Space INTELLIGENCE NOTES

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FROM THE WORLD PRESS

FROM THE SEMITECHNICAL LITERATURE

FROM THE TECHNICAL LITERATURE

BOOKS

FROM THE WORLD PRESS

USSIANS HONOR GLENN AND PROPOSE JOINT MOON FLIGHT. Gennadi Kovalenko, hief editor of Molodoi Kommunist (Young Communist) monthly magazine and spokesman for 11 young Russians visiting the United States recently, suggested a joint US-USSR flight to the Moon.

"It would be wonderful," he said, "if our scientists--yours and ours--could plan to put all three astronauts--Gagarin, Titov, and Glenn--together in a flight to the Moon."

Mr. Kovalenko said the Russian people "worried with you" during Colonel John H. Glenn's flight and were "happy and relieved with you" when he landed safely. In addition, he pointed out that Colonel Glenn was officially honored by the Soviets; for example: "We have Glenn postcards in Russia, but we haven't seen any here," he said.

The Russian group, ranging in age from 24 to 37 and composed of teachers, scientists, journalists, a doctor, and a factory worker, were interviewed in Columbus, Ohio, where they visited for a week after arriving by plane from New York. (Source: New York Times, March 10, 1962)

SOVIET EXPERT SAYS A-WASTE DUMPING ONLY PRACTICAL USE FOR SPACE ROCKETS. A leading Soviet atomic scientist, Peter L. Kapitza, believes the only practical significance in cosmic rockets is to carry radioactive wastes from the Earth to outer space burial grounds.

Kapitza, writing in the April issue of the Soviet Bulletin of Atomic Scientists, stated that disposal of dangerous radioactive waste, the storage of which is both difficult and hazardous on Earth, is the "fundamental obstacle standing in the way of development of atomic technology." Disposal of such waste materials in outer space, he concludes, would be cheap, safe, and a very practical solution to a major problem.

The only other possibility for rockets in outer space that Kapitza mentions is to colonize other planets, a suggestion that he dismisses because "we are not yet crowded down here; we have enough room."

Disposing of radiation wastes in deep space is not a new idea. Others have suggested it before. However, coming from Kapitza as the "only practical significance" of cosmic rockets, the idea could gain currency at least in the USSR. This could happen because Kapitza is not only a leading and highly influential Soviet scientist and director of the Soviet Academy of Sciences' Institute of Physical Problems, but it is rumored he was director of the Soviet's successful man-in-space program.

Kapitza's remarks on conquest of outer space are part of his general discussion on what he sees as the future of science. He singles out space as one of two outstanding problems facing scientists today. The other, which he characterizes as "the No. 1 problem of contemporary physics," is to achieve controlled fusion by taming the power of the hydrogen bomb.

The Soviet scientist lists a number of other challenges, including the creation of a light superalloy capable of withstanding temperatures greater than 1000°C, development of stronger plastics, and the direct transformation of chemical power into electrical power. (Source: Washington Post, April 5, 1962)

ARTIFICIAL GRAVITY TO AID FUTURE COSMONAUTS. Soviet newspaper Trud, publication of the Central Labor Union, stated recently that it may become necessary to build a system of artificial gravity into future spaceships to counteract the effects of sustained weightlessness. An artificial force of one-quarter or even one-tenth that of Earth's gravity might prove sufficient, the article stated, and methods of doing this are already known.

The subject was raised in an article stating that cosmonaut Gherman Titov had suffered nausea, apparently as a result of weightlessness during his 17-orbit flight.

His training, Trud stated, was unable to prevent the sickness. As a result of all the data obtained after Titov's flight, changes have been introduced into the system of the cosmonauts' training to increase their resistance to weightlessness. These changes include more specialized gymnastics.

Trud said that although Glenn reported feeling no unpleasant sensations when weightless, "it should be borne in mind that he circled the Earth only three times, while the phenomena experienced by Titov were observed after protracted weightlessness." (Source: Washington Post, April 5, 1962)

IRON CURTAIN DOWN FOR US-POLISH MEDICAL RESEARCH. The US will finance a $2,000,000 medical research program by Polish and US medical scientists under a recently signed agreement with the Polish Government. This agreement between the US Public Health Service and the Health and Social Welfare Ministry of Poland came after nearly a year of negotiating.

Included in this agreement, the first such undertaken with an Iron Curtain country, are some ten laboratory projects which will require close collaboration by research scientists of both countries. These projects range from the functioned organization of the brain to the causes of prenatal malformations in children.

All projects involve problems in which scientists of both countries have an intense mutual interest and in which investigations are already underway.

Most of the research will be done in Poland by Polish scientists. An exchange of scientists and coordination visits will be used to check results, exchange data, and continue various training of personnel.

For the US, the agreement helps ease an acute shortage of qualified research scientists as well as giving an opportunity to contract for exacting laboratory work at bargain prices. The Polish Government, at the same time, will gain a source of supplementary funds for the purchase of foreign goods.

Should all go well, perhaps astrobiology and space medicine programs can be developed in future agreements. (Source: New York Times, April 2, 1962)

SOV

SWISS REJECT BAN ON ATOMIC WEAPONS. On April 1, 1962, the men of Switzerland, in a nation wide vote, rejected a proposal to write into their Federal Constitution a total ban on the manufacture, import, transit, storage, and use of nuclear weapons. Nearly 55 percent of the country's registered voters went to the poles. The vote was 537,387 to 286,858. Women did not participate as they are denied suffrage in national affairs.

The issue was brought to a vote through the efforts of a nonparty committee with strong left-wing support. Nearly 80,000 signatures of registered votes were collected. The vote was strongly in favor of a ban in western Switzerland and strongly opposed to a ban in German-speaking Switzerland.

The government's position, which evidentally had strong influence, was that the question of equipping the Swiss Army with nuclear weapons was purely academic at this time, and it was unwise to mortgage an unforeseeable future by writing a ban into the constitution.

Bernard Beguin, a prominent Swiss political commentator, said of the vote, "I feel that those who voted yes (for the amendment) in western Switzerland wanted to say no to the bomb with a capital B, and those who voted no in German Switzerland wanted to say no to communism with a capital C." (Source: New York Times, April 2, 1962)

FROM THE SEMITECHNICAL LITERATURE

WILL RUSSIA DEVELOP FUTURE THERMONUCLEAR WEAPONS IN OUTER SPACE? The recent release of thermonuclear weapon information by Russia leads to speculation concerning the reason for publishing details that have been so highly protected. The report containing this information, "Thermonuclear Weapons," was written by M. B. Neyman and K. M. Sadilenko and discusses the operating principles of these weapons in some detail. Mr. Neyman is identified as a professor of chemistry, while Mr. Sadilenko is identified only as a member of the Soviet Academy of Science.

The report describes a simple atomic bomb as a device consisting of nuclear fuel (uranium or plutonium), a neutron reflector surrounding the fuel, a conventional high explosive, a detonator, and a bomb casing (see Fig. 1). Subcritical lumps of fuel are driven together by the detonating high explosive so that the critical mass is exceeded and a fission chain reaction is started. A strong bomb casing retards scattering of fuel in the early stage of an explosion, while a neutron source placed near the center of the bomb will speed up the chain reaction.

