Space INTELLIGENCE NOTES

SPACE SYSTEMS INFORMATION BRANCH, GEORGE C. MARSHALL SPACE FLIGHT CENTER

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FROM THE WORLD PRESS

FIRST PRIVATELY PRODUCED EUROPEAN LASER. A gallium arsenide laser, believed to be the first produced by private industry in Europe, has been successfully operated by Standard Telecommunication Laboratories Limited, British associate company of International Telephone and Telegraph Corporation.

Inspecting the laser (announced in February of this year) in Fig. 1 are two of the British scientists who developed the device. This light amplifier, as described by its research development team, has produced line narrowing, the threshold effect, and space coherence together with polarization effects--all criteria of successful laser operation. (Source: Data supplied by ITT)

USSR CONCEDES MARS 1 FAILURE. On the 16th of May 1963, the Soviet Union officially conceded that its Mars 1 space probe was no longer in contact with Earth. Thus the announced mission of the spaceship of photographing Mars and transmitting the results back to Earth could no longer be accomplished. However, the Soviets announced that the vehicle set a new record for long distance space communications of 98,800,000 km (61,400,000 mi) and passed by a meteor previously unseen from Earth. (See Fig. 2)

The failure was attributed to the orientation system, which apparently prevented the narrow-beam radio antenna from being correctly aimed at the Earth, keeping the ground receiving stations from maintaining contact with the probe. According to the Tass (Official Soviet News Agency) announcement, the on-board power supply would have been adequate to insure radio transmissions over 320 million km (200 million mi). (Source: The Nashville Tennessean, May 17, 1963)

FIG. 1

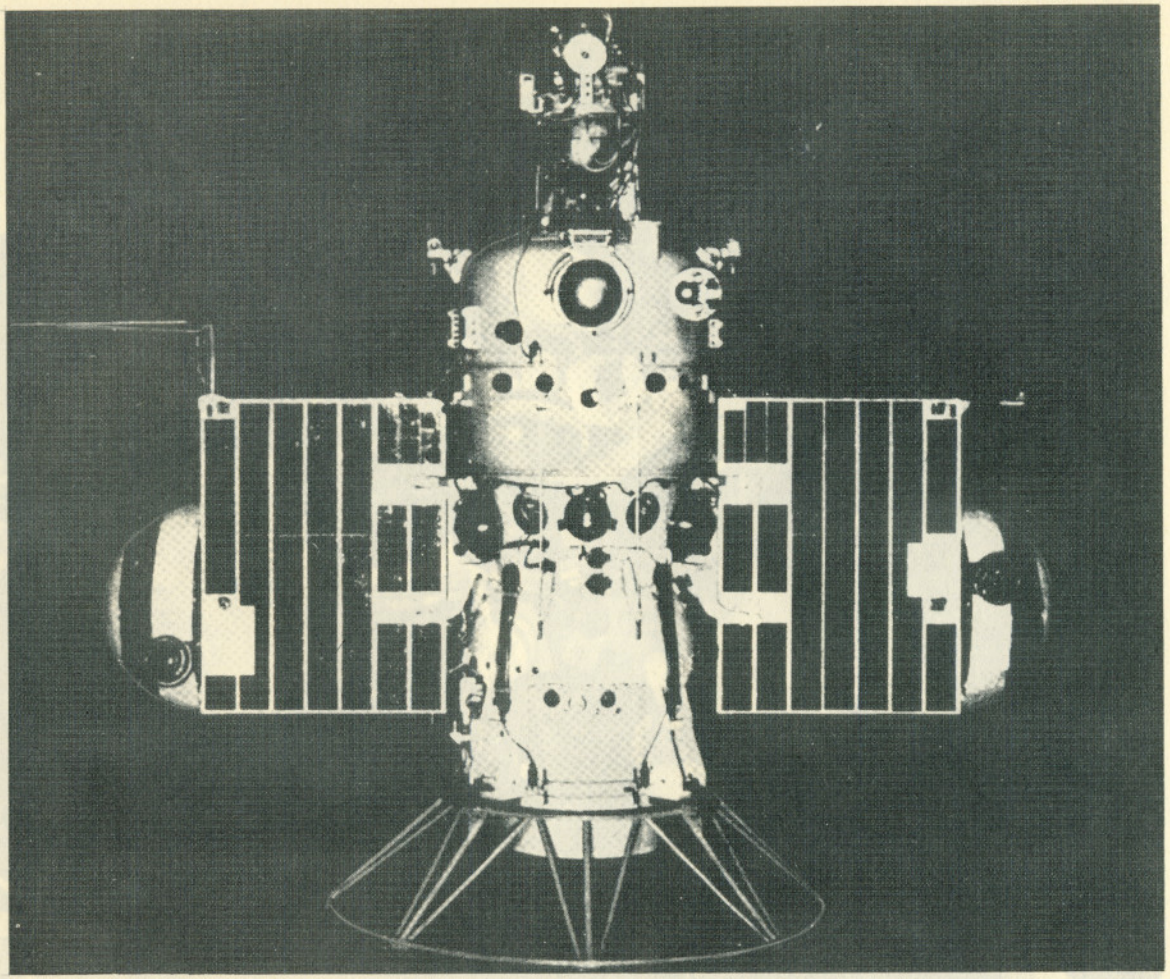

FIG. 2. Soviet Mars 1 probe

SOVIETS INITIATE A NEW SERIES OF PACIFIC SHOTS. On 11 May 1963, the Soviet Union announced that it would test another series of newly developed "improved versions of carrier-rockets for cosmic objects." The improved rockets will be launched from Soviet territory during a two-month period, extending from 15 May to 15 July 1963, into two target areas in the central Pacific. Ships and aircraft were warned against entering the areas bounded by: 10° north latitude - 170° west longitude, about 1600 km (1000 mi) southwest of Hawaii; and 35° north latitude - 175° east longitude, about 1100 km (700 mi) northwest of Midway Island.

The Tass announcement did not specify the mission of the new series but implied that the Soviet designers had prepared improved rockets "for further exploration of space."

The Soviets have utilized the Pacific range for its 11,000 to 13,000 km (7000 to 8000 mi) rocket launches since 1960. At that time the Russians stated that the first series of that year's launchings was designed to test "more powerful rockets" than those previously available to them. Manned spaceships with four- to five-ton payloads were subsequently orbited.

A series of eight tests conducted in the autumn of 1961 served to test the accuracy of a supposedly new guidance system. This was believed to have been used in the August 1962 flights of Nikolayev and Popovich.

It was further stated that Soviet ships, equipped with special measuring instruments, will check the performance of the rockets. (Source: New York Times, May 12, 1963)

SOVIET COSMONAUT DECRIES US CAPSULE. Major Andrian Nikolayev termed the United States Sigma 7 an "unreliable American contraption" when he spoke over Radio Moscow in a Cosmonautics Day broadcast April 12. Nikolayev, whose four-day, 64-circuit orbit in his Vostok 3 spaceship exceeded the space time of anyone else, said he and Pavel Popovich saw Sigma 7 on a recent visit to Sao Paulo, Brazil, where the space capsule was on display. United States Cmdr. Walter Schirra made 6 circuits of Earth in Sigma 7 last October.

"To be frank," Nikolayev said, "I would not like to find myself in his (Schirra's) place. You have no idea how cramped and uncomfortable this capsule looks in comparison with the cabins of our remarkable Vostok cosmic ships." (Source: The Sun, Baltimore, April 13, 1963)

EUROPEAN INDUSTRY URGES SPACE RESEARCH INCREASE. The European space program is presently being stepped up on a four-year plan by an important segment of Western European industry. Precise proposals, put forth

April 8 by 125 companies and scientific groups that have joined to form Eurospace, included the following projects: (1) a chain of 12 communications satellites turning about the Earth, with the first satellite launched in 1968; (2) a light satellite set into orbit about 100 km (62.5 mi) high as a time-keeping and navigational aid; (3) the development of satellite launchers using existing national and European-wide programs; (4) studies on a launching base in the equatorial zone.

Nine countries--Britain, France, West Germany, Italy, Belgium, the Netherlands, Norway, Sweden, and Switzerland--are covered by Eurospace, whose suggestions would come to a total outlay of more than one billion dollars. The Eurospace committee said that the sum was well within Europe's means, and its report declared that "space research and realization are and will be an essential motor for economic expansion, bring about in many fields an improvement in industrial techniques and are thus at the origin of a great deal of progress." Eurospace is designed to enter Europe in the space race immediately to avoid its being left behind in the scientific, technical, and economic fields.

