qualitative results relating to nucleon form factors are obtained.

112. Velocity Distribution of Electrons

"Velocity Distribution of Electrons in a Strong Electric Field," by L. M. Kovrizhnikh; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1394-1400

A method is developed for determination of a nonstationary solution of the Boltzmann equation in the case of strong electric fields. An expression is derived for the electron distribution function in a completely ionized plasma located in a strong electric field. It is shown that in a first approximation the distribution is a maxwellian one superimposed on the general translational motion of the electron gas. In a first approximation the translational velocity increases proportionally with time whereas the temperature remains constant.

113. Nuclear Shell Model Applied

"Reduced Widths for Nucleon Associations in the Shell Model of the Nucleus," by V. V. Balashov, V. G. Neudachin, Yu. F. Smirnov and N. P. Yudin, Institute of Nuclear Physics, Moscow State University; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1385-1389

A method is considered which can be employed to calculate the reduced widths for compound nucleus level decay involving the emission of deuterons, tritons and  $\alpha$ -particles. The analysis is based on the shell model of the nucleus.

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114. Dispersion Relations for Mesons

"Dispersion Relations for Inelastic Processes Involving K-Mesons," by Yu. Wolf, Joint Institute for Nuclear Research; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1379-1384

Dispersion relations for processes of the  $K + N \rightarrow Y + \pi$  type are presented. The intermediate state spectrum is investigated. The structure of the amplitude for scalar and pseudoscalar K-mesons is given.

115. Inelastic Collisions

"Inelastic Collisions Between Fast Polarized Particles and Atoms," by V. V. Batygin and I. N. Toptygin, Leningrad Polytechnic Institute; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1372-1378

The differential cross section for scattering of electrons, positrons, and  $\mu$ -mesons on atoms has been derived in the Born approximation as a function of the polarization of the particles in the initial and final states. The change in the polarization vector which occurs when the particles are scattered on free unpolarized electrons is also determined.

116. Dispersion Relations in Quantum Electrodynamics

"Application of the Dispersion Relations Method in Quantum Electrodynamics," by V. Yu. Faynberg; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1361-1371

An approximate set of dispersion equations for the Green's function of the photon and vertex part has been derived in quantum electrodynamics on basis of the dispersion relations and unitarity conditions. The "nonsubtraction" procedure is employed in an asymptotic investigation of the solutions of the equation. Agreement with the renormalized perturbation theory when the fine structure constant tends to zero is accepted as the boundary condition. It is shown that the vertex function asymptotically decreases with growth of the square of the photon 4-momentum  $q^2 = (p_+ + p_-)^2$  for  $p_+^2 = p_-^2 < m^2$  where  $p_-$ ,  $p_+$  are the electron and positron 4-momenta. This leads to finite renormalization of the charge in the approximation under consideration.

117. Structure of Nucleons

"A Certain Possibility of Investigation of the Structure of Nucleons and Nuclei," by N. G. Birger and Yu. A. Smorodin, Physics Institute imeni Lebedev, Academy of Sciences USSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1355-1360

It is shown that in the interaction of high energy particles the sum of the quantities  $(E - p \cos \theta)$  for all particles emitted after the interaction is equal to the mass of the target particle which effectively participates in the interaction. Thus the distribution of  $\sum (E - p \cos \theta)$  is specified by the structure of the target particle. Application of this type of analysis to the experimental data on nucleon-nucleon interactions shows that interactions with the part of the target possessing mass close to that of the  $\pi$ -meson are dominant.

118. Field of a Charged Particle

"Field of a Charged Particle in a Moving Field," by B. M. Bolotovskiy and A. A. Rukhadze, Physics Institute imeni Lebedev, Academy of Sciences USSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1346-1351

The field produced by a charge passing through a moving medium is considered. Energy losses due to emission of Cherenkov-Vavilov radiation and excitation of plasma waves are determined.

119. Magnetic Moments

"The Anomalous Magnetic Moment of Nucleons in Chew's Method," by Yu. M. Lomsadze, V. I. Lend'yel, and B. M. Ernst, Uzhgorod State University; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1342-1345

Corrected values of nucleon magnetic moments due to  $\pi$ -meson and nucleon virtual currents have been obtained by the Chew's method. Account of the contribution of strange particles and of the hypothetical  $p^0$ -meson is made under various assumptions regarding their intrinsic parities.