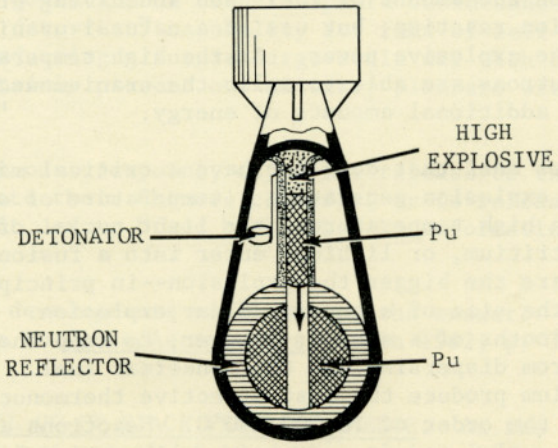


FIG. 1

The inner spherical surface of a bomb can carry a number of explosive charges in the form of spherical lenses as shown in Fig. 2. Subcritical charges of nuclear fuel in the shape of spherical biconvex or concavo-convex lenses can be placed over the explosive surfaces, and their mating parts are placed opposite them in the central part of the bomb. As the high-explosive charges are detonated simultaneously, a jet of gas is ejected from each towards the center of the bomb. The implosive force

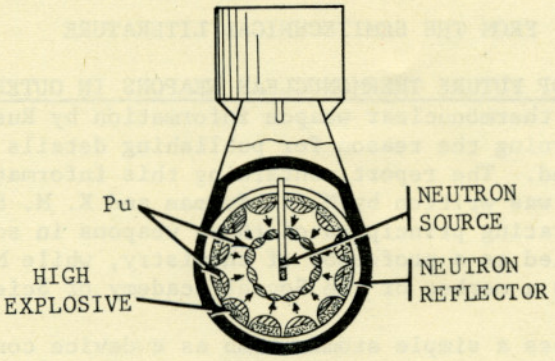


FIG. 2

of this "shockwave" hurls the fuel elements together with such pressure and heat that considerably more than the critical mass of nuclear fuel enters into the fission reaction. How powerful the explosion will be depends primarily on the amount of fuel used and having proper contact to initiate a fission reaction, but use of a natural-uranium casing can further increase the explosive power. At the high temperatures of an explosion, fast neutrons are able to split the uranium nuclei in the casing to liberate additional amounts of energy.

A hydrogen bomb uses fuel that does not have a critical mass. To detonate it, an atomic explosion generating a temperature of over 10,000,000°C is needed. At such high temperatures, the light nuclei of thermonuclear fuels (deuterium, tritium, or lithium) enter into a fusion reaction. The more nuclei there are the bigger the explosion--in principle, there is no upper limit to the size of a thermonuclear explosion. Reactions must take place in millionths of a second, however, to keep the triggering atomic explosion from dispersing the thermonuclear fuel. For this reason, deuterium and tritium produce the most effective thermonuclear reaction at temperatures on the order of 10,000,000°C. Reactions at such temperatures yield helium nuclei and free neutrons, liberating 8.2×10^{10} kcal per kilogram of fuel and producing a thermal effect of 8.4×10^{10} cal per gram of fuel.

The advanced hydrogen-uranium bomb adds another phase to the fission-fusion process of the deuterium-tritium bomb. When a plutonium charge is exploded (first phase), it causes a thermonuclear reaction in lithium hydride (second phase). Fast neutrons produced by these phases induce the fission of uranium-238 in the bomb casing (third phase). This third-phase reaction can increase the power of an explosion from tens or hundreds of thousands of tons to millions of tons.

Although the report by Messrs. Neyman and Sadilenko proved interesting, such information has been available in open literature of Western nations for several years. Even so, the significant fact is that the Russians have allowed the information to be published. Why? We can only guess, but knowing how the Russians have developed past propaganda campaigns, it is not beyond the realm of possibility that this is the beginning of a new one. Simple facts about thermonuclear weapons, their use, and after-effects could be used to develop a wider opinion that future testing must be done in outer space or even on the Moon. Should the Russians announce this to be their intention, it could have a tremendous influence for two reasons. First, they would assume a humanitarian role in not wanting to further endanger all mankind; and second, they would indicate a technology that could not only deliver a weapon beyond the Earth but could also record certain data over vast distances with accuracy.

Another interesting possibility is that by increasing anxieties throughout the world concerning thermonuclear bombs and atmospheric pollution, Russia could accuse the western powers of imperiling the world's population with future atmospheric testing. Many authorities are already quite concerned today over the amount of radiation present in the air we breathe. Not only could further testing be used to sway world opinion against us, but additional pollution of the atmosphere could conceivably cancel our "thermonuclear deterrent" capability for fear of self-extermination. The prospect of conducting a future large-scale war with conventional weapons would most certainly present our military planners with a modern-day "Gordian knot."

From a less ominous viewpoint, maybe the release of this information is merely to placate their Chinese comrades, or to release data that is no longer important, or to "feed back" Western information to keep us wondering.

Perhaps future developments will give us the answer. (Source: Adapted from an article in Space/Aeronautics, March 1962, p. 34)

US-INTERNATIONAL CO-OP SPACE PROGRAMS EMERGE. At the present time, NASA is working with scientists of 12 nations on satellite and sounding-rocket programs, most of which are described in Tables 1 and 2. This work has been progressing for some time with considerable success. During 1961, for example, the Italian Space Committee launched the first of its Nike-Cajun rockets from Sardinia, using emitted sodium-lithium vapor to measure upper-atmosphere winds and temperatures. Another example of this international cooperation is the ground-support activities of several countries in tracking various satellites such as Echo, the first communications satellite.

Table 1

NASA'S INTERNATIONAL SOUNDING ROCKET PROGRAMS

Country	Cooperating Agency	Scientific Objectives	Launching	
			Place	Date
Japan	Japan Radio Research Laboratories	Electron-temperature determination	Wallops Island, Virginia	Spring, 1962
New Zealand	New Zealand National Space Research Committee (University of Canterbury)	Measure winds and wind shears in mesosphere; correlate with ground-based, low-frequency radio scattering	New Zealand	Spring, 1962
Norway-Denmark	Norwegian Space Committee (Norwegian Defense Research Establishment and Copenhagen Technical University)	Measure distribution of ions and electrons in the auroral ionosphere	Andoya, Norway	Spring, 1962
Pakistan	Pakistan Upper Atmosphere and Space Research Committee	Measure of upper-atmosphere winds turbulence, and diffusion	Pakistan	Summer, 1962
Sweden	Swedish Committee on Space Research (Institute of Meteorology, University of Stockholm)	Measure wind in mesosphere during occurrence of noctilucent clouds	Jokkmokk, Sweden	Spring, 1962

Table 2

NASA'S INTERNATIONAL SATELLITE PROGRAMS

Country	Experiments	Scientific Objectives	Launching	
			Place	Date
Canada Ionospheric Topside Sounder (S-27) Alouette	Canadian Defense Research Telecommunications Established (DRTE)	Electron density distribution galactic-noise measurement	Pacific Missile Range, California	1962
United Kingdom International Ionosphere Satellite #1 (S-51)	University College, London Birmingham University University College, London University College, London Imperial College, London	Electron temperature and density Electron density Measure ion mass, composition, and temperature Solar Lyman Alpha (1216 A) and solar X-rays Primary cosmic rays	Cape Canaveral, Florida	1962
United Kingdom UK Satellite #2 (S-52)	Cavendish Laboratory, U. of Cambridge Meteorological Office, UK Air Ministry U. of Manchester, Jodrell Bank	Galactic radio noise Atmospheric ozone Micrometeoroids	Wallops Island, Virginia	1963

The culmination of two significant programs will be realized later this year with the launching of the first of a series of international satellites. These will be launched in conjunction with British and Canadian space projects.