The organization stated that intellectual resources available in Europe could bring about a creative program that would help rather than merely duplicate the United States program. (Source: The New York Times, April 9, 1963)

SOVIET SAYS EARTH HAS "SATURN" RING. Soviet astronomer Pyotr Shcheglov believes Earth has a ring resembling a ring of Saturn in shape. Tass reported that Shcheglov discovered a stationary "flat cloud of hydrogen shaped like a pancake" around Earth "at an altitude of 10,000 km (6200 mi)" and that the discovery was made with new highly sensitive instruments.

Tass said a spaceman on the Moon could see the cloud by using a special instrument. The "pancake ring" is about 1000 times denser than "interplanetary gas," the agency said. (Source: The Atlanta Journal and Constitution, March 31, 1963)

ASTRONAUTS' TRAINING REVIEWED. Maj. Gen. Richard L. Bohannon, Deputy Surgeon General of the US Air Force, has predicted a step-up for American spacemen similar to that of the Russians. Speaking to an aerospace medicine symposium at Brooks Air Force Base, Gen. Bohannon stated that after Soviet cosmonaut Titov's space sickness, the Russians "intensified their training for the weightless state, with emphasis on active and passive exercises for improving the vestibular function by raising the threshold of response to specific stimuli." The vestibular function is the body's balancing mechanism, originating from processes within the inner ear. A large American research study will be devoted to the same purpose, the General said.

At present the Russian program of exercises includes "gymnastics, acrobatics, high diving, trampoline work, loop trainers, rotating chairs, swings, oscillating platforms, weightless pools, and tumble wheels." The General stated that the Russians "feel that parachute jumps, better than anything else, develop boldness, composure, stamina, orientation, and body control under zero pressure."

Gen. Bohannon pointed out that although America's program is not as intensive as the Russians', no adverse effects were suffered by US astronaut Walter Schirra in his six-orbit, nine-hour weightless state. (Source: Daily Press, Newport News, Va., February 5, 1963)

SOVIETS FEAR SHORTAGE OF MATHEMATICIANS. Soviet scholars are concerned about the possibility that training of mathematicians is inadequate in the USSR. Five prominent Siberian mathematicians in a letter to Izvestia urged the establishment of a new network of specialized mathematics and physics high schools, a system of boarding schools attached to universities, and introduction of "applied mathematics facilities" at universities to prepare a new generation of electronic computer technicians. The scientists are in conflict with educational authorities whose basis for opposition to plans for specialized training at an early age is that all Soviet youngsters must receive a standard minimum in education.

The problem was formulated in terms of national power and prestige, for the scientists stated that the balance of mathematical competence currently is in the US. Pointing out that it is not just a question of increasing the number of mathematics graduates, the scientists suggested a fundamentally different approach to their training: incorporating a more specialized curriculum for high school students, making an effort to uncover special interests among students at an early age, and raising the level of teaching and textbooks in high school mathematics.

Poor teacher preparation was attributed to the lack of qualified mathematicians and physicists employed as professors at Soviet teacher colleges. The Siberian scholars urged a system of refresher courses to enable high school science teachers to keep up with the times.

Similar concern in the United States was expressed in a recent report by Prof. John G. Kemeny of Dartmouth College that called for reconsideration of the methods by which mathematicians are being trained in the United States. (Source: The New York Times, March 26, 1963)

US AND RUSSIA TO COLLABORATE ON WEATHER. The United States and Russia have reached a bilateral agreement to cooperate on a weather satellite program. Dr. Hugh Dryden, vice-director of NASA, and Soviet Academician Anatoly A. Blagonrarov headed delegations from the two nations, whose space collaboration was announced after a week of talks.

The program is to include a communications link for exchange of weather data received with the use of artificial satellites as well as joint testing of communications through a passive satellite, an Echo 2.

The communications link, to be established between the United States Weather Bureau's National Meteorological Center outside Washington and the Central Institute of Weather Forecasting in Moscow, was the result of the nations' agreeing to coordinate their weather satellite launchings and to have at least one weather satellite in continuous operation, beginning in 1964.

According to The New York Times, the connection is planned for test operation early next year, with the cost to be shared by the US and USSR; however, other countries may have access to the circuit on a receive-only basis. The Times reports Dr. Dryden's description of the connection as a "four-wire, full-time link" capable of handling two-way facsimile transmissions and teletype messages as well as voice messages. The link will extend from America to Russia via North Atlantic cable and microwave units across Europe. The nations plan to transmit cloud cover pictures and analyses within a few hours after the pictures have been received from their satellites and processed by ground tracking stations.

The announcement stated that Soviet and American scientists will use the 76-m (250-ft) radio telescope at Jodrell Bank Observatory in Britain as a link in the exchange of signals through an American satellite. Signals sent to the Echo 2 by the Russians would be picked up by the Jodrell telescope and transmitted to the Americans. (Source: The New York Times, March 26, 1963)

NEW ATOM PART IS CONFIRMED. Existence of a new sub-atomic particle, a phi-meson, was predicted last year by Dr. Jun John Sakurai, a Japanese scientist who now works at the University of Chicago. He gave the particle its name, which was adopted by the confirming groups, one at Brookhaven Laboratory on Long Island and the other at the University of California at Berkeley.

The phi-meson is intermediate between an electron and a proton. Dr. Sakurai predicted it would have a mass equivalent of 1020 million electron v. The experimenters found it had a mass of 1019 million, which is within the error range predicted by the scientist.

The prediction was based on a tentative arrangement of sub-atomic particles into groups of eight, as proposed by Dr. Murray Gell-Mann at the California Institute of Technology.

The phi-meson, produced by bombarding liquid hydrogen with K-mesons, has a life of only two ten-thousandths of one billionth of one billionth of a sec. (Source: The Huntsville Times, April 15, 1963)

FROM THE SEMITECHNICAL LITERATURE

SILENCE SURROUNDS SOVIET SPACE SHOT. A month has passed since the initial Soviet announcement of the successful launch of Luna 4; yet the Soviet Union has issued no further information following the last Tass release on April 7, 1963. The announcements covering the space feat had indicated a further study of the scientific information received from the instrumentation on board the spacecraft, which approached within 8500 km (5300 mi) of the Moon's surface and then began an elongated orbit of the Earth. It was mentioned that the 1420-kg (3128-lb) "automatic interplanetary station Luna 4" (Soviet terminology) on its first orbit will be at a maximum of approximately 700,000 km (400,000 mi) and a minimum of 90,000 km (56,000 mi) from Earth. The influence of the gravity of the Sun and the Moon was expected to create sufficient disturbances, causing the spacecraft to leave the Earth's gravitational sphere and to become an artificial satellite of the Sun.

The initial Soviet Moon efforts, called Luniks 1, 2, 3 by Western observers, were launched in 1959 and achieved varying degrees of success. Lunik 1, called Mechta or Dream by the Soviets, was launched January 2 and became the first satellite of the Sun after missing the Moon by 7600 km (4700 mi). In its initial travels near the Moon, Lunik 1 relayed information concerning the Moon's magnetic field to the Earth. The second Moon probe, Lunik 2, launched on September 12, crashed on the Moon's surface in the vicinity of the Seas of Clarity, Serenity, and Vapors. The final effort, Lunik 3, weighing 279 kg (614 lb), was launched October 4, photographed the reverse side of the Moon, and transmitted the images electrically back to Earth. None of these early Soviet space shots are presently in flight, having descended into the denser atmosphere and burned.

A comparison of the weight of the final stage or payload of the Soviet Moon shots has lead to the speculation that the heavily instrumented Luna 4, weighing five times as much as Lunik 3, was destined for such missions as "soft landing" on the Moon, photography of the Moon, or a Moon-mapping orbit. Up to the present time the Russians have not specified the ultimate objectives of the space shot in any official Tass announcements, although Moscow Radio broadcasts heard in the United States have indicated that the objectives included (1) photography of the Moon's surface; (2) study of potential landing areas for future manned flights; (3) landing of a capsule; and (4) the acquisition and return of seismological and mineralogical data.