120. Amplitude Expansion of a Reaction

"Threshold Momentum Power Series Expansion of the Amplitude of a Reaction Involving the Formation of Low Energy Particles," by I. T. Dyatlov, Leningrad Physicotechnical Institute, Academy of Sciences USSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1330-1336

It is demonstrated that the linear terms and those quadratic terms of the threshold momenta power series expansion of the amplitude of an arbitrary process near the threshold which specify the angular distributions can be obtained by considering the analytical properties of the amplitude.

121. Calculation of Phase Volumes

"A Method of Calculation of Phase Volumes," by L. G. Zastavenko. Joint Institute for Nuclear Research; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1319-1323

A method for calculation of phase volumes is developed for 2, 3, 4 and 5 particles. The error of the method increases with growth of the number of particles  $n$ , but evidently does not exceed 5% for  $n = 5$ .

122. Electron Scattering

"Scattering of Electrons by Light Non-Spherical Nuclei," Ye. V. Inopin and B. I. Tishchenko, Physicotechnical Institute, Academy of Sciences Ukrainian SSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1308-1318

Scattering of electrons on nonspherical nuclei is treated in the Born approximation. Expressions for the elastic and inelastic scattering cross sections have been derived in the general case of oriented nuclei possessing arbitrary deformations. The theory is compared with experiments on inelastic scattering of electrons by light nuclei.

123. Study of Protons in a Nucleus

"Distribution of the Density of Protons in a Nucleus With a Given Angular Momentum," by L. P. Rapoport and S. G. Kadmenskiy, Voronezh State University; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1303-1307

The density of protons in a nucleus possessing a given angular momentum  $p_1$  ( $r$ ) is computed on basis of the experimental distribution of the total proton density  $p$  ( $r$ ). Spatial separation of nuclear shells is demonstrated by means of the distribution thus obtained.

124. Degenerate Fermi Gas

"The Conditions of Applicability of Statistical Formulas to a Degenerate Fermi Gas," by Ya. B. Zel'dovich and Ye. M. Rabinovich; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1296-1302

A degenerate ideal Fermi Gas in an arbitrary potential field is considered. It is shown that the statistical formulas can be applied to the problem of variation of density under the action of a potential  $V(r)$  if the motion of particles with Fermi-boundary energy is quasiclassical in the potential field. This statement is consistent with the nonapplicability of the quasiclassical approximation to the motion of particles with smaller energy and in particular to bound particles when  $V < 0$ . The corrections to the statistical formulas in the one-dimensional and three-dimensional problems have opposite signs.

125. Bismuth Fragments

"Fragmentation on Bismuth Nuclei", by V. F. Darovskikh, N. P. Kocherov, and N. A. Perfilov, Radium Institute, Academy of Sciences USSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1292-1295

Fragmentation on bismuth nuclei induced by 660 MeV protons was studied by imbedding small bismuth particles in a nuclear emulsion. Data have been obtained on the cross section for the process, angular distribution of the fragments (forward-backward ratio), and the charge and energy distribution of multicharged particles.

126. Scattering of  $\pi^+$  Mesons

"Elastic Scattering of 5 to 22 Mev Mesons on Carbon," by V. G. Kirillov-Ugryumov, L. P. Kotenko, Ye. P. Kuznetsov, F. M. Sergeev, and A. F. Grashin; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1273-1280

Elastic scattering of 5 - 22 MeV  $\pi^+$  -mesons on carbon in a propane bubble chamber was investigated. A phase shift analysis of the angular distribution shows that a repulsive potential acts on the meson in the S state in the nucleus.

127. Emitters of Alphas

"Emitters of Alpha Particles With Energies of About 9 and 12 Mev," by V. A. Karnaukov, V. I. Khalizev, and G. N. Flerov; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1266-1272 (Reported by Flerov, Proceedings of Second UN Conference on Peaceful Uses of Atomic Energy, Geneva, 1958)

Lead was irradiated with accelerated oxygen and carbon ions. Isotopes emitting  $11.8 \pm 0.4$  and  $9.0 \pm 0.3$  MeV particles with half life periods of approximately 1 minute and  $35 \pm 10$  seconds, respectively, were detected among the reaction products. Some ideas concerning the identification of the isotopes are discussed.