NASA's role in international space exploration extends from a mandate for cooperation from the US Congress and from the experience and precedents of the IGY. But this role extends far beyond merely supplying launching facilities and vehicles. Also included are technical guidance, laboratory support, and training of scientists of cooperating nations. The main objective of all this work is to increase the number of scientific talents in space research.

At first, much of the cooperating nations' work will involve ground-support efforts, such as tracking and data recording. To accomplish this, NASA is establishing a global network of tracking and communications stations. Some two dozen of these stations already exist in about 20 nations. Most of the stations are manned, wholly or partly, by technical personnel of those nations, and the full cost of operation for several of the stations is being borne by the participating nations themselves. (Source: International Science and Technology, March 1962, p. 64)

FROM THE TECHNICAL LITERATURE

AERODYNAMICS

CALCULATION OF TURBULENT BOUNDARY LAYER WITH COOLING AGENT FED THROUGH A POROUS WALL. A method of calculation is given by V. M. Polyayev and I. V. Bashmakov in Mashinostroyeniye, No. 11, 1961, for the boundary layer of a porous wall through which a cooling agent is fed. The method is based on solutions of equations of momentum, energy, concentration, continuity, and state. These equations are solved under the following assumptions:

1. The temperature of the liquid film of the cooling agent relative to the porous wall is negligible.

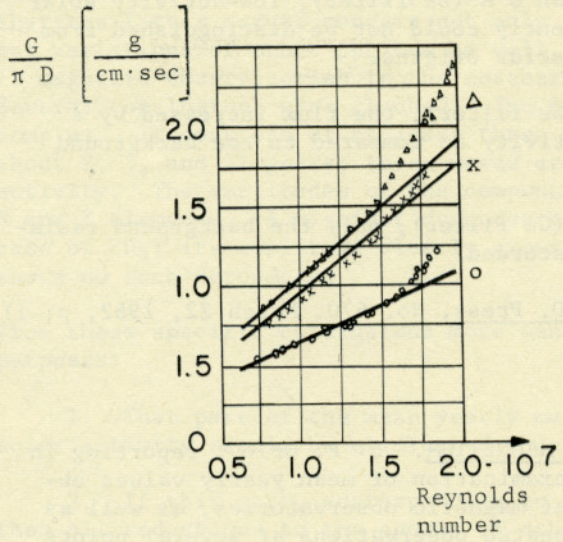
2. The temperature of the liquid film is equal to that of the cooling agent under the ambient pressure.

3. The thermal losses are negligible and the heat flow to the liquid film is consumed fully in heating and evaporating the cooling agent.

4. The specific heat for the entire thickness of the boundary layer is constant.

5. The chemical reactions in the boundary layer are disregarded.

6. The Prandtl number is 1.



Δ - T_∞ = 1143° ; u_∞ = 720 m/sec
x - T_∞ = 1033° ; u_∞ = 695 m/sec
o - T_∞ = 753° ; u_∞ = 450 m/sec

FIG. 3

Figure 3 shows the theoretical dependence (solid curves) of the specific consumption of the cooling agent on the Reynolds number, where G is the total consumption of the cooling agent, D is the diameter of the tube, and T_∞ and u_∞ are the temperature and speed of the inflowing gas, respectively. The curves calculated by the method discussed and experimental data by Kinney and Abramson are plotted for relative wall temperatures T_w of 0.5, 0.36, and 0.326. (Source: Dept. of Commerce, A.I.D. Press, No. 653, February 27, 1962, p. 1)

ASTROPHYSICS

SHORTWAVE SOLAR RADIATION INVESTIGATIONS. Equipment installed on the second Soviet spaceship to investigate shortwave radiation is discussed by A. I. Yefremov and others in an article appearing in Iskusstvennyye Sputniki Zemli.

The operational principle of the equipment was the separation of various parts of the radiation spectrum by a set of filters, made of different materials, which were automatically and successively placed in front of the receivers. The latter were ВЭУ open-type (secondary) electron multipliers with BeO and Srf photocathodes. The equipment consisted of two basic parts: СФ-1, -2, and -3 optical units, used as photon counters, which were placed on the outside of the spaceship; and a PT recording-circuit unit placed inside the ship. Each СФ unit contained two receivers and disks with filters turning synchronously in front of them, a preamplifier, and optical pickups designed to disconnect the equipment when it was on the shadow side of the orbit or when the Sun was outside its field of detection. The PT unit contained three independent ИСС counters, each of which was connected to one of the СФ units. The following materials were used for the filters: SiO_2, LiF, CaF_2, Al, $(CH)_n$, Be, and Cu.

The equipment described in the preceding paragraph made it possible to conduct measurements and recordings whose processing led to the following conclusions:

1. In the 44 to 110-Å range (with a $(CH)_n$ filter), the radiation flux was constant at $1.5 \cdot 10^4$ pulses$\cdot$cm$^{-2}\cdot$sec^{-1}, ±8 percent.

2. In the 8 to 21-Å range (Al filter), the flux was constant at $6.2 \cdot 10^4$ pulses$\cdot$cm$^{-2}\cdot$sec^{-1} except for a period of 9 and 4 min of high solar activity; during the latter period the flux increased by 63 percent.

3. In the range shorter than 8 Å (Be filter), low-activity solar radiation was very weak and frequently could not be distinguished from the background radiation from nonsolar origins.

4. In the 5 to 10-Å range (Be filter), the flux increased by a factor of 11 during high solar activity as compared to the background radiation previously recorded.

5. In the 1.4 to 3-Å range (Cu filter), only the background radiation from nonsolar origins were recorded.

(Source: Dept. of Commerce, A.I.D. Press, No. 670, March 22, 1962, p. 1)

GEOPHYSICS

SECULAR VARIATIONS OF THE EARTH'S MAGNETISM. B. P. Orlov, reporting in Trudy, No. 18, 1961, states that examination of mean yearly values obtained for the geomagnetic field at magnetic observatories, as well as a comparison of the results of repeated observations at several points on the surface of the Earth, has shown that changes in the field are of a complex nature and result from:

1. Periodic changes of a planetary nature (the so-called westerly drift of the geomagnetic field may be one such change).