Interest in mineralogical information indicates that Luna 4 could have attempted a "soft landing" on the Moon. This is further confirmed by the spacecraft's weight of 1420 kg, which is even greater than the approximate 1130 kg of the projected US Surveyor, which will contain such equipment as drills, a system for chemical analysis of the core, and TV

cameras to record the operations. Other equipment would include cameras to show the lunar surface and numerous instruments to measure lunar gravity, radiation temperatures, magnetic fields, lunar quakes and tremors, etc. (Source: Los Angeles Times, April 4, 1963, and The New York Times, April 3, 1963)

THE CANADIAN SATELLITE--ALOUETTE. The Canadian satellite Alouette was cooperatively launched on September 29, 1962, by the US National Aeronautics and Space Administration as an effort to study the ionosphere by placing an ionospheric swept-frequency sounder in orbit outside of the atmosphere for the first time. This permits sounding the ionosphere from above by the radio echo-sounding technique in which a command signal sent to the satellite activates the sounding transmitter and associated receiver, which conducts a frequency sweep every 15 sec. The resultant echoes received from the ionosphere below the satellite are telemetered to the ground at a frequency of 136 Mc/s and recorded on tape. This provides measurements of the missing upper part of the electron density height profile, which is that portion of the ionosphere above 320 km (200 mi) presently not measureable from Earth. This inability is attributed to the great density of free electrons and ions 320 km (200 mi) or so above the surface of the Earth which are electrically conductive and reflect the radio waves.

The 145 kg (320 lb) satellite has a swept-frequency sounder that required 46 m (150 ft) aerials after it had been placed into orbit and separated from the launching rocket. This difficult problem was solved by rolling "steel tape" antennas inside the satellite and then releasing them in the form of an overlapping tube or pole. Four such poles extend to form a cross, with the arms 46 m (150 ft) tip-to-tip and 23 m (75 ft) respectively, with the 107 cm (42 in.) diameter satellite at the center. Although the poles are too long and slender to support their own weight on Earth, in the gravity-free environment of an orbiting satellite, they are feasible and constitute only 20 kg (45 lb) of the satellite's weight.

Through data received from a US Transit satellite, it was determined that a transmitter power of 100 w during the pulse was needed to obtain detectable echoes against the background of radio noise from the galaxy. Previously, such powers were obtainable only through thermionic tubes, but new transistor improvements and original circuitry made it possible to employ the more desirable transistor exclusively in the 100 w sweep-frequency transmitter.

The power needs of the satellite, averaging about 15 w are derived from the Sun through the use of 6500 solar cells, which cover most of the surface area of the 107 cm (42 in.) diameter by 82 cm (32 in.) high satellite.

The orbit of the satellite was carefully selected to explore the ionosphere over the greater portion of the sunlit and dark sides of the Earth. Since the ionosphere varies primarily with Sun time, it was found desirable to incline the orbit at 85° to the equator instead of 90° to speed up the local time survey. The bulge of the Earth's equator then exerts an unsymmetrical force on the satellite as it travels around the Earth, which results in a precession rate that doubles the rotation of the orbit relative to the Sun and completes the local time survey in three months instead of six.

First results from the satellite have been published by the three agencies cooperating in this venture: DRTE, Ottawa, Canada; the Radio Research Station, Slough, Great Britain; and the US Central Radio Propogation Laboratory, Boulder, Colorado. E. S. Warren of DRTE finds resonance phenomena when the transmitter frequency passes through the so-called "plasma" and "cyclotron" resonant frequencies of the local ionosphere around the satellite. The ionized gas appears to "ring" after the transmitter pulse with the decaying resonance being picked up on the receiver. When the satellite passed through high latitudes, a strong correlation was evident between the ionization density and the particles of the outer Van Allen radiation belt that were counted in the satellite, especially in a narrow band of latitude. Diffuse clouds of ionization several hundred kilometers thick have also been reported in the path of the satellite.

J. W. King of the Radio Research Station reports an analysis of the variation of the electron density with height at temperate and equatorial latitudes indicates that the electron density decline is dependent upon the gases composing the atmosphere and their temperature.

R. W. Knecht and T. E. Van Zandt of the Boulder station are studying data from a chain of telemetry stations following the length of North and South America in order to plot contours of the electron density from 80°N to 50°S and up to 1000 km (621 mi) above the Earth. (Source: New Scientist (No. 328), February 28, 1963)

FROM THE TECHNICAL LITERATURE

ASTRONOMY

NEW SOVIET SOLAR FLARE THEORY. Soviet scientist A. B. Severnyy, using a specially designed tower telescope at the Crimean Observatory in the USSR, obtained experimental confirmation of his solar flare theory. It postulates that the rapid compressions of magnetic fields on the Sun heat the plasma to temperatures around 30,000,000°, which result in thermonuclear reactions and the formation of deuterium. The large flares release energy which is equivalent to that released by the explosion of hundreds of thousands of hydrogen bombs. The special telescope enables the determination of the velocity of motion of solar matter and makes motion pictures of solar processes. (Source: Soviet Belo Russiya (Soviet White Russia) March 20, 1963)

BIOSCIENCES

MORPHOLOGICAL CHANGES PRODUCED THROUGH SPACE FLIGHT. Soviet scientist V. G. Petrukhin reported the effects of space flight on experimental animals (68 mice and 4 guinea pigs) placed in Soviet orbital spacecraft. Returning to Earth after exposure to overloads, vibrations, weightlessness, and cosmic radiation, the animals were subjected to autopsy at intervals of 2, 3, 5, 9, 10, 30, and 60 days. Microscopic examination revealed dystrophic changes in the brain, liver, heart, spleen, lungs, and the adrenal glands.

The brain exhibited anoxial injuries to ganglionic cells of the cerebellum, cornu Ammonis, and the cerebral cortex from 2 to 10 days following the flight. By the 60th day, however, the majority of the ganglionic cell injury had been repaired. Liver cells which demonstrated granular dystrophy from the 2nd to the 3rd day, vacuolar dystrophy from the 2nd to the 9th day, and fatty dystrophy from the 5th to the 30th day, displayed no pathological damage by the 60th day.

Heart tissue, showing protein dystrophy in the myocardium (chiefly in the left ventricle) from the 2nd to the 5th day and fatty dystrophy of the myocardium beginning on the 3rd day, were fully restored by the 9th day. Spleen cells displayed irregularities in hemopoiesis at irregular intervals. Lung tissue, which had suffused capillaries on the 2nd and 3rd day, recovered by the 5th day. Finally, adrenal glands showed suffusion and the presence of lipoids on the 2nd and 3rd day with the emergence of fat globules in many cells on the 9th and 10th day. All pathological evidences disappeared by the 30th day.

It was concluded that the body changes were comparable to that occurring from the disruption of hemodynamics: suffusion, hemorrhages, and further signs of Selye's "stress" syndrome, with a delayed return to normal. (Source: Library of Congress, A.I.D. Press, No. 911, March 4, 1963)

COMMUNICATIONS

EVALUATION OF SHORT RADIO PULSES. In an article written for a Soviet periodical, Soviet scientist A. B. Dogadkin proposes a method for evaluating the shortest possible duration of pulses generated by any electronic or semiconductor system. The method is founded on the analysis of frequency characteristics. Calculations are based exclusively on the value of the tuning range or on the bandwidth $\triangle f$ in the case of pulse modulation in an amplifying system. Since it is impossible to excite radio pulses in klystrons, TWT, etc., whose duration is less than the limiting value determined by $\triangle f$, the expression of this value is found to be

$$\tau_{lim} = \frac{0.63}{\triangle f} .$$

This expression indicates that the "shock" method is the most simple method of exciting short pulses. This was verified through experiments with reflex klystrons operating on cm and mm wavelengths and having bandwidths of 100 and 110 Mc. Experiments demonstrated that the use of focusing-electrode short-videopulse modulation could generate pulses of 3 nsec without lowering the amplitude. (Source: Elekto Svyaz (Electrical Communications), No. 2, February 1963)

GEOSCIENCES

NEW HYPOTHESIS CONCERNING THE CIRCULATION OF THE ATMOSPHERE. A new hypothesis concerning the circulation of the atmosphere in relation to the Earth's rotation has been proposed by R. F. Usmanov, Senior Scientist of the Central Institute of Weather Forecasting and a member of the First Soviet Antarctic Expedition. It states that the rotation of the Earth causes its air envelope to take a form of relative atmospheric equilibrium, the atmospheroid, which is similar to that of a geoid.