128. Sputtering of Copper

"Sputtering of Copper by Hydrogen Ions Possessing Energies up to 50 Kev," by N. V. Pleshivtsev, Institute of Chemical Physics; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1233-1240

The dependence of the sputtering coefficient  $S$  (atoms/ion) on the energy, angle of incidence, and mean ion current density was investigated by means of an ion gun. The angular distribution of the sputtered particles and the micro-relief of the surface were also studied. It was found that  $S \sim (\ln E)/E$  for ion energies  $E = 15 - 55$  Kev. The sputtering coefficient increases with growth of the angle of incidence and within a certain range is independent of the mean beam current density. For normal and oblique incidence of the beam the angular distribution of the sputtered particles significantly differs from the cosine law. "Grooves" are formed along the direction of incidence of the beam when the latter strikes the surface at an oblique angle. The data indicate that at intermediate ion energies momentum transfer is of most importance in the elementary sputtering act.

129. Polarization of Neutrons and Protons

"Polarization of Neutrons From the  $T(p,n)He^3$  Reaction and Protons From the  $He^3(n,p)T$  Reaction," by K. P. Artemov N. A. Vlasov, and L. N. Samoylov; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1187-1192

The spectra and angular distributions of tritons produced in the reactions  $C^{12}(d,t)C^{11}$ ,  $F^{19}(d,t)F^{18}$  and  $Al^{27}(d,t)Al^{26}$  for 20 Mev deuterons were measured on basis of the  $\beta$ -radioactivity of tritium.

The spins and parities of a number of states of  $F^{18}$  and  $Al^{26}$  have been derived by comparing the triton angular distributions obtained with Butler's theory. The probability of excitation of levels of the residual nucleus sharply drops with increase of their energy.

130. Scattering of Gammas on Cd-114

"Resonance Scattering of Gamma-Quanta on Cd-114 Nuclei," by N. N. Delyagin, Institute of Nuclear Physics, Moscow State University; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1177-1186

Polarization of neutrons produced in the  $T(p,n) He^3$  reaction by 8 - 10 Mev protons was determined by measuring the right-left asymmetry of protons produced in the inverse reaction  $He^3 (n,p)T$ . The dependence of the asymmetry on the angle of emission of the proton from the  $He^3 (n,p) T$  reaction has also been measured. Polarization of the  $T (p,n) H^3$  neutrons and  $He^3 (n,p) T$  protons reached 30% for an angle of incidence of about  $40^\circ$  and primary proton energy of approximately 10 Mev. With decrease of proton energy the polarization decreased but the angle of emission corresponding to peak polarization does not appreciably change.

131. Interaction With 9 Bev Protons

"Interaction of 9 Bev Protons With Free and Quasifree Nucleons in Photographic Emulsions," by N. P. Bogachev, S. A. Bunyatov, I. M. Gramenitskiy, V. B. Lyubimov, Yu. P. Merekov, M. I. Podgoretskiy, V. M. Sidorov, and D. Tuvendorzh, Joint Institute Nuclear Research; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1225-1232

The problem of the angular and energy characteristics of secondary particles produced in the collisions between protons and nucleons is considered.



132. Isotopic Masses and Binding Energies

"Isotopic Masses and Binding Energies of Nuclei for Masses Between 186 and 196," by R. A. Demirkhanov, T.I.G. Gutkin, and V. V. Dorokhov; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1217-1224

Values of the masses and binding energies are presented for the nuclei of osmium, irridium, platinum, gold and mercury isotopes. The masses were measured on a mass-spectrograph possessing a resolving power of 60,000-80,000. The isotope masses were derived from doublets by direct comparison with the masses of corresponding organic compounds. The masses of 18 stable isotopes were measured and the masses of 18 radioactive isotopes were computed. The data thus obtained were used to evaluate the binding energy of nuclei, the binding energy per nucleon ( $E/A$ ), the binding energies of the last neutron and proton ( $B_n$  and  $B_p$ ) and the pair energies of neutrons and protons ( $P_n$  and  $P_p$ ). For  $N = 116$  the binding energy of nuclei has been found to vary in a nonmonotonous manner for even as well as odd values of  $Z$ .