2. Physical processes in the "centers" of the secular march within the Earth at a depth of several thousand kilometers (there are at least five such centers).

3. Physical processes in the Earth's crust related to the structure of the crust and to tectonic, geochemical, geothermal, and other phenomena.

4. The physical processes in the upper layers of the atmosphere influenced by solar activity.

If the sharp secular changes which were noted had been caused solely by the influence of solar activity, they would to a considerable degree have been of a uniform pattern throughout the northern hemisphere. Since this was not the case, it is assumed that the changes result from the activation of physical processes within the Earth that affect the magnetic field on the surface.

Orlov, with co-author N. V. Adams, also reports in the same issue of Trudy on solar activity and secular changes in the Earth's magnetic field. Their article says that discrepancies between curves based on Wolf's sunspot numbers and curves plotted by Kalinin and Afanas'yev for external secular variations in the level of the Earth's magnetic activity (δF_a) have been used as a starting point for a study whose purpose is to show that the latter curves contain not only the 11-year cyclical variation but variations of other periods as well. Data accumulated since 1920 by 13 magnetic observatories in the northern hemisphere were analyzed. Several conclusions were reached. The δF_a part of the secular march is complex. It consists of at least three component waves with periods of about 2, 5, and 11 years; these waves are definitely related to solar activity. The amplitudes of the component waves are dissimilar in their H and Z elements. A distinct dependence on latitude is evident in the case of δH_a; its amplitude clearly grows toward the south. However, δZ_a shows no such dependence.

From these specific conclusions more general ones are drawn for mapping purposes:

1. That part of the mean yearly magnetic values attributable to solar activity should be eliminated when compiling magnetic-field charts.

2. If this part, corresponding to the δZ_a value, is eliminated, then all reductions to the epochs of other years must be made using only the deep part of the δF_a secular curve, a part of which can be forecast with greater accuracy than δF_a itself.

3. Even when the reduction of magnetic values is made for mean yearly values in which δF_a has not been discounted, the reduction can be made only for the δF_c part (secular variations related to the physical processes occurring within the Earth) of the secular curve on magnetic maps with a scale of less than 1:1,000,000; otherwise such errors will be reflected in the accuracy of the map.

(Source: Dept. of Commerce, A.I.D. Press, No. 666, March 16, 1962, pp. 1 and 2)

MATERIALS

FIRE-RESISTANT POLYVINYL ALCOHOL FIBERS AND FABRICS. Fire-resistant textiles have been produced at the Leningrad Textile Institute imeni S. M. Kirov by direct phosphorylation of polyvinyl alcohol fibers and fabrics. Freshly obtained fibers were heated in air at 210°C for 5 min and treated at 70°C for 40 min in a bath containing 4 percent formaldehyde, 20 percent sulfuric acid, and 25 percent sodium sulfate. After washing and drying, the fiber was heated in a phosphorus oxychloride

solution in chloroform at 60°C for 3 hr. When the phosphorylation process was completed, the fiber was washed in ethyl alcohol and its phosphorus content determined by the colorimetric molybdate method.

Fire tests showed that at a phosphorus content up to 1.94 percent, the fiber ignites by the flame of a match, burns for 1 sec after removal of the flame, and extinguishes itself without smoldering. At higher phosphorus contents the fiber does not ignite.

Fabrics from polyvinyl alcohol vinol fibers were phosphorylated by the same method, but did not burn or smolder upon the introduction of 4.23 percent phosphorus. The fibers and fabrics turned black during phosphorylation, acquired a whitish coating in air, and after washing, varied in color from brown to orange or yellow, depending on the quantity of phosphorus introduced. The fibers were fire resistant only in the form of ammonium salt or acid ester; they retained this quality during boiling in distilled water but lost it during treatment with hard water or alkalis. The loss is a result of substituting cations, which condition the hardness of the water, or ions of alkali metals for the ammonium or hydrogen ions of the phosphoric acid esters of the polyvinyl alcohol.

Unlike the ammonium salt, the calcium and sodium phosphates formed during the treatment are stable at flame temperature and do not decompose with the evolution of phosphoric acid, which is an active fireproofing agent. Washing these fibers and fabrics with a 5 percent ammonium chloride solution complete restores their fire resistance. Polyvinyl alcohol fibers were also phosphorylated by using methylene chloride instead of chloroform as the solvent of phosphorus oxychloride, washing with water instead of ethanol, and reducing the phosphorylation time. These fibers passed the fire tests with good results. (Source: Dept. of Commerce, A.I.D. Press, No. 652, February 26, 1962, p. 4)

POLYMER ADHESION STUDIED BY THE LUMINESCENCE METHOD. The nature of the separation boundary between two polymers in adhesion has been studied at the Institute of Physical Chemistry, Academy of Sciences USSR, with the use of the luminescence method, both by introduction of phosphors into one of the polymers and by utilization of the natural polymer luminescence. The experiments were conducted with natural and synthetic rubber, guttapercha, vinyl perchloride, and paraffin.

The separation boundary between two polymers was subjected to microscopic examination in ultraviolet light on specimens prepared from two-layer films obtained by various methods and, in some instances, subjected to heat treatment. It was found that combinations of polymers and paraffin and systems of nonpolar polymers with a close structure exhibit diffuse separation boundaries similar to those occurring in self-adhesion. The degree of diffusion was expressed in microns or millimeters; it reached

0.119 to 0.165 mm in the case of the heat-treated gutta-percha-paraffin system. In contrast, systems containing even one component with polar groups exhibited sharp separation boundaries.

It is concluded that the diffusion and electrostatic theories of adhesion do not contradict one another. A double electric layer is always formed when two polymers are brought into contact, even in the case of self-adhesion. The double layer is maintained indefinitely in some cases, but disappears in others as a result of diffusion. It was also observed that deformation of the specimens causes a sharp increase in luminescence intensity, with a simultaneous change in luminescence color. It is therefore believed that the luminescence method might be applicable in studying local stresses in microscopic volumes and the formation of cracks. (Source: Dept. of Commerce, A.I.D. Press, No. 639, February 6, 1962, p. 1)

ADHESION OF HIGH POLYMERS TO HIGH-MOLECULAR SUBSTRATA. The effect of the molecular weight, polarity, and polydispersity of high polymers on their adhesion to high-molecular substrata and the dependence of the adhesion on temperature have been studied at the Moscow Institute of Fine Chemical Technology imeni M. V. Lomonosov. The experiments were conducted with specimens of butadiene-acrylonitrile copolymers which differed both with respect to their contents of polar component and to their molecular weights (fractions with different molecular weights of nitrile rubbers СКН-18, СКН-26 and СКН-40 with 20, 30, and 40 percent acrylonitrile, respectively). Polyamide was used as the substratum. The adhesion between the rubber and the polyamide was determined with the use of an adhesiometer designed at the Central Scientific Research Institute of Leather Substitutes.