This atmospheroid is readily responsive to the pulsating velocities of the Earth's rotation, and any variation in its shape produces a wind system (the circulation of the atmosphere), which restores its stability. Since the majority of the air mass is situated over the Northern Hemisphere, the Earth's atmosphere is asymmetric, which influences the planetary circulation of the atmosphere. (Source: Priroda (Nature), No. 2, February 1963)

SENSITIVE SEISMIC STATION AT PYATIGORSK. The Pyatigorsk seismic station has registered 4402 earthquakes (only 174 of local origin) in the past nine years of existence. Its equipment includes a complete set of Kirnos instruments and the Golitsyn heavy pendulum. Several types of vibrations have been registered, including slow "long" waves of one to several minutes attributed to the effect of rapid drops in air temperatures on the Earth's crust; wind vibrations induced by the friction of the air mass acting against the Earth's surface; and even vibrations of the sagging in the Earth's crust caused by heavy oil pumping in the Baku area. Earthquakes have been recorded whose epicenters were in the Western or Southern Hemispheres at distances exceeding 15,000 km (9000 mi). (Source: Priroda (Nature), No. 2, February 1963)

SOVIET GEOPHYSICISTS CLAIM IMPROVED MAGNETOMETER. V. N. Bobrov, of the Institute of Terrestrial Magnetism, the Ionosphere, and the Propagation of Radio Waves, recently announced the development of a new magnetometer, shown in Fig. 3, in an article in Vestnik. The new magnetometer incorporates the use of a newly developed pattern of a stable, highly sensitive quartz element, which is virtually unaffected by normal temperature changes.

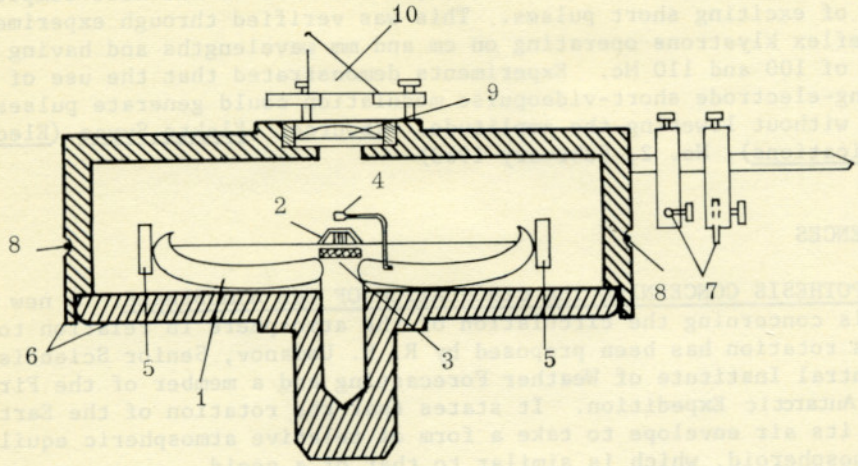

FIG. 3

1.	Frame	6.	Sealed casing
2.	Quartz mirror	7.	Carriages
3.	Electromagnetic plate	8.	Single-turn coil
4.	Quartz mirror	9.	Lens
5.	Magnets	10.	Prism

Small changes in the Earth's magnetic field are usually measured by observing the deflections of a precision magnet balanced on agate knife edges. In the new Russian pattern the magnet is supported on a quartz fiber.

The basic unit of the device consists of a frame made of fused quartz rod which supports the thin quartz thread, providing suspension and torsional control of the magnet system with its quartz mirror. In the center of the quartz frame is an electromagnetic "damping" plate to attenuate the oscillations of the system. A second quartz mirror is used to monitor its correct alignment. Magnets on the sides of the quartz frame compensate the steady component of the field, whose changes are to be measured. The entire unit is enclosed in a hermetically sealed casing on the outside of which are two carriages with additional magnets for changing the sensitivity and for aligning the sensitive part of the instrument to the appropriate field direction. The magnetometer is calibrated with a single-turn coil wound around the outside of the casing. Deflections of the magnet are measured optically by the lens and prism.

According to requirements, the magnets are made with moments ranging from 0.1 to 10 e.m.u. The free oscillation period is less than one second even at sensitivities at which the instrument can record field changes of a millionth of a gauss for each two minutes of arc that it is deflected.

On the basis of these quartz units, the Institute has developed a series of four stationary magnetic variometers for recording the variation of the total force T of the Earth's magnetic field, its horizontal component H, vertical component Z, and declination D. Tests at the Central Magnetic Observatory have shown the instruments to be of high quality. The performance of the T and Z variometers remained unchanged over a period of two years, and production of the instruments has now been authorized. The sensitive quartz unit can also be used for portable field variometers. The Institute is making single component instruments for T, Z, H, and D, and also a three-component version (D, H, and Z) for field work. (Source: New Scientist, March 28, 1963)

LASERS

THE LASER RACE. A tremendous outpouring of technical literature on laser research and developments indicates a major US-USSR technological competition for this offspring of the space race. The exploration of laser technology from the standpoint of its many applications to space projects is resulting in almost daily announcements of new accomplishments by Russian and American scientists working in the field.

Within the past six months the United States has successfully used laser (or tested it experimentally) to:

a. Make better radars, carry radio and television programs, transmit telephone calls and electronic mail, and communicate under water.

b. Weld, drill, cut, etch, and shape the hardest and the tiniest objects.

c. Track satellites from the ground.

The laser race seems to extend even to an international contest for forecasting the possible future uses of this ingenious device. Scientists of the United States's NASA foresee laser as the "ultra" means for the transmission of intelligence. They have reported that, theoretically, one laser could transmit more information than 25,000 television stations operating simultaneously.

Russian scientists have dittoed the American forecasts of laser potential for communication and topped them by predicting its use to transmit great quantities of power energy (as reported in last month's Space Intelligence Notes).

So fast has the pace of laser development become, that rarely a week passes without some announcement of an advance in laser technology. For example, the following abstracts were prepared from eight selected reports on laser research published in the Russian literature during the month of January:

1. "Plane-Parallel Layer as an Optical Oscillator." This article was written by A. M. Goncharenko, B. A. Sotskiy, and F. I. Fedorov for the January-February issue of Kristallografiya (Crystallography).

The article gives a new method of generating light beams, in which optical range oscillation conditions are determined analytically for a plane-parallel anisotropic layer coated with a metallic film on both sides. The anisotropic layer is assumed to have a negative absorption coefficient, and the existence inside it of plane monochromatic waves is postulated. From Maxwell's equations, a simplified expression is derived for the oscillation criterion.

The following conclusions are drawn:

a. The conditions of light generation are independent of the properties of the surrounding medium.

b. Adjustment of the term g (a function of the thickness, density, and conductivity of the metallic film) in the expression permits the oscillation criterion to be controlled, with predictable effect on the oscillations in actual practice.

c. Although the amplitudes are indefinite in all equations defining energy density and flux, they can be determined from the dependence of the absorption coefficient on emission density.

2. "Pulsation of a Ruby Laser." M. D. Galanin, A. M. Leontovich, Z. A. Sviridenkov, V. N. Smorchkov, and Z. A. Chizhikova wrote in Optika i spektroskopiya (Optics and Spectroscopy) in January of an experimental study that has been carried out to determine the dependence on temperature and pumping power of the frequency, amplitude, and half-width of peaks in the output beam of a ruby laser. Mean peak values were compared with mean pumping power during the peak time. It is shown that the mean frequency and mean amplitude of the peaks increases linearly with pumping power, and the half-width of the peaks decreases accordingly.

Variation of the half-width of line R_1 with temperature was determined to correspond to the data obtained by A. L. Schawlow, and the decrease of the threshold with temperature to be linear if the variation of populations of levels R_1 and R_2 with temperature is taken into account. The theoretical linear-approximation variation of the frequency of the peaks does not agree with experimental results, which indicates the pulsations are nonequilibrium relaxational auto-oscillations. The effect is explained in terms of the dependence of energy density on the mean lifetime of photons, which in turn depends on the direction of emission.

3. "Stability of Laser Steady States." This report, by B. I. Stepanov, appeared in Akademiya nauk SSSR, Doklady (Reports of the Academy of Sciences, USSR) in January.

Stepanov believes a theoretical study of laser oscillation shows that among various possible steady states of the field the stable states are those for which the ratio of losses to the initial amplification factor is minimal.

If a stable field is present (no matter how small its amplitude), all other fields disappear in time, being suppressed by the stable state. If no stable field is present, then other steady-state fields can be established. If the reflection factors on all boundaries have no spectral selectivity, then the losses of escaping radiation are approximately the same for all frequencies, while the absorption factor depends strongly on frequency.

Oscillation is, therefore, stable for the frequencies of the maximum absorption band in the absence of oscillations. Interference limitations can lead to small changes in these frequencies. If the coatings have a very narrow passband, the frequency of the stable field in the laser will be close to that which undergoes maximum reflection at the coating. Propagation in bounded plane-parallel resonators, spherical resonators, and bounded plane-parallel resonators including cylinders is considered. If there is no reflection at the side walls, the oscillation is strongly directional.

