APRIL 13, 1959

TITAN - -
Ready for Second Stage Testing

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Probe to Solar System's Edge 19
Explosions in Space (Part III) 21
Mahon to Push for More *Atlases* . . 34

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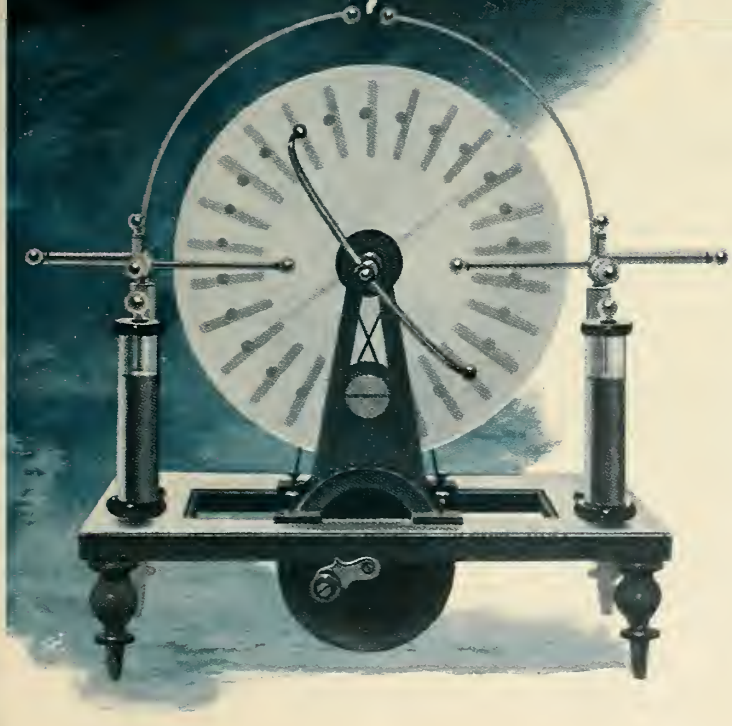
what is charge?



Earth's attraction for a lightning bolt?

+ or −, which is up?

A resonant phenomenon?

A singularity in a field?

What is the nuclear "glue" for like charges?

A better comprehension of charge is important to Allison because energy conversion is our business and charge is one keystone for this conversion work. Thus we have a deep and continuing interest in electrons, protons, positrons, neutrons, neutrinos—charge in all its forms.

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Energy conversion is our business

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

APRIL 13 HEADLINES

To the Edge of Interstellar Space
In 1962 NASA will fire minimal payload rocket and in next 8-10 years will perfect communications for receiving its data 19

Mahon to Demand More *Atlases*
Chairman of House Defense Appropriations Subcommittee tells *M/R* his group will "seriously consider" adding hundreds of millions of dollars for more of the Convair missiles 34

Pacific Missile Range Investment to Sky Rocket
Some $250 million will be spent by end of 1962. Extra $75 million probably will be funded in next two years for base construction 36

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Nuclear Explosions in Space
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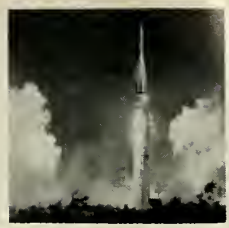
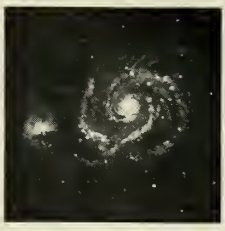
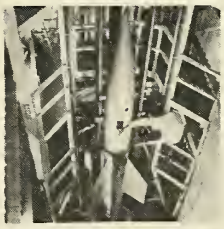


COVER: With three successful flights in succession, Martin's *Titan* ICBM soon will go into second stage testing.



NASA is planning to send a minimal rocket to the edge of the solar system in a test of long-range communication (p. 19).

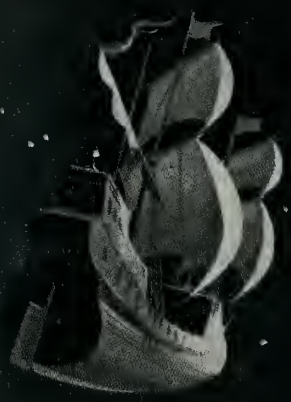
SUPPORTING Project *Argus* (see third article by Prof. Fred Singer on p. 21) are *Jason* research rockets.



BRITAIN's *Thunderbird* undergoes six foot drop test to simulate shock of launching at English Electric's facility.

S.E.P.R. F32 solid-fuel motor undergoes test. S.E.P.R. well-known for its liquid work now is heavily engaged in solids (p. 28).

SOLAR SAILING



EXPANDING THE FRONTIERS OF SPAC

SOLAR SAILING: Space travel with the aid of solar radiation pressure—an area of advanced research at Lockheed. Vehicle would employ a sail that would be raised and lowered in flight. The artist has depicted Magellan's ship "Trinidad" to symbolize man's great voyages of discovery.

Lockheed Missile Systems Division is engaged in all fields of missile and space technology—from concept to operation. Advanced research and development programs include—man in space; space communications; electronics; ionic propulsion; nuclear and solar propulsion; magnetohydrodynamics; computer development; oceanography; flight sciences; materials and processes; human engineering; electromagnetic wave propagation and radiation; and operations research and analysis.

The successful completion of programs such as these not only encompasses the sum of man's knowledge in many fields, but requires a bold and imaginative approach in areas where only theory now exists.

ECHNOLOGY

The Missile Systems Division programs reach far into the future. It is a rewarding future which men of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, Dept. D2-29, 962 W. El Camino Real, Sunnyvale, California, or 7701 Woodley Avenue, Van Nuys, California. For the convenience of those living in the East or Midwest, offices are maintained at Suite 745, 405 Lexington Avenue, New York 17, and at Suite 300, 840 N. Michigan Avenue, Chicago 11.