It was found that increase in the molecular weight of the rubber specimens reduces their adhesion to polyamide; the adhesion becomes constant for molecular weights above 300,000 to 350,000. Increase in the contact temperature improved the adhesion of all the specimens, especially those with lower molecular weights. When the contact occurs at room temperature, the adhesion of nitrile rubber to polyamide is almost independent of the polarity of the rubber; however, adhesion drops sharply with an increase in the polarity of the adhesive at high temperatures. Polydispersity of the adhesive was found to reduce its adhesiveness, owing to a decrease in the content of fractions with a low molecular weight. The adhesion of polar nitrile rubber to nonpolar polyisobutylene (П-118, with a molecular weight of 118,000) was found to be very low and almost independent of the molecular weight or the polarity of the adhesive and of the contact temperature. The data are believed to confirm the diffusion theory of adhesion. (Source: Dept. of Commerce, A.I.D. Press, No. 640, February 7, 1962, p. 5)

METALLURGY

HYDROGEN EMBRITTLEMENT OF TI-AL ALLOYS. Soviet scientist V. A. Livanov, in an article appearing in Voprosy Metallovedeniya (Problems of Metal Science), reports that the effect of aluminum on the hydrogen embrittlement of titanium has been studied at the Moscow Aviation Technological Institute. Specimens containing 0, 3, 5, 7.5, and 10 percent aluminum and 0 to 0.06 percent hydrogen were tested at room temperature. It was found that 3 to 5 percent aluminum decreases the susceptibility of titanium to hydrogen embrittlement, owing to the increase in hydrogen solubility in α-solid solution and to retardation of the diffusion of hydrogen. The beneficial effect of aluminum is especially pronounced with respect to notch toughness a_k (see Fig. 4). While the notch toughness of commercially pure titanium decreases sharply at hydrogen contents above 0.015 percent, that of the titanium alloy with 3 percent Al begins to decrease only when the hydrogen exceeds 0.022 percent. In the alloy with 5 percent Al (BT5), a significant decrease is observed only when the hydrogen content exceeds 0.033 percent.

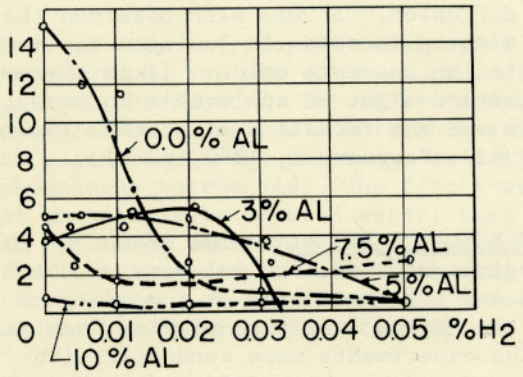


FIG. 4

The maximum permissible hydrogen content for BT5 is approximately double or triple that for commercially pure titanium. The notch toughness of the titanium alloy with 7.5 percent Al is generally low, and in the range studied is affected only slightly by hydrogen content. The alloy with 10 percent Al is so brittle that its notch toughness is approximately zero. (Source: Dept. of Commerce, A.I.D. Press, No. 637, February 2, 1962, p. 1)

METEOROLOGY

ANTI-HAIL TECHNIQUES PROVE EFFECTIVE IN CAUCASUS VALLEYS. The note cited below reports on the work of Soviet geophysicists who have been actively working over a period of years to devise methods of preventing disastrous hail storms in the mountain valleys of the Georgian SSR where the grape crop has been destroyed on many occasions under such circumstances.

At the approaches of the Alazanskaya Valley, radar sets scan the sky to detect the arrival of hail storms. From eleven points situated on the peaks of the Tsib-Gomborskiy Range, rockets are fired into the hail front;

these rockets are loaded with an unspecified chemical substance. This chemical has an almost instantaneous effect--the clouds break and soft hail falls on the mountain slopes, but only rain falls on the vineyards in the valley. This work has been pursued by specialists of the Georgian Academy of Sciences and the Hydrometeorological Service of the USSR; these personnel live and work in the special facilities of the Alazanskaya Anti-Hail Stationary Expedition. (Source: Joint Publications Research Service, No. 11281, December 1, 1961, p. 9)

NUCLEAR PHYSICS

NEW COSMIC RAY DISCOVERY AND NEUTRINO RESEARCH. Academician D. V. Skobel'tsyn announced recently at a meeting of the Academy of Sciences USSR that members of the Lebedev Physics Institute have made an important discovery in the study of nucleons thanks to a new method of experimental research based on the so-called "ionization calorimeter." This device measures with high precision the energy of cosmic ray particles. Skobel'tsyn further stated that future studies of the structure of matter will make use of cosmic ray particles of high penetrating power. A special installation being built by Georgian scientists will be particularly important for this purpose. One of the most significant particles is the high-energy neutrino which may make it possible to probe the entire mass of the Earth. Neutrino research calls for the construction of a special installation deep underground; the basic parameters of such an installation have already been determined. (Source: Dept. of Commerce, A.I.D. Press, No. 663, March 13, 1962, p. 3)

PHYSICS

INTERACTION OF AN ELECTRON BEAM WITH ELECTROMAGNETIC WAVES IN AN ISOTROPIC DIELECTRIC. P. B. Bliokh and E. A. Kaner, reporting in Radiofizika, Vol. 4, No. 5, 1961, state that the interaction of a quasineutral electron beam with electromagnetic waves passing through an unlimited anisotropic uniaxial crystal has been investigated by means of linear approximation. Electromagnetic waves with two types of polarization (ordinary and extraordinary waves) are studied and dispersion equations obtained for both types. These equations are analyzed graphically. The following problems are considered: (1) conditions of time- and space-variable beam instability, and (2) the dependence of time- and space-variable amplification on angles characterizing the directions of wave and beam propagation.

The first problem is studied by methods developed by P. A. Sturrok (Physics Review, Vol. 112, 1958, p. 1488) but the scope is limited to the case of "resonance" occurring when $v = \omega$ in the dispersion equation for the extraordinary wave. For this case, both time and space instabilities are found to be "convective." Consideration of the dispersion equations for the ordinary wave showed that time instability is absent. Space instability for the ordinary wave is always "fictitious."

The second problem was analyzed on the basis of the dispersion equation of the extraordinary wave. It was found that time instability is absent and space instability is fictitious when there is no interaction of the beam with the electromagnetic waves when their directions coincide. Instability of the beam directed along the wave vector takes place only in an anisotropic dielectric when the general direction of the beam and wave forms a certain angle with the crystal axis. If simultaneously with this angle α the beam velocity v_o is changed in such a way that the condition of resonance $v_o = \omega(\alpha)$ are satisfied, instability intervals will expand. However, in the directions $\alpha = 0$, $\pi/2$, π, and $3\pi/2$, instability is always absent. (Source: Dept. of Commerce, A.I.D. Press, No. 653, February 27, 1962, p. 3)

ACCELERATION BY AN ELECTRON BEAM PLASMA WITH A FROZEN MAGNETIC FIELD. It has been noted in the Zhurnal Eksperimental'noy i Teoreicheskoy Fiziki that plasma with a frozen magnetic field can be accelerated by a bombarding electron beam, since the presence of the magnetic field makes the plasma opaque to electrons. A study at the Physics Institute imeni P. N. Lebedev has indicated possible methods for increasing the transfer of energy from electrons to plasma.