4. "Effect of Energy Level Degeneration and Radiation Losses on the Optical Properties of the Three-Level Laser." Another report by B. I. Stepanov in conjunction with P. Gribkovskiy appeared in Akademiya nauk BSSR (Reports of the Bulgarian Academy of Sciences) in January.

The authors state that a theoretical study considers the effect of energy level degeneration and radiation losses on the optical properties of the three-level laser. An energy-level distribution function, which takes into account energy level degeneration, is used to calculate the population at each of the three levels. The negative absorption factor is derived from the distribution. The nonlinearity parameter, the threshold pumping energy density, and the steady-state generated power output are then calculated, taking into account the radiation loss factor.

The dependence of absorbed pumping power, luminescence power, and generated power on input pumping power is shown in a graph, which can be used to show the energy changes in a pumped system when reflectors are introduced into the system and oscillation begins. Oscillation is accompanied by a decrease in the population of level 2 and an increase in that of level 1; it is this increase in level 1 population which leads to increased

pumping-power absorption and oscillation. Increased pumping energy density during oscillation does not increase the number of active particles but increases only the absorbed power.

5. "Dependence of Laser Oscillation Threshold on Resonator Properties." A. M. Samson, B. I. Stepanov, and L. D. Khazov wrote for Akademiya nauk SSSR (Reports of the Academy of Sciences, USSR) in January 1963 telling of solutions of nonlinear transfer equations for a plane-parallel layer with a negative absorption factor obtained by them in an earlier work used to derive a formula for the threshold value of the negative absorption factor required for oscillation to occur. This formula is adjusted to account for radiation losses due to absorption by impurities and escaping radiation.

A formula for the threshold pumping energy of a three-level laser is then derived using transition probabilities. This formula is used to determine the dependence of threshold pumping power on the properties of the resonator. Since it is derived within a probability framework, the formula can also be used to study the dependence of threshold pumping power on properties of the substance, such as temperature, particle density, etc. The values of various parameters of the ruby laser are calculated as an example.

6. "Nonlinear Theory of the Optical Properties of Plane-Parallel Layers." A. M. Samson collaborated with B. I. Stepanov in Optika i spektroskopiya (Optics and Spectroscopy) in January on this work.

Methods of geometric and wave optics are used to describe steady-state conditions in a plane-parallel layer of a medium with negative absorption, with the nonlinear dependence of the absorption factor on the density of radiation in the layer taken into account. Equations are established in terms of radiation density, absorption factor, a nonlinearity parameter, layer thickness, and the reflection factor of the boundaries. Graphic solutions are obtained for various sets of conditions, and properties of the layer as an amplifier are examined in detail.

It is shown that the plane-parallel layer cannot be used as an amplifier of radiation, because the intensity of the output beam is weakly sensitive to the input beam. Equations are derived which can be used to evaluate the noise level of an oscillating layer. External noise in the incident radiation is not amplified. Wave optics equations are used to describe interference phenomena. Approximate solutions are obtained for some conditions; these can be used to calculate the reflection and transmission factors of the layer.

7. "Amplification Properties of a Dielectric Fiber." A. M. Prokhorov reported in Optika i spektroskopiya (Optics and Spectroscopy) in January 1963 of work done in a theoretical study describing amplification in a dielectric fiber with luminescence centers constituting a four-level system pumped from level 1 to level 4, with nonradiative transitions from level 4 to level 3 and from level 2 to level 1.

It is assumed that (1) level 2 is sufficiently above level 1 at operating temperature so that it is not ordinarily populated, and (2) relaxation probability from level 2 to level 1 is sufficiently great so that particles do not accumulate on level 2. Expressions are obtained for energy density in the fiber, including the energy-density maximum. Because of the existence of the latter there is a limit to the useful length of fiber, and power output can be increased only by using a bundle of fibers.

The noise characteristics of the bundle would be worse than those of a single fiber, because input energy would have to be divided among the fibers. Under saturation conditions the emitted spectra of the bundle differ weakly from those of the fiber. The greater the saturation, the less spectral narrowing takes place. The effect of spontaneous emission on the energy density distribution in the fiber is considered.

8. "Absorption, Luminescence, and Stimulated Emission of Noedymium in SrF_2 Crystals." Ya. E. Kariss and P. P. Feofilov in Optika i spektroskopiya (Optics and Spectroscopy) in January told that an experimental study has been made to determine absorption and luminescence spectra of Nd^{3+} ions in SrF_2 single crystals to investigate their laser action. The absorption spectra of Nd-doped SrF_2 crystals were found to be fully analogous to those of the host crystal, differing only in slight shifts and some line intensity redistribution.

In the infrared region groups of lines were found around 5.0, 2.5, and 1.6 μ, corresponding to transitions within the ^4I multiplet. The following were found to be the most intense luminescence lines at 77°K: 6737, 8696, 8754, 9135, 10,353, 10,440, 10,500, 10,749, and 10,847 Å. The duration of luminescence was found to be the same for the whole spectrum, i.e., $(1.3 \text{ to } 1.4)\cdot 10^{-3}$ sec at 300°K and $1.6\cdot 10^{-3}$ sec at 77°K.

Laser action was established at the 10,440 Å line in a cooled 5 x 5 x 30-mm single crystal with optically polished parallel ends, one of which was coated with silver. Pumping was done with a spiral Xe lamp. The output pulse contains characteristic intensity peaks, which increase in amplitude and frequency with increased pumping power. The beam is directional within 1/2°.

These published technical reports together with public announcements and claims appear to substantiate the generally held belief among Western scientists that the Soviet's efforts to date have roughly paralleled those of the United States.

In 1959 the Lenin prize was awarded to the authors of important Russian papers on lasers. Also at that time, they claimed to have discovered the laser in 1951. (Sources: NASA Information Releases; Kristallografiya (Crystallography) No. 1, January-February 1963; Optika i Spektroskopiya (Optics and Spectroscopy) No. 1, January 1963; Doklady Akademiya nauk SSSR (Proceedings of the Academy of Sciences, USSR) No. 1, January 1963, No. 2, February 1963; Doklady Akademiya nauk BSSR (Proceedings of the Bulgarian Academy of Sciences) No. 1, 1963)

LIFE SCIENCES

SOVIETS DEVELOP MICROBIOLOGICAL SENSOR SYSTEM. Soviet scientists have developed a microbiological sensor AMH-I system based on the gas exchange of anaerobic bacteria which furnishes data on the viability of microorganisms in spaceships. It consists of a hollow cylinder divided by a hermetically sealed glass partition. The upper portion contains seeding material (spores of Clostridium butyricum), while a nutrient medium is placed in the lower. On a signal from Earth or from a programmed device on board, an automatic mechanism transfers spores to the nutrient medium.

Gas pressure in excess of 5 atm may be produced by the multiplication of the anaerobic microorganisms in the nutrient medium. This activates a telemetric system that transmits the signals to Earth. The system, which has been successfully flight tested on spaceships, can be utilized for long range flights since bacterial spores remain alive for years.

More recently, other systems have been developed that help to determine the dynamics of reproduction of nonsporegenic microorganisms as well as changes in the various elements in nutrients. These also have been flight tested and may be used as a means of testing viability and biological conditions on planets of the Solar System. (Source: Library of Congress, A.I.D. Press, No. 911, March 4, 1963)

STUDY OF PLANT LIFE ASSISTS SPACE FLIGHTS. In order to determine the influence of space flight on the photo-synthetic mechanisms of plants, A. A. Shakov, S. A. Stanko, and V. S. Khazanov have studied plant behaviors in the Pamir Mountains, USSR. Here, at an altitude of 4000-5000 m (13,000-16,000 ft) the light conditions approximate those existing in space. Radiation conditions resembling those beyond the atmosphere are attained by adding shortwave ultraviolet "C" rays from an artificial source to the intense light in the 430 to 1000 mμ range and the "A" and "B" uv rays as demonstrated by A. V. Gurskiy.

Experiments have shown that the native high-altitude plants utilize more than 90 per cent of the light in the 400-600 mμ range to counteract the destructiveness of uv rays. Low-altitude plants are able to adapt themselves through successive generations to an increase in uv light. Thus barley (Pallidum-4) grown at 3860 m (1266 ft) in seven generations increased its ability to absorb light in the 430 to 1000 mμ range by 15,000 ergs/cm^2/sec.