133. Forbidden Transitions in Tu-169

"Forbidden Transitions in the Deformed Tu-169 Nucleus," by E. Ye. Berlovich, V. N. Klement'yev, V. G. Fleysher, O. B. Larionov, F. Sh. Murtazin, and D. A. Apostolov, Leningrad Physicotechnical Institute, Academy of Sciences USSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1202-1206

Lifetime values of  $(3.6 \pm 0.1) \cdot 10^8$  sec and  $(6.7 \pm 0.2) \cdot 10^{-7}$  sec were obtained by delayed coincidence measurements for the 379 Kev and 316 Kev levels of the  $Tu^{169}$  nucleus. The partial probabilities for eight transitions have been determined on basis of these data and those on the relative transition intensities from both levels and the multipolarity ratios. For the 177 Kev (E2), 177 Kev (M1), 198 Kev (E2) 198 Kev (M1), 308 Kev (E2), 240 Kev (E1) and 260 Kev (E1) transitions which are forbidden with respect to the projection of the total angular momentum on the deformation axis, the delay factor comprises  $10^3 - 10^4$  per unit forbiddenness, a value which significantly differs from the usual value (10-100). The 63 Kev (E1) transition which is forbidden with respect to the projections of the orbital and spin momenta and also with respect to the quantum number characterizing oscillations along the deformation axis is less probable by five orders of magnitude than that predicted by Weisskopf's estimation. However, it is in good qualitative agreement with Nilsson's calculation of the probability for deformed nuclei.

134. Production of Fm-250

"Cross Section for Production of Fm-250 in the Reactions Pu-241 (C-13, 4n) Fm-250 and U-238 (O-16, 4n) Fm-250," by V. V. Volkov, L. I. Guseva, B. F. Myasoyedov, N. I. Tarantin, K. V. Filippova; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1207-1211

The cross section for production of Fm<sup>250</sup> in the reaction Pu<sup>241</sup> (C<sup>13</sup>, 4n) and U<sup>238</sup> (O<sup>16</sup>, 4n) has been determined depending on the energy of the bombarding particles. Comparison of the cross section for production of Fm<sup>250</sup> with the fission cross section in these reactions shows that in the overwhelming majority of cases the excited compound Fm<sup>254</sup> nucleus undergoes fission, and only in a very few cases de-excitation takes place as a result of neutron emission. The maximal cross section for production of Fm<sup>250</sup> by irradiation with oxygen or carbon ions is respectively  $1.10 \cdot 10^{-30} \text{ cm}^2$  and  $5.10 \cdot 10^{-30} \text{ cm}^2$ . The difference between the cross sections is probably due to the effect of the Coulomb barrier.

135. Cyclotron Resonance

Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59

Cyclotron resonance in metals is the subject of articles by M. S. Khaykin and P. A. Bezuglyy, and A. A. Galkin. Cyclotron resonance in metals, first recognized by M. Ya. Azbel and E. A. Kaner (ZhETF, 30, 811 (1956); *ibid.* 32, 896 (1957); *ibid.* 33, 1461 (1957) by solving the transport equation, stimulated wide interest in observing this phenomenon, similar to cyclotron resonance in semiconductors and occurring in metals at anomalous skin effect conditions.

M. S. Khaykin (Institute of Physical Problems, Academy of Sciences USSR) studied the cyclotron resonance in tin at 9,400 Mc at 2.4°K. (ZhETF, 37, 5, 1473 (1959)). By using highly sensitive measuring methods, a resonator with linear high frequency currents, tens of minima of cyclotron resonance were observed at various orientations of the magnetic field to the crystalline axes.