In one method, based on scattering and reflection of electrons, multiple electron reflection may be used. The electron beam is injected between two plasma clouds or between a plasma cloud and a magnetic mirror, along the axis of the latter. Electrons scattered or reflected by the magnetized plasma are confined for a longer time between the mirror and the plasma.

A second method is based on the inductive increase of electron mass; i.e., if the incident electron beam has a marked inductance value, the total imparted to the plasma may exceed the mechanical impulse of the beam particles. As a result, the reactive force on the plasma will exceed by several orders of magnitude the force obtained by the first method. Impulse transfer may also result from electron scattering by inhomogeneities introduced by the plasma in the external magnetic field or from a decreased transparency of the plasma when a beam of plasma hits another plasma layer.

The latter process is thought to be the cause of the pressure produced on the plasma of comet tails by solar plasma beams carrying internal magnetic fields. (Source: Dept. of Commerce, A.I.D. Press, No. 647, February 16, 1962, p. 2)

LONG HIGH-PRESSURE ARCS. In a study aimed at developing a method for heating dense plasma to temperatures of the order of several tens of thousands of degrees with relatively small power expenditure, a device

was developed to produce arcs up to 8 cm long at pressures of several tens of atmospheres. The device consists of a stainless steel cylinder which is 400 mm long, with an 85-mm inner diameter, and closed at the end by steel flanges.

The chamber, cooled by a water jacket, is designed for a working pressure of 100 atm. The copper electrodes (a fixed anode and a movable cathode) pass through the ends of the cylinder; they have tungsten tips and are covered by a quartz shield to increase electrical and thermal insulation. For cooling, water is passed through a concentric jacket of nickel silver inside each electrode. The interelectrode space is thermally insulated from the body of the chamber by another stainless steel cylinder, whose inner surface is covered with 8 to 10 layers of tungsten and molybdenum plate. This shielding system, mounted on ball bearings, is rigidly fixed to the armature of an electric motor, which is also located inside the main chamber and which is capable of rotating the shield at 2500 rpm. The resulting rotation of the gas around the electrodes improves the hydrodynamic stability of the maximally heated plasma in the center of the chamber and yields arcs in 1 to 100 atm helium which are stable and twice as long as without rotation.

Experiments were conducted in pure helium and in hydrogen, but the arc in hydrogen was very unstable; even with rotation the longest arc was 3 cm, i.e., too short to permit measurements. When the arc is longer than 3 cm (in helium), most of the energy is expended in the discharge column.

At pressures higher than 20 to 30 atm, radiation losses are the determining factor in the energy balance. Analysis of the relationships between pressure, voltage gradient, and current in the arc makes it possible to calculate the radius of the arc channel, the plasma temperature, and the degree of ionization of the plasma.

A temperature of $2.2 \cdot 10^4$°K was obtained with a power production of $2 \cdot 10^5$w/cc of plasma. It is suggested that radiant losses may be decreased by mixing the helium with a substance having a lower ionization potential, though such a mixture would be harder to heat than pure helium, and at sufficiently great plasma density, only the coldest external layers of the plasma column would radiate.

This note was abstracted from an article by Ye. S. Borovik which appeared in the Soviet Journal of Technical Physics. (Source: Dept. of Commerce, A.I.D. Press, No. 636, February 1, 1962, p. 3)

PROCESS ENGINEERING

RESIDUAL STRESSES IN TITANIUM ALLOY. An article by V. Ye. Loginov in Aviatsionnyy Institut-Trudy reports that the effect of machining on residual stresses and strain hardening in heat-resistant or titanium-alloy parts has been studied at the Moscow Aviation Institute. It was

found that the hardness and depth of the strain-hardened layer depend greatly on machining conditions in both milling and grinding and are reduced by decreased feed, depth of cut, and cutting speed.

The effect of the milling method on the magnitude of stresses is particularly high; climb milling produces lower stresses and should be used where possible. The distribution of residual stresses in titanium alloys differs for different machining methods. In milling, compressive residual stresses appear as a result of plastic deformation of the outer surface layer, while in grinding, high tensile stresses which sometimes reach the yield point appear as a result of steep temperature gradients caused by low heat conductivity. The effect of feed on the depth of the stressed layer, which is strong at all cutting speeds, can be reduced considerably by cooling with a CO_2 spray.

An investigation of the residual stresses in the blades of an axial compressor made of BT8 titanium alloy (C135AMo; Ti-7Al-4Mo) showed that finishing operations are mainly responsible for the magnitude of residual stresses and the depth of the stressed layer. This layer can be removed to a depth of 30 to 60 μ by electropolishing. (Source: Dept. of Commerce, A.I.D. Press, No. 649, February 20, 1962, p. 6)

ELECTROSPARK MACHINING OF CARBIDE DIES. N. K. Foteyev states in the December 1961 issue of Mashinostroitel' that with the use of adequate pulse parameters, electrospark machining does not have the drawbacks of abrasive machining, which is costly, does not produce high-quality dies, and cannot be used for intricately shaped dies.

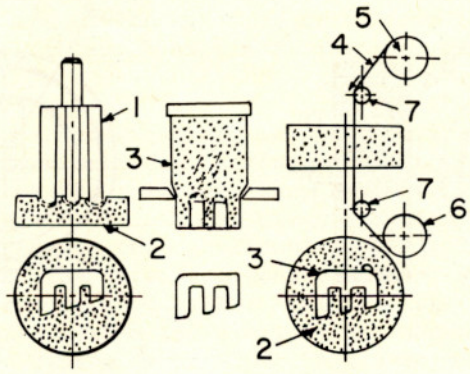
Experiments have shown that pulse generators which generate pulses with durations of several tens of microseconds for roughing to several microseconds for finishing are the most effective in high-quality machining. The pulse energy should be within the range of a few tenths of a joule for roughing to less than 0.01 joule for finishing. Even intricately shaped dies do not require additional finishing after electrospark machining. Two methods are in current use (see Fig. 5):

1. Direct (a) and inverse (b) copying of the electrode-tool shape.

2. Machining with a continuously moving wire electrode (c).

The latter method does not require a shaped electrode; the desired shape is obtained as a result of the motion of the wire electrode.

A special electrospark machine, "Elektrom-15," for machining with a wire electrode has been designed and built at the Central Scientific Research Laboratory for Electric Treatment of Materials. (Source: Dept. of Commerce, A.I.D. Press, No. 646, February 15, 1962, p. 5)



1. Electrode tool; 2. Carbide dies;
3. Carbide punch; 4. Wire electrode;
5. reel with wire; 6. reel with worn wire;
7. guiding rollers

FIG. 5

VIBRATORY FORGING. Figure 6 shows a new rotary forging machine, in which outer rotor 2 with center O_i and inner (working) rotor 3 with center 0 rotate in the body 1. The working rotor has a slot for split die 4 and striking head 5 with a roller. The rotors rotate in opposite directions, and the number of blows thus equals the sum of their rpm. The workpiece is deformed by very rapid blows of the head, which oscillates radially as a result of the rotors' rotation. An experimental machine of this type was manufactured at the Novosibirsk "Tyazhstankogidropress" Plant and used for forging bodies of revolution.