New data indicates that photoadaptation, which enables plants to absorb more light, is triggered by additional uv irradiation, causing the chloroplasts to change form. Chloroplast changes would be greater if the plants were unable to use energy from visible light to repair injuries from short-wave uv rays. Thus plants without sunlight die if exposed to uv from an artificial source. It was shown that red light does not possess photoreactivation qualities.

It was suggested that long range flights to Jupiter and Saturn would encounter reduced radiation, and thus artificial light would be required for photosynthesis. Therefore, it would be useful to study the photoadaptation of plants to artificial light and to sunlight condensed by aluminum reflectors. Finally, the effects of ionizing radiation on chloroplasts and plant pigments should also be investigated since exposure to small doses of radiation from isotopes of radioactive elements causes irreversible increases in the diameter of chloroplasts. (Source: Library of Congress, A.I.D. Press, No. 911, March 4, 1963)

MATERIALS ENGINEERING

ELECTROCHEMICAL ABRASION METHOD DEVELOPED. An electrochemical machining method that appears to produce close tolerances in a neatly controlled way--by speeding electrochemical dissolution of a metal surface with the aid of mechanical abrasion--has recently been developed by the Institute of the Science of Machines and Automation of the Byelorussian Academy of Sciences.

The method has something in common with the hybrid electrochemical/ultrasonic approach which also originated in the USSR. In the new technique, the part to be treated--a tool steel, perhaps, that is too hard for conventional machining--has selected areas of its surface masked with a thin, protective skin. It is then immersed, as the anode, in an electrolyte of sodium hydrogen phosphate and potassium nitrate that also contains carborundum powder. A cathode, with a hole in it, is positioned a short distance away.

As soon as the current has been turned on, air is blown through the hollow core of the cathode and carborundum particles continuously bombard the surface of the anode (see Fig. 4), eroding away the protective coating

and then the metal itself. The technique is said to be fast and efficient, and a smooth finish is obtained. A current density greater than 6 amp per sq cm is recommended.

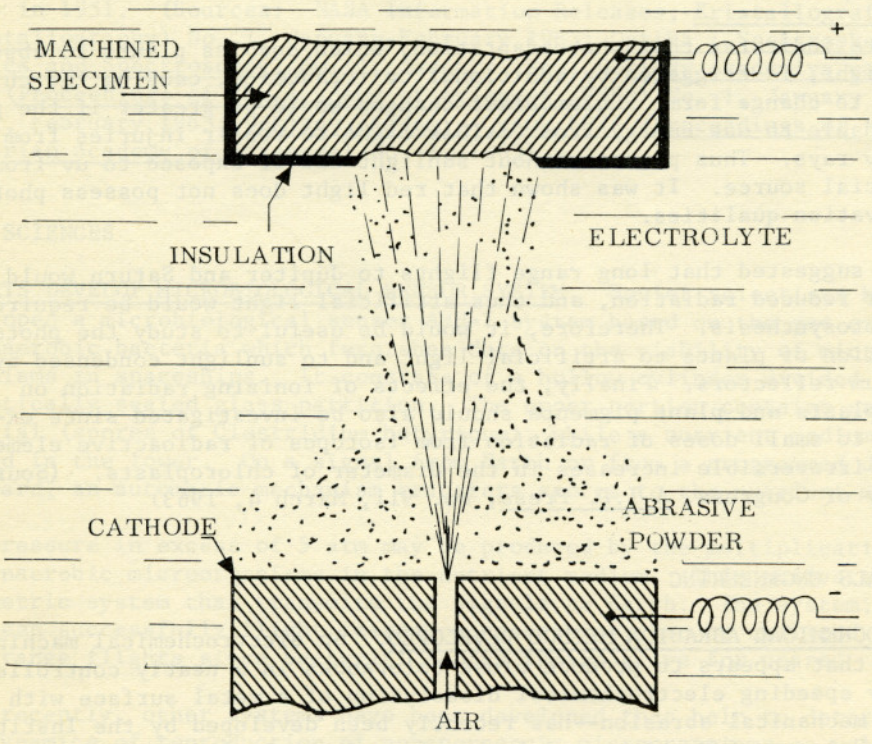

FIG. 4

(Source: New Scientist, February 7, 1963)

MECHANICAL PROPERTIES IN EXPLOSIVELY FORMED MATERIALS. The properties of OT-4 [RS110B] titanium-base alloy and AMG5BM [5056, solution-annealed] aluminum alloy have been investigated at the Tula Mechanical Engineering Institute, USSR, by M. A. Krishtal, I. A. Firsanov, Yu. I. Vayner, S. A. Golovin, and S. K. Maksimov. Tensile tests of specimens taken from various sections of explosively formed parts demonstrated little change from the initial state, although the elongation of specimens from areas with maximum deformation drops greatly.

Even though the specimens were strain hardened in explosive forming, they did not exhibit any increased strength, which indicates the presence of defects that decrease the strength and ductility of explosively formed parts. Electron-microscope analysis exposed the presence of cracks, which were shown to be caused by improper size and distance from the blank of the charge. It is postulated that too short a distance causes embrittlement of the alloy when the deformation rate exceeds the critical; and that too great a distance causes repeated deformation under the action of initial and reflected shock waves. (Source: Library of Congress, A.I.D. Press, No. 953, April 27, 1963)

EXPLOSIVE FORMING METHODS IN A WATER TANK. Explosive forming methods developed by the Kharkov Aviation Institute, USSR, include four processes for forming in a water tank. The first method, which is planned for small parts with a small die, includes the removal of the die with the blank from the water tank after each forming operation. The second, which deals with large parts and large dies, involves the removal of the water instead of the die from the tank and replacing the processed part with another blank before the water is replaced.

In the third method, an expendable water tank, made from cardboard or other inexpensive material, is used only for one explosive forming operation. The last method entails the use of water tanks made from steel sheet or large tubing, whereas the tanks used for the first two methods are made of concrete lined with metal or wood and have antiseismic interlayers. It is estimated that the cost of explosively formed end closures 2000 to 3500 mm (78.7 to 137.8 in.) in diameter that are made from sheets 5 and 16 mm (0.20 and 0.63 in.) thick is only one-ninth that of conventionally formed end closures. (Source: Byulleten' Tekhniko-Ekonomicheskoy Informatsii (Bulletin of Technical-Economical Information), No. 1, 1963)

THEORETICAL PHYSICS

MUTAGENIC EFFECTS OF ANTIPARTICLES. Since space flight may expose man to far greater concentrations of antimatter than are on Earth, its biological effects have been investigated. The most readily available antiparticles are positrons; consequently Cu^{62} was used as a positron source and C^{64} as a mixed positron-electron source. The "Canton" strain of Drosophila melanogaster was utilized for the experiments. Groups of 200 to 300 insects were first placed into very thin paper tubes with a large number of very small holes equivalent to 1/3 of the surface. After the ends were tied, the tubes were enclosed within a copper tube 2 mm (0.08 in.) thick, 50 mm (1.97 in.) long, and 10 mm (0.39 in.) in diameter that was previously exposed to a neutron beam.

Although the half-life of Cu^{62} is 10 min, the insects were enclosed for 30 min. A similar pattern was followed for Cu^{64} except that the copper tube was replaced by copper foil 50μ thick. Results demonstrated that Cu^{62} positrons (no radiations of electrons) produced recessive lethal mutations, fragmentation of sex chromosomes, and non-disjunction of microchromosomes, which is comparable to reactions from electrons and x-rays. The combined action of positrons and electrons from Cu^{64} produces recessive lethal mutations in offspring as well as sterility in irradiated insects, which is similar to changes induced by ionizing doses of electrons and x-rays without antiparticles.

The statistics of mutation distribution in the offspring of individual males irradiated by a positron beam exhibit the same regularity that characterizes the effects of particles other than antimatter. Thus the effect of antiparticles in mixed irradiation may be calculated, provided that the difference in the energy and half-life of antiparticles is considered. However, the effect of direct annihilation of positrons on electrons of valency bonds within the gene presents a special problem since such collisions cause not only emission of γ quanta but also unusual breaks in chromosomes. (Source: Library of Congress, A.I.D. Press, No. 911, March 4, 1963)

TRACKING

RADIO WAVES FROM KOSMOS-1 AND KOSMOS-2 MEASURED. Soviet scientists Ya. L. Alpert, V. B. Belyanskiy, and A. F. Kutyakov studied the differences in the Doppler shift of coherent radio waves transmitted by the Kosmos-1 and Kosmos-2 artificial Earth satellites. Ya. L. Alpert developed a highly accurate method of measuring the gradient of electron concentration and the refraction angle of radio waves along the satellite orbits. This consisted of a coherent multi-channel radio receiving system and a special device for recording the phase difference. A special feature of the system consisted of a multiple frequency conversion and a large general amplification factor.