P. A. Bezuglyy and A. A. Galkin studied the cyclotron resonance in indium at a frequency of 9300 Mc. (ZhETF, 37, 5, 1480 (1959)) The results of measurements of the ratio R(H) (surface resistance in the magnetic field) to R(O) (surface resistance in absence of field) were plotted in graphs and facilitated the evaluation of the effective mass of carriers responsible for resonance. The comparison of curves R(H)/R(O) at temperatures of 4.2 and 2.45°K indicated a sharper resonance at lower temperature.

136. Inelastic Scattering

Inelastic Scattering of Neutrons and Protons by Nuclei," by A. G. Sitenko and V. F. Kharchenko, Kharkov State University imeni Gor'kiy; Kiev, Ukrainskiy Fizichniy Zhurnal, Vol 4, No 5, Sep/Oct 59, pp 569-576

Direct inelastic scattering produced by interaction of the incident nucleon with the external nucleon is analyzed. The interaction with the nuclear core is represented by a diffraction model. As an example the computation of proton scattering on a silicon nucleus  $\text{Si}^{29}(p,p_1)\text{Si}^{29*}$  ( $Q = -1.28$  Mev) and on the Li nucleus  $\text{Li}^6(p,p_1)\text{Li}^{29*}$  ( $Q = -2.19$  Mev) was carried out.

137. Spectral Line of Plasma

"Deformation of the Contour of a Spectral Line Emitted in a High Temperature Optically Dense Plasma," by N. G. Preobrazhenskiy, Siberian Physicotechnical Institute, Tomsk State University imeni Kuybyshev; Tomsk, Izvestiya Vysshikh Uchebnykh Zavedeniy, Fizika, No 6, 1959- pp 31-41

An attempt is made to systematize from a single point of view the processes affecting the magnitude and the distribution of emission intensity in various sections of spectral lines emitted by atoms and ions of a inhomogeneous high temperature plasma of considerable optical density. The mutual relation of theories by H. Bartels (Z. Phys., 149, 594 (1957); 150, 526 (1958)) and R. Cowan and G. Dieke (Rev. Mod. Phys., 20, 418 (1948)) are analyzed. Particular interest is paid to the deformation of the contour of the line by superposition on it of a sufficiently intense continuum.

138. Electron Temperature in Discharge

"Measurement of Electron Temperature and Electron Concentration in a Mercury Discharge," by T. B. Vilenskaya and A. S. Makarova, Siberian Physicotechnical Institute, Tomsk State University imeni Kuybyshev; Tomsk, Izvestiya Vysshikh Uchebnykh Zavedeniy, Fizika, No 6, 1959, pp 102-106

The probe method is applied to measurements of electron temperature and electron concentration in a discharge in mercury vapor in a pressure range of 0.01 to 25 mm Hg. The relation of electron temperature and electron concentration to the strength of the discharge current was established. A comparison of relative intensities of spectral lines

computed according to Fabrikant's formulas with previously obtained experimental data confirmed the assumption that optical rules of forbidden transitions may be applied to the atom excitation by a mercury shock.

139. Equilibrium of Plasma

"Equilibrium of a Plasma Under Helical Symmetry," by B. B. Kodomtsev; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1352-1354

A simple example of plasma equilibrium in a magnetic field with helical symmetry is presented.

140. Plasma Oscillations

"Oscillations of an Inhomogeneous Plasma in a Magnetic Field," by L. I. Rudakov and R. Z. Sagdeyev; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1337-1341

Small oscillations of a hot plasma confined by the pressure of a magnetic field are treated with aid of the kinetic equation in the "drift" approximation without the collision integral. Two types of waves can exist for the wave vector lying in a plane perpendicular to the direction of the unperturbed magnetic field. One of these is a slow (drift) wave with a propagation velocity of the order of the mean electron (ion) drift velocity in the unperturbed state and the other is a magnetoacoustic wave. The first type of wave is characteristic only of an inhomogeneous plasma. For a certain interdependence between the zero magnetic field gradients, plasma density and plasma temperature the drift current in the unperturbed plasma may lead to amplification of such oscillations. The criteria for instability of this type have been obtained.