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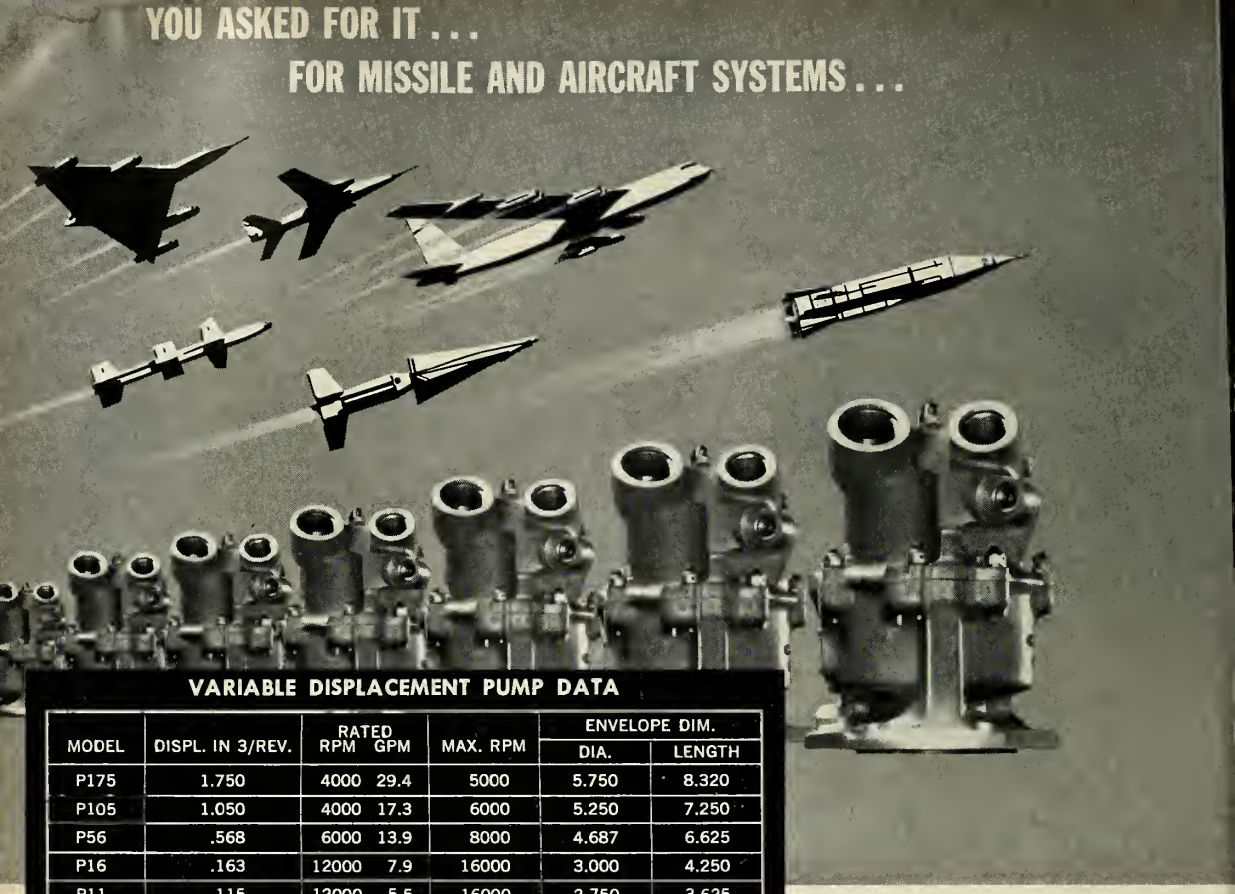

VARIABLE DISPLACEMENT PUMP DATA

MODEL	DISPL. IN 3/REV.	RATED RPM	RATED GPM	MAX. RPM	ENVELOPE DIM. DIA.	ENVELOPE DIM. LENGTH
P175	1.750	4000	29.4	5000	5.750	8.320
P105	1.050	4000	17.3	6000	5.250	7.250
P56	.568	6000	13.9	8000	4.687	6.625
P16	.163	12000	7.9	16000	3.000	4.250
P11	.115	12000	5.5	16000	2.750	3.625
P064	.064	12000	3.1	18000	2.125	3.125
P044	.044	12000	2.1	18000	2.125	3.062

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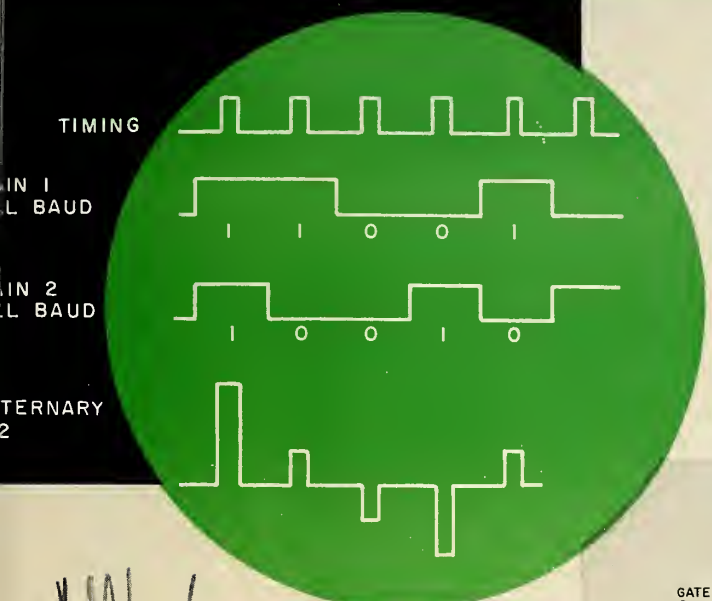
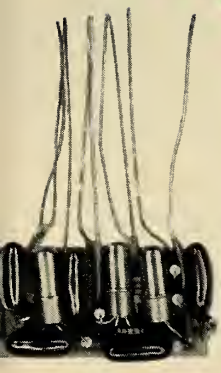
PULSE CODE MODULATION