Simultaneously with measurements of the Doppler shift, the recording of amplitudes of all received waves was accomplished through the use of individual receivers and recording devices with various recorder speeds [from 0.5 mm/sec (0.020 in.) to 1.0 m/sec (0.039 in.)]. The minimum distance of the recording system from the satellite was 750 km (470 mi). Vertical receiving antennas were used. (Source: Library of Congress, A.I.D. Press, No. 938, April 8, 1963)

VEHICLE ENGINEERING

BODY SHAPE EFFECT ON RECOVERY TEMPERATURE AND HEAT EXCHANGE DURING SUPERSONIC FLOW. In a recent article, Soviet Academy of Sciences member M. G. Morozov mentioned experiments that dealt with the effect of differently

shaped grooves. The vertical dimensions of the grooves were several times larger than the thickness of boundary layer on the mean value of the recovery coefficient and heat transfer of bodies in supersonic air flow. Tests were conducted with a cone-cylindrical body having smooth and grooved inserts at M = 1.7 in a supersonic wind tunnel with a test section 27 x 27 mm (1.06 x 1.06 in.). The air temperature was varied between 69° and 131°C (157° and 268°F) in the forechamber, while the pressure was maintained at 720 mm Hg.

The pressure chamber was maintained at 144 mm Hg. Test recovery coefficients varied from 0.833 to 0.933, and the heat-transfer coefficients from 160 to 322 kcal/m hr °C. The experiment demonstrated that the recovery coefficient for inserts with rectangular grooves does not exceed 0.9; at the same time, the recovery coefficient for other types of grooves is >0.9. Heat transfer coefficients values for inserts with rectangular grooves vary from 160 to 293 kcal/m^2 hr °C. It was further shown that changes in the surface profile generally produced larger recovery and heat-transfer coefficients than those for smooth surfaces. (Source: Library of Congress, A.I.D. Press, No. 949, April 23, 1963)

ELECTROHYDRAULIC TRANSDUCER. The Soviets have developed an electrohydraulic transducer that efficiently converts an electric signal into mechanical energy by the use of hydraulic output by way of a change in oil pressure. The purpose of the converter is to enable hydraulic motors of various mechanical equipments to be controlled electrically.

The complete apparatus is shown in Fig. 5A. The stator, similar to that of a two-phase induction servomotor, is secured to the casing and carries the windings of the fixed and control phases. The shaft, which is a force fit in the cover, carries the ferromagnetic core. This core is built up of transformer stampings with axial slots. A thin-walled duralumin cylinder is mounted on the shaft by means of the bearing; it is free to rotate, but its movement is controlled by the torsion spring.

Oil under pressure is supplied through the passage and the radial holes to the interior of the cylinder. It flows down the slots and escapes through the radial orifices situated in the end plate. The distribution passages, shown in Fig. 5B, are connected to each other by tubing within the transducer and piped to the hydraulic output system. When the cylinder is in its neutral position, the pressures in the outlet pipes are equal. When the appropriate ac signal is fed to the stator control winding, the cylinder rotates against the torsion spring, thereby producing a corresponding pressure change in the oil output leads.

The transducer is cooled by oil leak-off from the orifices flowing around the stator windings and out through the port.

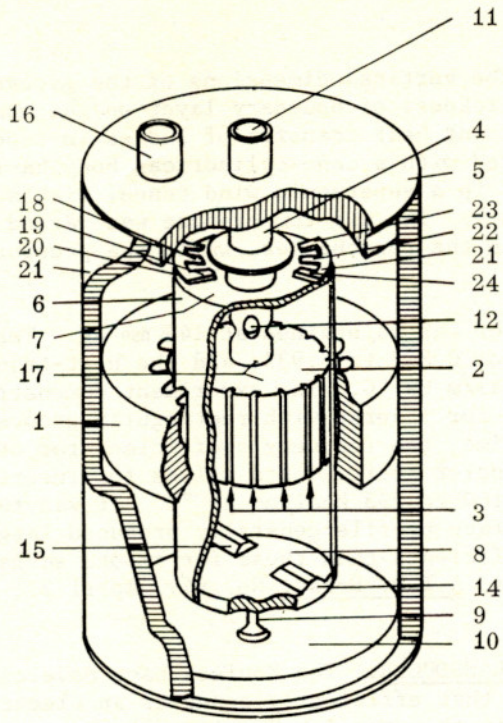

FIG. 5A

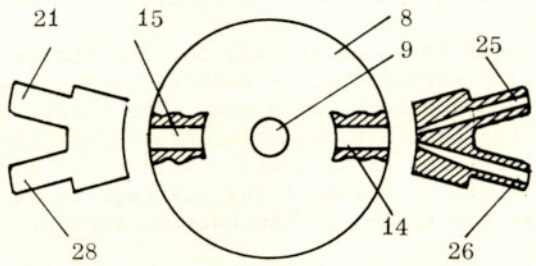

FIG. 5B

1. Stator
2. Ferromagnetic core
3. Axial slots in transformer
4. Shaft
5. Cover
6. Duralumin cylinder
7. Bearing
8. End plate
9. Torsion spring
10. Open space
11. Oil passage
12. Radial holes
13. Casing
14 & 15. Radial orifices
16. Oil port
17. Armature
18, 19, 22, 23, & 24. Pole shoes
20 & 21. Differential transformers
25, 26, 27, & 28. Oil distribution passages

As the transducer has only one moving part (the cylinder), and its moment of inertia is small, the device has a low time constant.

The transducer also includes two induction pickups which measure the angular rotation of the cylinder. The output signal from the two differential transformers is varied by movement of the armature (with pole shoes), which is fixed to the shaft of the cylinder. The magnitude of the ac voltage is proportional to the angular displacement of the cylinder, and the phase depends on the direction of rotation. The output of one pickup is fed to the amplifier, which supplies the stator control phase. The output of the other pickup may be used for distant reading or other purposes.

The specifications are:

Supply - 220 V mains; 4.5 liters/min of oil at 5 atm
Input - stator control phase 2 x 12 V, 5 VA
Output - oil pressure difference from 0 to 2.1 atm

(Source: Soviet Technology Digest, July 1962)

SCIENCE AND TECHNOLOGY SECTION TRANSLATIONS

The following article was selected and translated from current Soviet literature by the Science and Technology Section.

"On a Lunar Journey" by B. Stepanov

A new Soviet rocket flies towards the Moon. Already hundreds of thousands of kilometers are behind, and the forward movement is proceeding, as before, with a high accuracy built into the rocket by Soviet scientists and engineers. Yet to send a rocket to the vicinity of the Moon from Earth is a very complicated engineering task. In order that the rocket reach its target, it must be guided to a pre-determined spot in space where the Moon will appear after a considerable period following the rocket's launch. Yet the rocket speed, initially 11.2 km/sec, is not constant, and under the influence of the Earth's gravitation it decreases quite rapidly; at a distance of 1500 km from Earth it decreases to 10 km/sec. When the rocket approaches the Moon, at a point 66 thousand km away, the minimum speed is only 2.31 km/sec.

At this exact point the attraction of the Moon and Earth are balanced. In proportion to the approach to the Moon, the rocket speed again begins to increase, and at the moment of departure into an assigned area it will become 3.3 km/sec.

In order to ensure the rocket's arrival at a designated location, an error in speed in the terminal portion of the rocket's flight may not exceed several meters per second nor the angular declination more than

one tenth of a degree. Inasmuch as the level of the rocket's trajectory turns during the rotation of the Earth around its axis, the rocket must therefore start accurately in a predesignated moment. Delay or advance of the launch by only 10 sec will cause a deviation error of 200 km (120 mi) from the assigned location. It must be remembered that regardless of the high degree of accuracy of the guidance system for the rocket, errors, although very small, are possible. Several small errors operating in unison may cause a greater deviation in the accuracy of attaining the target than the separate effect of any single error. This explains the elaborate preparations for launching rockets.

The operations of the measurement and calculation services must be extremely clear and accurate at this point. Already during the first hour of the rocket's flight it is necessary to determine the trajectory for its further flight and to establish whether or not it was launched sufficiently accurately to arrive at the designated point. It is necessary to know the exact time and exit location of the rocket earlier.