141. Study of  $\mu$ -Meson Flux

"Study of the High Energy  $\mu$ -Meson Flux in Broad Atmospheric Showers," by S. N. Vernov, B. A. Khrenov, and G. B. Khristiansen, Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1252-1265

Experimental data on the possible existence of the narrow beams of  $\mu$  - mesons (diameter in observation plane  $\geq 0.5$  m) have been obtained with aid of an arrangement which permits one to study simultaneously broad atmospheric showers on the surface of the earth and underground. Data on broad atmospheric showers obtained at the surface of the earth can be employed to construct a picture of generation of the narrow  $\mu$  - meson beams.

142. Shift of Curie Temperature in Fluorides

"Shift in Curie Temperature During Uniform Compression of Manganese and Cobalt Fluorides," by D. N. Astrov, S. I. Novikova, and M. P. Orlova, All-Union Institute of Physicotechnical and Radio Technical Measurements, Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1193-1201

The shift of the Curie temperature due to uniform compression has been determined for the antiferromagnetic substances  $MnF_2$  and  $CoF_2$ . The shift values are derived from the results of measurement of the magnetic susceptibility and variation of the linear expansion coefficients of polycrystalline samples at the transition temperature. At a pressure of  $(1900 \pm 100)$  at the shift for  $MnF_2$  was found to be  $(1.5 \pm 0.2)^\circ$ . No shift was detected in  $CoF_2$ . The antiferromagnetic transformation temperatures are respectively  $68^\circ K$  and  $39^\circ K$ .

143. Betatron Beam Extraction

"Electron Extraction From the Betatron Chamber by an Asymmetric Shift Method," by Yu. M. Akimov, Tomsk Polytechnic Institute imeni Kirov; Tomsk, Izvestiya Vysshikh Uchebnykh Zavedeniy, Fizika, No 6, 1959, pp 3-4

The Tomsk Polytechnic Institute tests various extractors for their betatrons: a magnetic shunt, asymmetric shift, toroidal pulse, and an electrostatic device. The asymmetric shift of the trajectory was studied by extracting the beam by a toroidal pulse. It was concluded from experimental data that with adequate modifications of the extractor a 100% electron extraction can be achieved by this method.

144. Construction of a Stereobetatron

"Construction and Magnetic Characteristics of a Two-Chamber Stereobetatron of 10 Mev," by V. A. Moskalev, Tomsk Polytechnic Institute imeni Kirov; Tomsk, Izvestiya Vysshikh Uchebnykh Zavedeniy, Fizika, No 6, 1959, pp 5-9

A preliminary report on the possibility of a stereobetatron construction with two accelerating chambers and nonbranching magnetic flux was earlier presented by the author (Zhur Tekh Fiz, Vol 26, pp 2060-2061, 1956). As a continuation, the advantages of the stereobetatron as compared to the conventional type are analyzed and experimental data on the construction and operation of the stereobetatron are given. At present, a pulsed 25-Mev stereobetatron is under construction at the Tomsk Polytechnic Institute.

145. Betatron Characteristics

"Study of Electron Capture Into the Accelerating Conditions in Betatrons and Synchrotrons," by P. A. Ryzin and A. B. Minervin, Physics Institute imeni Lebedev, Academy of Sciences USSR; Tomsk Izvestiya Vysshikh Zavedeniy, Fizika, No 6, 1959, pp 112-123

Basic results of the work by the authors at the Physics Institute imeni Lebedev, Academy of Sciences USSR, concerning the capture of electrons into the accelerating conditions of betatrons and synchrotrons are presented. A self-consistent solution of the multielectron problem, taking into account the initial and the boundary conditions is derived. The initial conditions consist in the variation of the injection voltage, as well as of the axially symmetric magnetic field during the injection; the boundary conditions refer to the electron collisions with the back of the injector and with the chamber walls. A detailed analysis of the adiabatic contraction of the electron orbit at rising magnetic field, of the effects of self-induction, of nonstationary current in the chamber, and of coulomb interaction, leads to an attenuation of betatron oscillations and of the shifting of the instantaneous orbits. The derived formulas facilitate the clarification of fundamental characteristics of betatrons and synchrotrons.