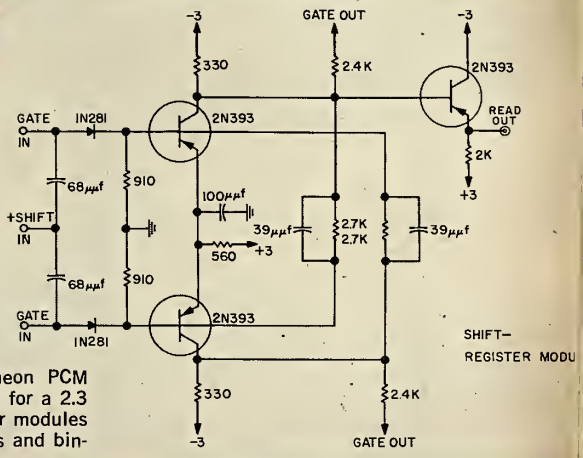


PCM is a new method of coding voice and analog information into digital form. It provides a completely digitalized message by time-division multiplexing of voice circuits. Adaptation of the technique offers advantages in signal-to-noise characteristics, signal regeneration, message security and equipment reliability not usually achieved with conventional techniques.

A 96-voice channel, fully transistorized PCM equipment for cable and radio transmission meeting rugged military requirements is now being developed by the Communications Department of Raytheon's Government Equipment Division. In this system a sampling frequency of 8,000 cycles is used. Each sample is coded in six-bit binary form, at a bit frequency of 4.6 mc. Many new circuit techniques, closely allied to high-speed data processing and computer systems are being developed for this equipment.



THE QUATERNARY WAVE combines information from trains 1 and 2, and the timing pulse regulates the width and position of the quaternary output wave. Thus, twice as much information is passed through the same bandwidth as is required for one train.



TYPICAL MOLDED MODULE used in Raytheon PCM equipment comprises logic circuitry required for a 2.3 mc shift register shown in the diagram. Other modules are used for repetitive and-or gates, flip-flops and binary-storage elements.

NEW OPPORTUNITIES WITH A FUTURE

Your background in design, development, production or manufacturing of radar, sonar, infrared, communication or countermeasure equipment may qualify you for an engineering future with Raytheon. Please write to Donald H. Sweet, Professional Personnel, Raytheon Manufacturing Company, Government Equipment Division, Wayland, Massachusetts.

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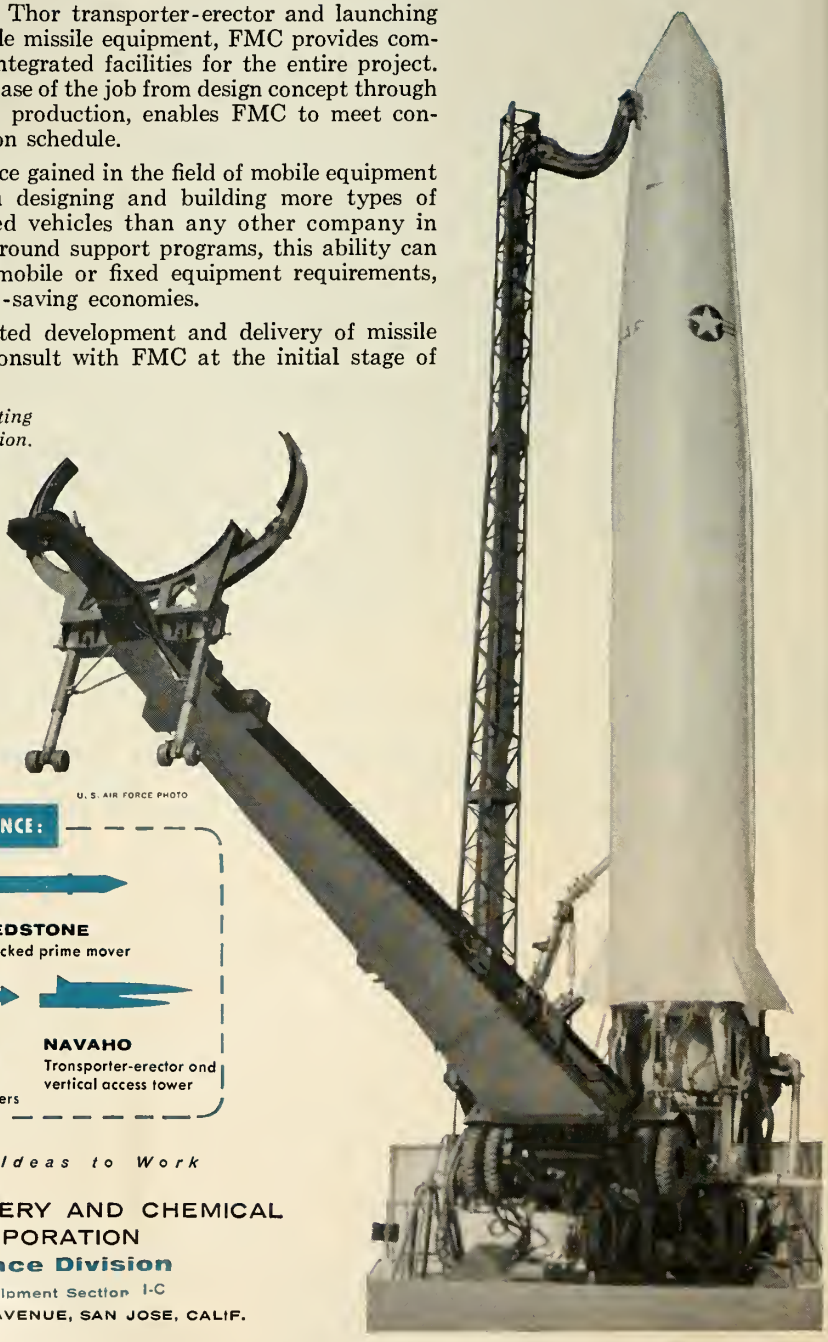

THOR transporter-erector, launching base and power trailer delivered by FMC in just eight months—2 months ahead of schedule—receives operational check-out.