On the basis of the above device, a second forging machine was developed for complex-shape parts, e.g., turbine blades (Fig. 7). In this second machine, the external surface of rotor 3 and internal surface of rotor 2 are tapered. The die in this machine has an impression corresponding to the shape of the blade being forged. Its working rotor moves axially without rotating and the outer rotor rotates but does not move axially. The head strikes once for each revolution of the outer rotor, and the working rotor moves to the left according to a preset program until forging is completed.

Recently a vibratory forging press was developed in which the vibrator is switched on after the upper half of the die contacts the blank and pressure is applied. In testing this press for hot and cold forging of

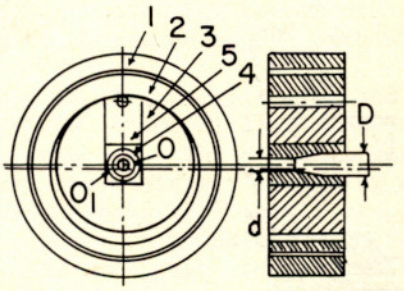


FIG. 6

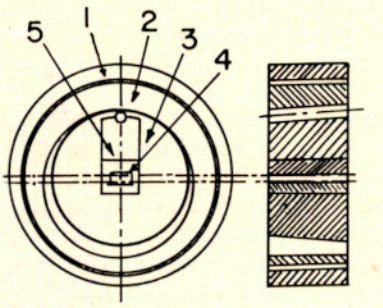


FIG. 7

aluminum alloy and 40XHMA and X17H2 (AISI 4340 and 431, respectively) steel blades, it was determined that vibration reduces external friction by 30 to 60 percent and improves forging precision. It also improves uniformity of deformation, as a consequence of which the structure is refined and hardness increased.

It is believed that vibratory forging will find wide industrial use, and it is recommended that design and development work on vibratory forging equipment be coordinated in a single center. (Source: Dept. of Commerce, A.I.D. Press, No. 664, March 14, 1962, p. 3)

PROPELLANTS

INTENSIFYING THE EFFECT OF ULTRASOUND ON COMBUSTION OF PULVERIZED PARTICLES. Previous studies by E. N. Andrade, C. A. Lane, H. Schlichting, G. D. West, and P. N. Kubanskiy, regarding the problem of increasing the burning rate of pulverized solid fuel by high-amplitude ultrasonic oscillations and the physical phenomena which cause the intensification, are reviewed in an article appearing in Teploener-getika, Vol. 9, No. 1, 1962.

Basically, the intensification is due to an inflow of oxygen made possible by acoustic-streaming blowoff of the combustion gases which envelop the particles. Acoustic streaming appears in the neighborhood of particles whose oscillation amplitude, though lower than that of the medium, is sufficiently high to produce the phenomenon. The oscillation rate of the particles depends on their dimensions; when they have a certain relatively large dimension, the rate lags behind that of the medium.

The existing theory of acoustic oscillations is not sufficient for calculating the motion of flow at very high amplitudes, but it is reasonable to expect that the motion then becomes more complex. An approximate calculation of the intensity of acoustic oscillations required for the intensification of flame combustion is calculated from the criterion $Re = v_c d/\nu \geqslant 5$, which is valid in this case, where v_c and ν are the oscillation speed and kinetic viscosity of the gases, respectively. Assuming that the pulverized-fuel particles are spherical with a 251-μ diameter and that gas temperature is 1200°C, and taking specified experimental data into account, the required intensity was found to be 152.44 db. For a selected ultrasonic oscillation frequency of 20 kc, the displacement amplitude would not amount to less than 35.1 μ. (Source: Dept. of Commerce, A.I.D. Press, No. 650, February 21, 1962, p. 1)

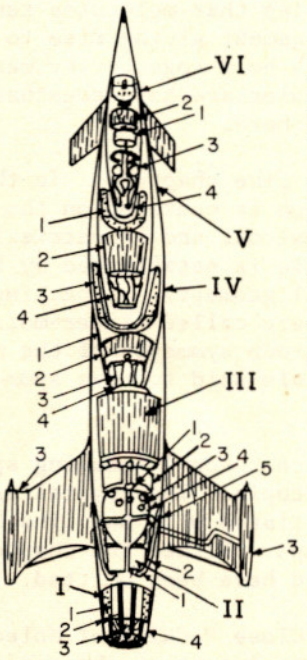
SPACECRAFT

USSR INTERPLANETARY SPACECRAFT. A Yugoslav source (unspecified) reports on Soviet design plans for an interplanetary vehicle that may be launched either directly from the Earth or, more likely, will be transported piecemeal to a space station orbiting the Earth for assembly and launching. The craft will have aerodynamic controls for maneuvering in gaseous atmospheres as well as controls for navigation in interplanetary space. (Figure 8 accompanies the article, but no direct reference is made to it in the text.)

I. First stage of rocket with liquid fuel engine: 1. fuel tank; 2. liquid oxygen tank; 3. fuel pumps; 4. combustion chambers.

II. Ramjet engine stage (athodyd): 1. compressed air; 2. fuel tank; 3. athodyd.

III. Nuclear engine stage: 1. working part of the engine; 2. atomic fuel; 3. assembly; 4. atomic fuel feed setup.



IV. Liquid fuel rocket engine stage: 1. fuel; 2. liquid oxygen; 3. assembly; 4. camera.

V. Liquid fuel rocket engine stage: 1. fuel; 2. liquid oxygen; 3. assembly; 4. camera.

VI. Stage with rocket engine and crew cabin.

FIG. 8

(Source: Dept. of Commerce, A.I.D. Press, No. 654, February 28, 1962, p. 1)

BOOKS. The following book reviews have been selected from various publications as noted:

Kitaigorodskii, A. I., Organic Chemical Crystallography (translated from the Russian). Consultants Bureau, New York. 1961.

This interpretive study was reviewed by Martin J. Buerger of the Department of Geology and Geophysics, Massachusetts Institute of Technology.

"Here is a book like a breath of fresh air; it is not a textbook, nor does it embellish a shopworn theme. Rather, it devotes itself to a thesis and to documenting the evidence for that thesis; and it complements many books devoted primarily to the crystal chemistry of inorganic substances, for it is concerned solely with organic substances. More exactly, the author seeks to understand why a given organic molecule, when crystallizing with other molecules of the same kind, selects that particular packing arrangement which crystal-structure analysis reveals. After much study, Kitaigorodskii convinced himself that there was a relatively simple theme here. He states this early in the preface, then in the body of the book, he presents, first, a theoretical basis for the theme, and second, a substantiation of it by the use of well-arranged data.