146. Nuclear Absorption of K<sup>-</sup>Mesons Strongest at Surface

"On the Nuclear Absorption of Negative K Mesons," by C. Grote, I. Hauser, U. Kreckler, U. Kundt, K. Lanius, K. Lewin and H. W. Meier, Institute of Nuclear Physics, Zeuthen; Berlin, Monatssberichte der Deutschen Akademie der Wissenschaften zu Berlin, Vol 1, No 11, 1959, pp 667-677

A 600-micron, 10 x 10 cm Ilford G-5 emulsion packet (emulsions provided by the Rumanian Academy of Sciences) was exposed to the K<sup>-</sup> beam of the bevatron. A strip perpendicular to the direction of the beam and three centimeters from the edge of the emulsion was examined for gray tracks, which were then followed to their ends. Only those track terminations which were more than 23 microns from one of the surfaces of the emulsion were included in the statistics. On tracks with Q-terminations, ionization and range measurements were conducted in order to separate the K<sub>2</sub> mesons from the protons. In this manner, 1,000 K<sup>-</sup>-captures at rest were selected for study. Tracks with ranges under 5 microns were not counted as arms. If the range was below 2.4 microns, the tracks were classified as "blobs," which could be caused partly by slow Auger electrons with a kinetic energy less than 13 Kev, and partly by the recoil of the remainder of the nucleus. Tracks with ranges between 2.4 and 5 microns were considered to be caused by the latter recoil.

In (38.4 ± 2) percent of all captures, one pi<sup>+</sup> meson was emitted. A separation of the results into K<sup>-</sup>-captures in light and heavy nuclei of the emulsion showed that 25 percent of the captures were by light nuclei. On the basis of experimental data, the upper limit of frequency of the 2 N-reactions was computed at 20 percent. It was found that the absorption of the K<sup>-</sup>-mesons takes place predominantly in the surface of the nucleus. The branching ratio for the production of various hyperons in 1 N-reactions was also determined.

147. Second Anniversary of Rumanian Cyclotron

"Fraternal Aid," by Fl. Ciorascu; Bucharest, Munca, 17 Jan 60, p 3

According to the author, who is the scientific director of the Institute of Atomic Physics of the Academy of the Rumanian People's Republic, the cyclotron given to Rumania by the USSR has been in operation for 2 years. Ciorascu says that the results obtained so far have been significant in the solution of problems related to the planning of reactors with fast neutrons.

In the future, research will be carried on to increase the precision of results and more complex projects will be attempted. The institute will construct a gamma ray spectrometer with two crystals and a cloud chamber with overcompression, the latter being already completely planned. The institute intends to increase the power of the cyclotron by using modern methods of spiralization of the magnetic field.

### Optics

#### 148. Resolution of Two Light Sources

"Concerning Conditions and Methods of Resolving Two Sources of Light Greatly Differing in Intensity," by A. N. Ryazanov, Kharkov State University; Kiev, Ukrainskiy Fizichniy Zhurnal, Vol 4, No 5, Sep/Oct 59, pp 634-639

A criterion for resolving two sources of light greatly differing in intensity is formulated for a homogeneous slit objective. It is shown that by proper diaphragming of the objective aperture, the intensity of side effects may be considerably reduced at the cost of a slight widening of the zero maximum. This method facilitates the resolution of two greatly differing light sources, practically unattainable with a homogeneous objective.

### Theoretical and Experimental Physics

#### 149. Relativistic Functions

"Relativistic Spherical Functions," by A. Z. Dolginov and I. N. Toptygin, Leningrad Physicotechnical Institute, Academy of Sciences USSR; Moscow, Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, Vol 37, No 5, Nov 59, pp 1441-1451

Properties of infinitely dimensional representations of the Lorentz group are considered which are of interest for solution of problems of relativistic elementary particle theory. Infinitely dimensional representations are applied to an analysis of the amplitudes of the  $a + b \rightarrow c + d$  reaction.