U. S. AIR FORCE PHOTO

HERE IS FMC'S PROFILE OF EXPERIENCE:

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NAVAHO
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ARPA—A Dangerous Compromise

We think it is about time that Congress and the Defense Department sat back and took a long look at the Advanced Research Projects Agency (ARPA) and what its present work in the military field is doing to the U.S. military posture.

ARPA is responsible for all military space activity. The services have no money budgeted for this purpose. They do, however, have a great deal of responsibility in this field because—whether or not the fact is easily visible at the moment—there is little doubt that controlling accessibility to space in the future will be tantamount to controlling the earth.

ARPA was born of political expediency and is essentially a creature of indecision. When the Space Age dawned and the first *Sputnik* circled in the heavens, all three services leaped into the missile and spacecraft business with both feet and an eye to the future. From the resultant melee of *Vanguards* and *Explorers, Jupiters* and *Thors,* claims and recriminations came the plea for a definition of the roles and missions of the three services in space business. What portions rightfully and logically belonged to the Air Force, to the Army and to the Navy?

For reasons of its own the Administration sidestepped the problem by establishing ARPA—now self-styled the "Fourth Service," the "Space Service" or whatever you like. ARPA is by name an advanced research agency. In actuality 75 and more per cent of its activities are in the military space field and its prime function is to solve the roles and missions problem without really making it necessary for the Administration to come to grips with it.

ARPA solves it by dividing up the development of any one project between two or three of the services with the idea that once developed the hardware will then be given to the service needing it most. This assumes that one service, at least, will a) want it and b) be prepared to use it. Roy Johnson, director, defined ARPA's role on March 26 of this year, saying:

"To date, ARPA has been performing its work (all military space projects) by assigning its projects, or parts thereof, to one or more of the service organizations, and in a few cases, to other government agencies for execution either directly or on behalf of ARPA. For effectiveness and efficiency of operation, they are assigned to the lowest organizational unit which has the necessary facilities, personnel, and contractual and other delegated administrative authority to do the best job for us. For example, rather than assigning work to the secretary of the military department, which in turn would have to select and assign it to lower levels within the department, ARPA directly assigns the work to such lower organizations as the Air Research and Development Command in the Air Force, the Army Ordnance Missile Command and the Chief Signal Office in the Army, the Bureau of Ordnance and the Office of Naval Research in the Navy. The secretary of the department concerned and the Joint Chiefs of Staff are advised prior to the time of assignment."

Aside from the fact that Johnson and his people are assuming a greater knowledge of the capabilities of the services than the heads of the services themselves, the ARPA system is leading toward a conclusion which may be disastrous in terms of two things—time and money.

This is because the ARPA method of using a combination of services in development fails entirely to take into consideration the fact that space vehicles are intricate, highly technical pieces of equipment which require especially trained operators, special maintenance and special logistics. Such training, maintenance and logistics cannot be arranged for after the article goes into production but must be planned and carried out to coincide with progress in development. The men, the sites and the support equipment must be ready when the first article comes off the production line.

At the moment, ARPA is developing a communications satellite. The Air Force has the booster, the Army the transmitter and the Navy the tracking. Unfortunately, however, the article being developed is a compromise which exactly suits the needs of none of the three services. Even if it did, no service has been assigned to carry out the advance preparations for its utilization.

Obviously, the roles and missions of the services are a difficult problem and it would take calm judgment and political fortitude to decide them. But the present compromise may turn out to be more costly than we can afford.

Clarke Newlon

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WING SPARS, FRONT AND REAR, HAVE SPAR CAPS ATTACHED TO WEB SECTIONS WITH HS92 PINS, A2B6 ALLOY, HEAT TREATED TO 95,000 PSI MINIMUM SHEAR HS60M COLLARS ARE USED.

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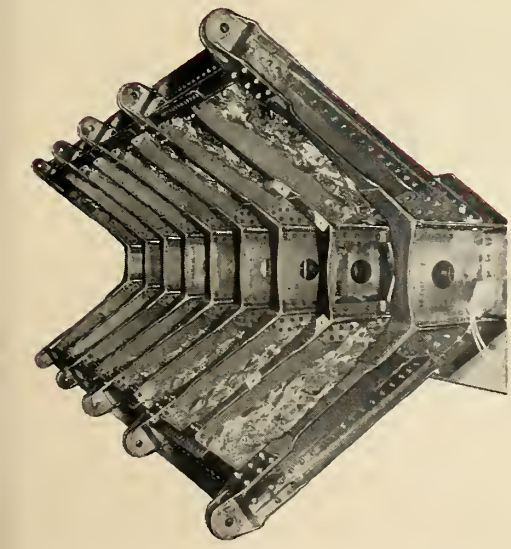
*X-15 .. A CHALLENGE FOR FASTENERS



WING ATTACH STRUCTURE IS ASSEMBLED WITH INTERFERENCE FIT HI-SHEAR RIVETS. THE HS128 PINS ARE 17-4PH STAINLESS STEEL, HEAT TREATED TO 120,000 PSI MINIMUM SHEAR. THE HS91 AND HS92 PINS ARE A-2B6 ALLOY, HEAT TREATED TO 95,000 PSI MINIMUM SHEAR. BOTH PINS USE HS60M R MONEL COLLARS.