Soviet scientists have already accumulated vast experience in placing rockets accurately on cosmic paths. One of the more ideal methods, which has already been tested, consists of launching a rocket when its last stage orbits as an artificial satellite and then from a suitable orbital location starting it on a given trajectory. As is well known, this was accomplished prior to the launch of the station "Luna 4."

What is the advantage of this approach? When the rocket is dispatched from the orbit of the artificial satellite, it is possible to discount the deviations that have originated during the period of its flight from Earth to its exit from the orbit of a satellite. A similar method also permits the transmission of additional speed to the last stage of the rocket, which is less than would have been required during a launch from Earth. This in turn enables the rocket to be guided on its cosmic journey with the maximum accuracy.

The following is also very important. Launch of the rocket from the orbit of a satellite is possible at the moment and location as required by the calculations of the scientists. Besides this, launching the rocket towards the planet from on board the satellite in an almost horizontal plane from the Earth permits an increase in the payload--devices and equipment. This results from a decreased requirement for a fuel reserve for a "horizontal" flight in comparison to that required for flight along a trajectory at an angle to the Earth's surface.

This then is the advantage of launching the rocket on a cosmic journey from the orbit of a satellite. But its attainment is a complicated engineering problem that has been successfully solved by Soviet scientists and engineers.

What technical ideas have been expressed concerning future flights towards the planets in the Solar System? Current literature contains an idea whose realization obviously would increase the payload, significantly over the present capability, and which could be dispatched to the Moon or any other planet in the Solar System.

Basically the proposal is: individual sections of a rocket (to be assembled later) are first placed in an Earth-circling orbit with the assistance of several comparatively small rockets. All of these components meet in space and are assembled together. This results in a new rocket that is in an orbit around the Earth and is capable of any cosmic journey without the expenditure of great amounts of fuel.

Future rockets will have to be launched not only from Earth but also from the Moon, which creates a problem. However the mass of the Moon is 80 times less than the mass of the Earth, while the Moon's attraction on its surface is only one sixth of the Earth's. This considerably facilitates flights to the Moon. In order that a cosmic ship reach the Moon it must attain a velocity of only 2.4 km (1.5 mi) per sec. This decreases significantly the required power of the rocket engines and the fuel reserved. Launches from the reverse side of the Moon would be especially suitable since the influence of the Earth's attraction is considerably weaker there. For example, flights to Mars or Venus require that the rocket be launched vertically at a speed around 4.5 km per sec.

The absence of radiation belts at the Moon significantly improves flight conditions for cosmic ships. Here the cosmonaut is not required to select a special orbit with a minimum level of radiation as is required for a flight from Earth or the landing on Earth of future interplanetary cosmic ships. Since it is practically possible to approach the Moon from any direction, the Moon becomes a convenient preliminary staging area for cosmic ships on their journey towards the planets of the Solar System.

When Yuri Gagarin was questioned about the possibility of flights to, and landings on, the Moon, he said that the Moon was not too distant a neighbor and that it wouldn't be too long before we could fly to, and land on, the Moon.

Colossal Soviet rockets, which have carried Y. Gagarin, G. Titov, A. Nikolayev, and P. Popovich into space, demonstrated to the whole world the actual possibilities for the accomplishment of future daring flights that only recently would have been considered as fantastic. The present remarkable flight of the Soviet station "Luna 4" serves as an example of such flights. (Source: Red Star, April 4, 1963)

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

Gagarin, Yuri, Road to the Stars. Published by the Foreign Languages Publishing House, Moscow, 1962. Price $0.70. Reviewed by W. F. Hilton.

This is Gagarin's autobiography, as told to two Pravda special correspondents and then translated into English. It makes interesting and easy reading and is non-technical. It brings out forcibly the human bravery aspect of these pioneer space flights.

The actual chapter headings are of interest, as they differ so markedly from what one might expect: Smolensk, my native region; I join the ranks of the working class; I become a pilot; the oath of allegiance; under the Northern lights; training for the great day; Wednesday, April 12; living for the Country.

The impression one gathers of Gagarin's boyhood is one of small educational opportunity, and that opportunity disturbed very much by the War. Throughout he had a determination to learn, coupled with hero worship of men doing brave deeds, many of which happened on his doorstep, due to the war. His progress from foundry to Technical College, and from Technical College to Air Force, is well described.

It was while he was an Air Force cadet that the first Sputnik was launched, and his friend said that manned space flight was fifteen years off. After his marriage he volunteered for service in the frozen North, where he slowly conceived the desire to go into space. The training period is described in detail. The account of the actual flight occupies only 12 pages in all. The book is interspersed with propaganda, working up to a climax towards the end. For all this, it is a good account of many things on the other side of the Iron Curtain. (Source: Journal of the Royal Aeronautical Society, November 1962)

Kopal, Zdeněk (ed), Physics and Astronomy of the Moon. Published by Academic Press, Inc., New York, 1962. Price $16.50. The book, containing 538 pages, was reviewed in Science magazine.

This book gives an authoritative account of the physics and astronomy of the Moon. This valuable addition to selenological literature is not only a reference book with well-documented discussions of facts and ideas but also a source book of unsolved problems and suggestions for further study.

The first three chapters deal with the dynamics of the Moon. In "The Motion of the Moon," D. Brouwer and G. Hori give an historical review and an analytical theory of the 'main problem' with the effect of perturbations

by the Sun and planets. This is followed by K. Koziel's "Libration of the Moon," and G. W. Grooves' "Dynamics of the Earth-Moon System." The several librations of the Moon are described and analyzed, theories of tidal deformation and friction are developed, and comparisons are made with observations.

Information about the surface of the Moon is obtained primarily from reflected light as described in the next three chapters. V. G. Fesenkov reports on "Photometry of the Moon," and A. Dollfus on "The Polarization of Moonlight" in separate chapters. They come to different conclusions about the fine structure of the Moon's surface. This section of the book closes with an historical review and analysis of "Lunar Eclipses." The next major section on selenography begins with a chapter on "Topography of the Moon" by editor Zdenek Kopal; continues with "Interpretation of Lunar Craters" by E. M. Shoemaker, who defends the impact theory of crater formation and then singles out the Copernicus region for detailed study; and concludes with "Physical Observations of the Lunar Surface" by N. A. Kozyrev, who believes he has detected gaseous emanations in the crater Alphonsus by their fluorescence.

In "The Luminescence of the Lunar Surface," J. F. Grainger and J. Ring present observational evidence for the production of visible light by ultraviolet radiation and high-speed particles from the Sun. Then in "Temperature on the Lunar Surface," W. M. Sinton compares the infrared, microwave, and millimeter-wave emissions from the Moon and concludes that the lunar surface is covered with a fine insulating dust.

J. V. Evans describes the theoretical and experimental investigations of the reflection of radar signals in "Radio Echo Studies of the Moon." Finally, H. C. Urey reviews speculations about the Moon in "Origin and History of the Moon."

Whether one is interested in landing on the Moon, in studying it for what light it might shed on the early history of the Earth, or in simply wanting to know more about it as our nearest celestial neighbor, The Physics and Astronomy of the Moon contains a wealth of information and hundreds of references. (Source: Science, 1962)

TECHNICAL ARTICLES IN THE JOURNAL LITERATURE

From time to time SIN will report on articles appearing in the journal literature of potential interest to our readers. Requests for copies of these articles should be directed to the Library, M-MS-IPL.

Pardoe, G. K. C., "Space Flight Projects Based on Blue Streak," Journal of the Royal Aeronautical Society, 66, No. 623 (November 1962), 690.

"Message from the Central Committee of the Communist Party of the Soviet Union, the Presidium of the Supreme Soviet of the U.S.S.R. and Government of the Soviet Union," Iskusstvennye Sputniki Zemli (Artificial Earth Satellites), No. 14 (1962), 3.

Malkevich, M. S., "Angular and Spectral Distribution of Radiation Reflected by the Earth into Space," Iskusstvennye Sputniki Zemli (Artificial Earth Satellites), No. 14 (1962), 30.

Averyanov, I. P., A. M. Kasatkin, A. V. Liventsov, M. N. Markov, Ya. I. Merson, M. R. Shamilev, and V. E. Shervinsky, "The Outgoing Earth's Thermal Radiation Measurements from a High-Altitude Geophysical Automatic Station During the Total Solar Eclipse on February 15, 1961," Iskusstvennye Sputniki Zemli (Artificial Earth Satellites), No. 14 (1962), 49.

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