IX. MISCELLANEOUS

100. Soviet Machine Translation Policy Guided by Scientific Council on Cybernetics

"Scientific Life; Chronicles," by T. M. Nikolayeva; Moscow, Voprosy Yazykoznaniya, No 6, Nov/Dec 1959, pp 150-151

On 10 April 1959, a Scientific Council for coordinating work in the field of cybernetics was organized under the Academy of Sciences USSR (Academician A. I. Berg, chairman of the council; Prof A. A. Lyapunov and A. A. Kharkevich, corresponding member of the Academy of Sciences Ukrainian SSR, deputy chairmen). Six linguists are also members of the Scientific Council: N. D. Andreyev, V. Ya. Rozentsveyg, P. S. Kuznetsov, A. A. Reformatskiy, Vyach. V. Ivanov, and S. K. Shaumyan.

A Linguistics Section (Vyach V. Ivanov, chairman) which unites 28 scientific workers -- linguists, mathematicians, psychologists and engineers -- has been formed under the council. The first meeting of the section was held on 3 July 1959. The Linguistics Section has been assigned the tasks of coordinating work, organizing special seminars under the section and other measures.

The following circle of fundamental questions pertain to the problems of the section: machine translation questions, logic-linguistic problems of constructing information machines and information languages, documentation, problems of logical semantics, general theory of sign systems and codes, decoding questions, theory of graphics (graphemology) in connection with the development of reading devices and the automation of typographical work, questions of structural linguistics (general theory of structural linguistics, phonological theory, investigation of morphological models, the development of syntactic structures and transform analysis, introduction of structural methods in semasiology, typological comparison of language systems), theory of translation as a special linguistic discipline based on methods of mathematical and structural description of language; theory of language communication, etc.

The section also participates in the development of problems relating to the sphere of activity of the Committee on Applied Linguistics (under the Section on Speech of the Commission on Acoustics of the Academy of Sciences USSR): construction of devices for automatic speech input, problems of acoustical phonetics and physiological acoustics, problems of efficient coding of speech information for its transmission along communication channels, etc.

151. Spring 1959 Activities of Association for Machine Translation in the USSR

"Scientific Life; Chronicles," by T. M. Nikolayeva; Moscow, Voprosy Yazykoznaniiya, No 6, Nov/Dec 1959, p 150

From March to June 1959 a recently organized linguistics seminar has functioned under the Association for Machine Translation at the First Moscow State Pedagogical Institute of Foreign Languages. The topics of the papers, heard and discussed at the weekly seminar meetings, defined the basic tasks of practical application of problems of general linguistics.

The majority of communications were devoted to the development of new methods of describing language phenomena -- papers of I. I. Revzin on one of the methods of determining the morpheme, Yu. S. Martem'yanov on paradigmatic units in a language, O. S. Kulagina on the problem of sentence topology. The recent achievements of contemporary linguistics and allied disciplines were described in a number of reports. These topics were elaborated on in the papers of Vyach. V. Ivanov on transform analysis, V. M. Zolotarev on finite state languages (Chomsky and Miller model), B. A. Uspenskiy on attempts at constructing a transformational grammar for the English language, L. I. Bogoraz on the theory of codes with error correction and their application to language, etc.

Under the association, work was conducted by separate language groups within whose organization were specialists working in applied linguistics in various institutes of the Academy of Sciences USSR. In particular, the following reports were heard in joint meetings of specialists in the Russian language: Ye. V. Paducheva on various types of outcomes of complex sentences made from simple sentences, K. I. Babitskiy on the analysis of unambiguous members in machine translation from the Russian language, Z. M. Volotskaya on features of word formation in Russian.

In additional seminar meetings regular contacts in exchanging experience in the field of machine translation algorithm construction took place. The problem of writing information in creating machine translation algorithms occupied a significant place (I. A. Mel'chuk gave a series of reports on the problem).

The Association on Machine Translation continued to function simultaneously with the work of the seminar. At the meetings of the association papers were presented which reported on the concrete results in constructing machine translation algorithms. The paper of T. N. Moloshnaya which reported on statistical counts of different types of grammatical configurations in machine translation from the English language and the report of T. M. Nikolayeva which reported on the principles in constructing an algorithm of independent grammatical analysis in machine translation from Russian were heard.

A special meeting of the association was devoted to a discussion of Y. Bar Hillel's book which generalized recent achievements in machine translation in the USA and England [Report on the State of Machine Translation in the United States and Great Britain, Technical Report No 1, Hebrew University, Jerusalem, 15 February 1959.].

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