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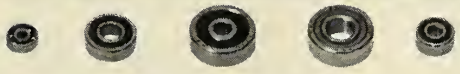
CASE HISTORIES

Camparatar measures dimensians ta anemillianth of an inch. One af many pieces af ultra-precisian equipment in the New Departure instrument/miniature ball bearing labaratories.



In many bearings, various dimensians and surface finishes must be held ta within talerances af ane millianth af an inch.

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washington countdown

IN THE PENTAGON

The era of push-button war is coming ever faster. A military crew successfully fired a Douglas *Thor*. Total countdown time: 17 minutes.

• • •

Not even the advent of Boeing's solid-propellant *Minuteman* in the next few years will necessarily eliminate the need for Convair's *Atlas* and Martin's *Titan*. The reason is the size of their warheads. The *Minuteman* will pack about one megaton . . . the *Atlas* about four. And the bigger warheads are needed to destroy a hardened missile base or nuclear factory.

• • •

Even the insiders are having a hard time forecasting the new line-up of the Air Force's top staff. With Secretary McElroy sitting on the list of promotions and assignments there are too many uncertainties. All three services, for instance, are debating whether or not to give up voluntarily a few four-star positions before Congress moves in and demands more. Air Force would like to give a fourth star to Lt. Gen. Emmett "Rosy" O'Donnell, now chief of personnel, but one senator is blocking it and she's adamant. And, Lt. Gen. Clarence Irvine, deputy chief of staff-materiel, resigned despite a request from AF Secretary James Douglas to stay on at least another year.

• • •

Irvine's post will probably go to his deputy, Maj. Gen. Mark Bradley. Deputy Chief of Staff-Personnel is most likely to go to either Lt. Gen. William Hall, now boss of Continental Air Command, or to Maj. Gen. Sory Smith, formerly chief of AF information and now commander of 4th Air Force at Hamilton AFB.

• • •

Gen. Laurence Kuter, present commander of Far East Air Forces, will go to North American Air Defense Command (NORAD). Gen. Frank Everest, now chief of the U.S. Air Forces Europe (USAFE), reportedly has asked for the Tactical Air Force, improbable as that may sound to many. Three of the top U.S. jobs, SAC in Omaha and Deputy Chief for Operations and Deputy Chief for Plans, both in the Pentagon, will stay with their present incumbents—Gen. Thomas S. Power, Lt. Gen. Dean C. Struther and Lt. Gen. John K. Gerhart. Should Rosy O'Donnell acquire the fourth star through some compromise with the senator, he probably would get USAFE, otherwise he will retire.

ON CAPITOL HILL

The Senate Space Organization Subcommittee will resume its investigation tomorrow on possible crippling rivalry among federal space agencies. Among the key witnesses: Pentagon R&D Director Herbert York. Among the key questions: Who is running the store?

• • •

The House Information Subcommittee is prodding the Pentagon to explain why it is restricting information about space monkey experiments on security grounds. The real reason is reported to be diplomacy—not security. India is understood to have put pressure on the State Department to stop all space monkey business because it offends Indian monkey worshipers.

• • •

Some Congressmen are talking in terms of adding a $1 billion package to the FY 1960 defense appropriations bill. The package would include extra funds for *Minuteman, Titan* and *Polaris* as well as *Atlas*.

AT NASA

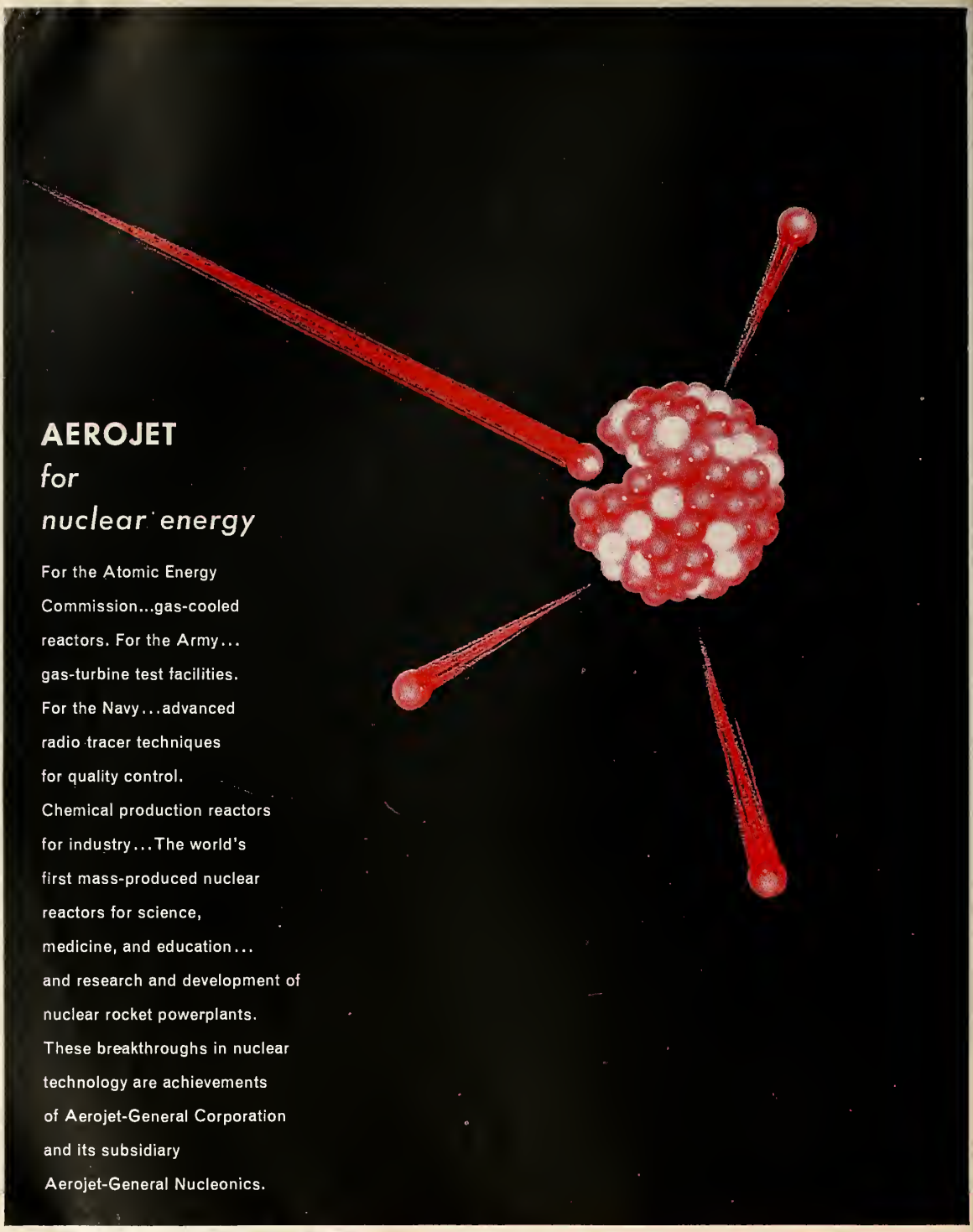
Vanguard III which is scheduled to be launched today will carry: (1) a 30-ounce precision magnetometer, (2) an inflatable plastic and aluminum balloon, and (3) a new third stage built by Allegheny Ballistic Missile Laboratory. The 30-inch balloon will be inflated with nitrogen when the payload separates from the third stage.