"The theme is touched off by this remark: 'Organic crystals are always so constituted that the projections in one molecule enter the hollows in another.' This implies that molecules tend to assume as close packing as possible, this arrangement giving rise to the least free energy, primarily because molecules hold together by means of surface forces. Crystals in which the molecules are held together by hydrogen bonding are, of course, not included here.

"The book contains only five chapters. In the first chapter, 'The Molecule,' the discussion is centered on the molecule as a building unit, especially in its dimensional and symmetrical aspects. The internal structure of the molecule is established by the bond lengths and bond angles, but the external geometry, or packing shape, is determined by van der Walls' radii, here called 'inter-molecular radii.' Molecular symmetry is the point-group symmetry of the molecule. (Figure 18 [in the book] shows a molecule said to have symmetry mm, but it appears to have symmetry $\bar{4}$m2.)

"'The elements of lattice theory' (meaning space-group symmetry) is only an introduction to the topic. The crystallographer already knows the material, and the uninitiated will not find here an understandable development of space groups. Either the chapter should have been written differently or it should have been omitted.

"Chapter 3, 'Theory of Close Packing of Molecules,' is the heart of the book. Unfortunately this important chapter is presented in Kitaigorodskii's private nomenclature for line groups and plane groups. The author

will certainly lose many who would have become his disciples if he had used international symbols. The reader, if he is willing to grant that the author knows what he is doing, will find the conclusions that result from this important study in a limited number of tabulations and will have to translate only these tabulations into standard symbols. The gist of the chapter is that certain plane symmetries permit a molecule to touch six others in its layer, and thus to assume a 'molecular coordination number' of six; other plane symmetries prohibit this.

"This and attendant considerations permit a survey of the space groups for suitable condidates for packing molecules in organic crystals in which a molecular coordination number of 10 to 14 is ordinarily achieved. It develops that a molecule abhors space groups with mirror symmetry, unless that molecule itself has one or more mirrors. Some of Nowacki's data on the distribution of organic crystals over the space groups are not in harmony with Kitaigorodskii's results, but it appears that some of these data are from old determinations which have since been proven incorrect.

"A packing coefficient, k, can be defined as the ratio of the sum of the volumes of the molecules in a cell to the volume of the cell. (This is not the same as Fairbairn's 'packing index,' in which the volumes occupied by the atoms are controlled by bonding radii.) This varies from 0.6 to 0.8 for aromatics, and much smaller numbers are unknown.

"This part of the book covers only 112 pages. The remaining chapters--chapter 4, 'Application of Close-Packing Theory to Organic Crystals,' and chapter 5, 'Crystal Structure Descriptions for Organic Compounds'--are devoted to a critical and systematic description of the structures of organic crystals. This mass of data substantiates the author's theory.

"The book appears to be printed by offset from excellent typing, with justified margins. The lack of italics is noticeable and causes awkwardness in some sentences. There are no bibliographies, and the few citations are chiefly footnotes to descriptions.

"In his book, The Theory of Crystal Structure Analysis, Kitaigorodskii proved he was a master of crystal-structure analysis. The present (but older) book shows that he is also a leader in interpreting the results of such studies. All crystallographers, particularly those steeped mostly in inorganic crystal chemistry, will profit from reading this original work." (Source: Science, Vol. 135, No. 3507, March 16, 1962, p. 912)

Geiger, Rudolph, Das Klima der bodennahen Luftschicht, (Climate of the Lower Atmosphere), 4th edition. Braunschweig, Germany: Vieweg. 1961.

Mr. H. E. Landsberg of the Office of Climatology, U. S. Weather Bureau, makes the following comments on this book:

"Meteorologists and ecologists, agricultrists and foresters, conservationists and geographers, architects and planners should wlecome this fourth edition of Geiger's textbook on microclimatology. Since its first appearance in 1927, this book has dominated the field. From a slender volume it has grown into an imposing tome. Its earlier editions, including the English translation of the second edition [reviewed in Science, Vol. 126, p. 214 (1957)], have helped to stimulate work in microclimatology a great deal.

"Even with a 30 percent expansion in this edition, including 1218 literature citations, the author still had to exercise considerable restraint in choosing his material. He has succeeded admirably. The appearance of Sir Graham Sutton's companion volume on micrometeorology made it possible to omit much of the basic theoretical material. But in the phenomenological realm the book is without equal.

"The contents fall under a few primary headings: interaction of the surface with the adjacent air; heat balance in this surficial atmospheric layer; climatic interactions with fields and forests; spacial reaction of climate to orographic influences; and finally, relations of microclimate to humans and animals. G. Hofmann contributed a chapter on methodology of observations. This bare outline does not indicate the richness of the teaching material in this book. Some professor might even follow the whimsical suggestion to take students out in a glaze storm and, as a final examination, let them answer all the microclimatic puzzles nature might pose in these cases.

"On the more serious side, I hope that Geiger's injunction is heeded; he urges man to change from the ignorant destruction of beneficial microclimates to the deliberate creation of favorable changes in housing and city planning, reforestation and water management, and farm production. Rational climatic modifications are certainly closer at hand near the ground than in the clouds.

"Presumably because of language problems the rather extensive Russian literature in the field has not found a foothold in the book. Perhaps in this as in some other respects one might cast an eye into the future. There is little doubt that a few years hence a handbook on microclimate will be needed. It would be wonderful to contemplate that Geiger, the undisputed master in the field, might take the helm and assemble a team to tackle this job." (Source: Science, Vol. 134, No. 3489, November 10, 1961, p. 1517)

Vancini, C. A., La Sintesi dell'Ammoniaca (Ammonia Synthesis). Edited by Ulrico Hoepli, Milan, Italy. 1961.

Mr. T. J. P. Pearce in his review of this book states:

"Total world production of nitrogen compounds, mainly derived from synthetic ammonia, now exceeds 12 million tons of equivalent nitrogen per year, and is still expanding rapidly. Many variations in synthesis-plant design have been introduced since ammonia was first synthesized commercially, and a wide variety of processes are now in use for the production and purification of the vast amounts of hydrogen required. This book sets out the technical and scientific background of these processes in a comprehensive fashion.

"New processes for hydrogen production, such as steam re-forming of methane and partial oxidation at pressure, are included, as well as the long-established processes, such as those based on coke, coke-oven gas, and electrolysis of water. The recently developed purification processes, such as CO_2 removal with hot potassium carbonate solutions, are included, except, surprisingly, the Italian 'Vetro-coke' process. Low-temperature processes for the production of oxygen, nitrogen, and mixtures of nitrogen and hydrogen are also given.

"Design of pressure vessels and of ammonia-synthesis plant generally is well covered. Each chapter has a comprehensive bibliography of technical and scientific literature, with, however, few references to patents. The book is well provided with line diagrams, and the theoretical parts are illustrated with simple calculations.

"Managers and designers of ammonia plants, or those concerned with large-scale hydrogen production, will find it a most useful book. An English translation would be very welcome." (Source: Endeavour, Vol. XX, No. 80, October 1961, p. 232)

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