• • •

The *Vanguard's* new third stage is expected to greatly increase the life span of the *Vanguard* program. The solid-propellant rocket will triple *Vanguard's* payload capability.

AROUND TOWN

Gen. Lauris Norstad says the greatest need of NATO forces is modern weapons which must come from the U.S. under a plan carrying to 1963. He discounts the possibility of a limited war in Europe; says there are no present plans to train West Germans in the use of the IRBM simply because other nations are available; feels strongly that a disengagement in Europe as proposed would greatly dilute security of West; and believes NATO strength lies in its mutual consultations and ability to overcome disagreements.



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industry countdown

STRUCTURES

Martin's two-stage solid *Bold Orion* air-launched ballistic missile under WS-169A went more than 1000 miles April 3 when launched from B-47 in its fourth successful air drop. Word is that no other companies have yet achieved the Martin range. One of the hottest competitions which will mean a volume production item, WS-169A probably won't be decided until after July 1. It's interesting that Gen. Thomas D. White has commented that the system will have the same accuracy as ground-launched ballistic missiles.

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Insiders say Pan American will receive Navy contracts to operate Pacific Missile Range stations at Guam and Midway. Other major contracts are reported in the mill for PMR development of Point Arguello, Hawaii and several other sites.

• • •

Rigid specifications can be expected in the DOD's quality control system uniform requirements coming out in about a month. Aim is for greater component reliability, with government monitoring control systems to be devised by contractors.

• • •

ADOS (Astronautical Defensive-Offensive System) is being unveiled by Avco at the World Congress of Flight. Developed for AF, system is still in the laboratory stage. It is designed to be an all-round weapons system to protect vehicles from attack or "piracy" in space.

• • •

Creation of a new "Bureau of Submarines" is being urged by Connecticut's Sen. Thomas J. Dodd. He wants a fleet of 100 missile-carrying atomic-powered submarines.

• • •

Watch for Supreme Court decisions in three cases involving the constitutionality of Industrial Security Regulations which allow DOD to force contractors to fire employes by barring them from classified material. Court will rule on ISR screening procedure which denied employes right to cross-examine their accusers.

PROPULSION

Significant advance in storable liquid propellants is indicated by North American's Rocketdyne Division. Firm discloses firing of all its production and experimental rocket engines with storables. Results: performance equal to or "slightly better" than standard LOX/RP with conversion factor "straight forward and relatively inexpensive.'

ARPA and DOD's Materials Advisory Board are slowly overcoming "inertia" in push for ultra-high thermal basic research. MAB solid rocket materials report is due May 15. Six other studies are in the works. Importance of investigating 10,000-60,000°F "Hell's fire" is pinpointed by Temple University's Dr. Aristid V. Gross. He says Russians are probably working in the field and could come up with "surprises" in search for new fuels and high-temperature materials.

• • •

Centaur and *Rover*—both users of liquid hydrogen—apparently are behind NASA's decision to go ahead with West Coast production unit for the material. Linde Co., a division of Union Carbide, won the 5-year contract to make about 2 million pounds of liquid hydrogen a year at its Torrance, Calif., plant.

ELECTRONICS

As space exploration increases, problem of shrinking radio spectrum for telemetry gets more acute. Attempts to find a solution appear likely to founder in politics. Eisenhower Administration has countered proposed $150,000 House study of problem with one of its own. They boil down to conflict over government vs. commercial preemption of bandwidths, with Congress leaning toward commercial side. If and when investigations get off the ground, telemetry needs may get shoved aside by VHF vs. UHF-TV hassle.

• • •

Industry experts believe big effort is required now in developing infrared techniques. Trouble is, says R. W. Powell of Aerojet-General's Avionics Division, "we know 90% of the physics of IR but only about 5% of its application."

ASTROPHYSICS

An attempt to observe Venus from a balloon at 80,000 feet will be made by Navy this summer. Project will be similar to one last November to observe Mars. That one failed when balloon ripped. Two-man team hopes to determine whether there is water in Venus' atmosphere.

SPACE MEDICINE

Psychophysiological studies of stresses encountered in manning space vehicles are continuing at Duke Medical Center under a new $80,000 AF grant. The Center is trying to plot expected human reactions to monotony, close confinement, etc. of space travel.

More about the missile week on page 39

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APRIL 13, 1959—VOL. 5, NO. 15

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

In 1962 NASA will fire minimal payload rocket and in next 8-10 years will perfect communications for receiving its data

To the Edge of Interstellar Space

by Hal Gettings

WASHINGTON—The National Aeronautics and Space Administration will launch a minimal rocket to the edge of the solar system in 1962. And during the eight to 10 years required for the probe to reach its destination, NASA will attempt to perfect communication techniques to receive transmitted scientific data back on earth.

The first hint of NASA's planning came several weeks ago from Eberhardt Rechtin, chief of the Guidance Research Division of JPL. Delivering a paper, "Communication Techniques for Space Exploration" at CalTech's Realities of Space Exploration Colloquium, Rechtin commented:

"Useful communication to the edge of the solar system can be achieved long before the space probe reaches that destination." He said the optimum time to fire for the edge of the solar system is about three years from now. Present or near-future rocket hardware makes such a venture feasible. However, the size of the payload undoubtedly will be small.

The rocket, which would probably have a cluster of 1.5 million pound engines for its first stage, would have to achieve a burnout velocity of over 14 miles per second in order to kick the instrument package towards the outer reaches of the solar system in the vicinity of Pluto.

The time that it would take the rocket to arrive at the orbit of Pluto, which is 2,668,000,000 miles from earth, would be over 4000 days.

Rechtin furnished the following facts:

• **Present solutions**—Worthwhile communication with space probes is achieved today with techniques not known before World War II. A greater quantity of useful information was obtained from *Pioneer III* with greater clarity, at greater ranges, and with better reliability than could even be conceived in 1950. Not only are these signals readable at levels millions of times smaller than with World War II radar receivers, but the signals themselves are more useful due to ingenious information coding techniques.

Pioneers III and *IV* produced considerably more useful information for the same power and bandwidth than was achieved even in the first *Explorer* probe fired less than a year before.

• **Immediate future**—It is easy to predict this nation's communications capability over the next several years (see table, p. 20). Characteristics of such extremely sensitive receiver configurations as the Microlock and the TRAC(E), of transistors, of parametric amplifiers, and of MASERS are so well understood that the only remaining controversy concerns how fast these developments might be incorporated.

The table shows effects of steadily increased transmitter power, increasingly stable vehicles with directional antennas aboard, and progressively more sensitive receivers on the earth. These capabilities are achieved with moderate-sized ground antennas of general utility. The illustration shows that television relaying around the earth is readily foreseeable and that useful communication to the edge of the solar system can be achieved long before the space probe reaches that destination.

• **Limitations**—There are several fundamental limits on communications capability, or at least on the rate of progress, and one is the overwhelming volume of data. For example, many hundreds of feet of trajectory information were teletyped from Puerto Rico back to JPL on one probe. This teletype information was fed into an IBM 704 which did rapid, real-time trajectory prediction for the positioning of antennas in the later stations.

Earlier, information of this type would have been presented as photo-

graphs of markings on an antenna pedestal which would have been laboriously read out by hand and still more laboriously entered into a computational procedure. Necessary as this amount of data was to obtain a precise orbit, this amount of information is small compared to the kind of information transmitted from a satellite surveying the earth.

Such satellites would transmit from 10^5 to 10^9 times as much information, all of which must be processed. There is some doubt whether any reasonable number of human beings could assimilate all this information in any reasonable time. Assimilation and data reduction almost unquestionably will have to be done by computers which present heavily reduced data to human viewers.

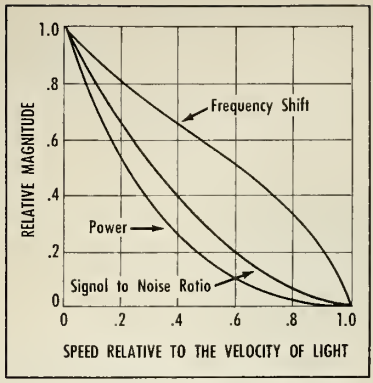
• **Noise**—Another limit is local noise. The earth itself, because it is warm (in effect, a "black body"), radiates noise which enters the system through the sidelobes of the antenna. There are several techniques under study for reducing this noise contribution.

One technique is to design antennas whose sidelobes are appreciably lower than that for conventional antennas. These so-called low-temperature antennas are in the early research phase only. Increased rejection of the earth's radiation by a factor of three might be possible, a factor of 10 would be outstanding.

Another proposal would shield the antenna from the earth by locating it in a valley and covering the whole valley bowl with a reflecting metal surface!

Another limitation is that imposed by the noisy atmosphere and galaxy. A low point in the combination of galactic and atmosphere noise occurs in the general region of 500 to 5000 megacycles per second. Galactic noise is strongly reduced as the transmission frequencies are increased, both because the galactic noise is less at these frequencies and because the galactic sources themselves become considerably smaller and more widely spaced.

The effect of the atmosphere is reduced by increasing the altitude of the station, avoiding looking at the earth's horizon whenever possible, and by keeping the transmission frequency something less than about 5000 megacycles per second.



EFFECT OF speed of receding vehicle.

• **Velocity**—The graph shows one of the limitations imposed by vehicles traveling at extremely high speeds. A relativistic phenomenon in communications occurs which is directly analogous to the forward beaming of energy when a near-relativistic electron collides with a stationary mass.

Even though energy appears to a moving observer to be radiated uniformly, the stationary observer thinks that the energy is all beamed forward. Therefore, for a vehicle rapidly receding from the earth at near the velocity of light, the apparent radiation back to the earth will be reduced significantly below that anticipated due to range alone.

In addition, the strong Doppler effect will make information arrive at a significantly reduced rate. Normal voice could sound like a 78 rpm record played at 33-1/3 rpm, as one example.

• **Time**—Another limitation is time. In exploring the region beyond the nearby planets, the time that it takes to reach the objective begins to stretch into years.

The amount of time that it takes to reach the destination is quite comparable to the time required to change the rate of the art in vehicles and communications. If a vehicle was launched today to the edge of the solar system there would not be a need for the extreme range communication system for some years to come.

The table shows the edge of the solar system could be reached by 1960 as far as communications are concerned. Actually, however, since it will take between eight and 10 years to go that distance with a vehicle, the chart should be corrected to show the communications capability which might exist eight to 10 years from now, at least as far as the transmitting and receiving system on the earth is concerned.

Time scales of this sort also create the possibility that we should not fire this year with a minimal vehicle because if we fired next year with a better vehicle we would arrive at the destination sooner. But the optimum time to fire for the edge of the solar system, in order to reach there in the earliest year, is about three years from now. As for firing for the stars, it is evident ion drive is necessary and the communications engineer has at least four years to come up with an earth receiving system even if the vehicle left today at the speed of light.

• **Cost**—One of the final limitations is cost. Data acquisition facilities including antennas, buildings, and data handling equipment represent an appreciable capital investment. Whether or not the facilities needed for space communications are built is a question of economics. If the percentage return on the capital investment is high enough, money will be found almost independent of the absolute amount. It only remains to show that the space age is economically worthwhile.

As evidence of this, Rechtin pointed out several basic facts of the economics of the space age:

First, the success of the early *Sputniks* has probably cost the United States at least $5 billion which will be paid for in lost contracts on the world market, additional military and economic aid to allies, and increased demonstrations of U.S. military and economic might.

Second, it can be shown that it is more economic to use communication satellites for world communications than to use any other technique when the channel capacity desired approaches that of television or greater. The capital investment involved for such communications is about $300 million.

Third, during the past year there has been increasing interest by commercial organizations in sponsoring their own satellite program for purely commercial gain. The concerns would even buy the vehicles.

LONG-TERM COMMUNICATION SYSTEM CAPABILITIES

CHARACTERISTIC	1958	1960	1962
TRANSMITTER POWER	0.1 W	10 W	100 W
VEHICLE ANTENNA GAIN	6 DB	16 DB	36 DB
RECEIVER SENSITIVITY (Noise Temperature)	2000°K	400°K	40°K
INFORMATION BANDWIDTH*			
1. Satellite Application	0.6 MC/S	> 10 MC/S	> 10 MC/S
2. Lunar Application	60 C/S	0.3 MC/S	> 10 MC/S
3. Mars Application	....	30 C/S	0.3 MC/S
4. Edge of Solar System	....	....	30 C/S

*Available bandwith for S/N = 10 DB assuming transmitter power, vehicle antenna gain, and receiver sensitivity as indicated above.

Nuclear Explosions in Space

- *High-altitude blasts seriously interfere with radio and radar*
- *Complete knock-out of electronic defense is unlikely*
- *Artificial release of molecules could sweep up extra ionization*

Third of four articles by PROF. S. FRED SINGER

WASHINGTON—Radio communication and radar, including long-range detection and guidance, are seriously disturbed by atomic explosions at high altitudes. The radiations from the burst create a great deal of ionization which acts as a barrier to the propagation of radio waves.

In some cases the layer of ionization may absorb radio waves and thus interfere with communications. In other cases it will reflect radar waves and therefore shield from detection all objects above the layer.

The implications of these effects are important to upper atmosphere scientists; because of their relation to the anti-missile defense problem, they are also of concern to military planners and missile engineers.

In spite of the seriousness of the effects it is doubtful whether an electronic missile defense can really be knocked out completely by atomic bursts. One can always pick a high enough operating frequency for radio or radar to get around the effects of the extra ionization produced by atomic bursts, although this frequency may be far removed from the optimum. Other countermeasures may be possible—for example, scavengers which can sweep up the extra ionization in the upper atmosphere.

• **Statement of problem**—The whole problem can be divided into three parts:

1. The amount and space distribution of ionization is caused by the energetic radiations released in an atomic burst and is determined by the size and type of bomb, also the burst altitude in relation to the ionosphere altitude (50 to 300 miles).

2. The electrons which are produced by the burst affect propagation of radio and radar waves; therefore we must know what happens to them after creation. Various natural methods cause them to disappear, but the rate of disappearance depends on many factors, principally altitude. It may also be possible to remove electrons by artificial means, i.e., by releasing materials in the upper atmosphere following a burst.

3. Finally, the disturbing effect of the newly-created electrons on radio wave propagation should be studied. Extra ionization produced at very low levels, 50 miles or less, may cause absorption of radio waves while ionization produced at very high levels will act as a reflector of radio waves. While this may be useful in some cases (e.g., by improving ground-to-ground communications on VHF), the reflecting action will also screen missiles moving above this layer from ground radar. The question which must be answered quantitatively is how high a frequency is necessary for reliable operation at all times under all possible conditions.

As in the case of atomic effects on vehicles in space, there are two important cases of atomic bursts:

1. Effects produced on the upper atmosphere in *close vicinity* to a burst, This might occur in the explosion of a nuclear warhead of a defensive anti-ICBM missile. Or it may occur if an ICBM attack is preceded by an explosion of a large nuclear device whose purpose is interference with radar detection of the missiles which follow.

2. The second case has to do with the effects at *large distances* from the atomic burst due to radiation carried into the opposite hemisphere along the magnetic line of force. This may occur when an enemy wishes to interfere with communications at a point in the other hemisphere without the risk of invading that territory with his missiles.

• **Strategy of distant bursts**—There are some intriguing problems connected with the latter application. In fact, a proper appreciation of the physical situation determines the strategic use of long-distance atomic bursts.

In the April 20 issue: Nuclear Explosions in Space and How They Can Be Detected by a Great Variety of Scientific Techniques.

AEROLAB's *ARGO* E-5 research missile, here on launcher at NASA's Wallops Island station, was used in connection with Project *Argus*.

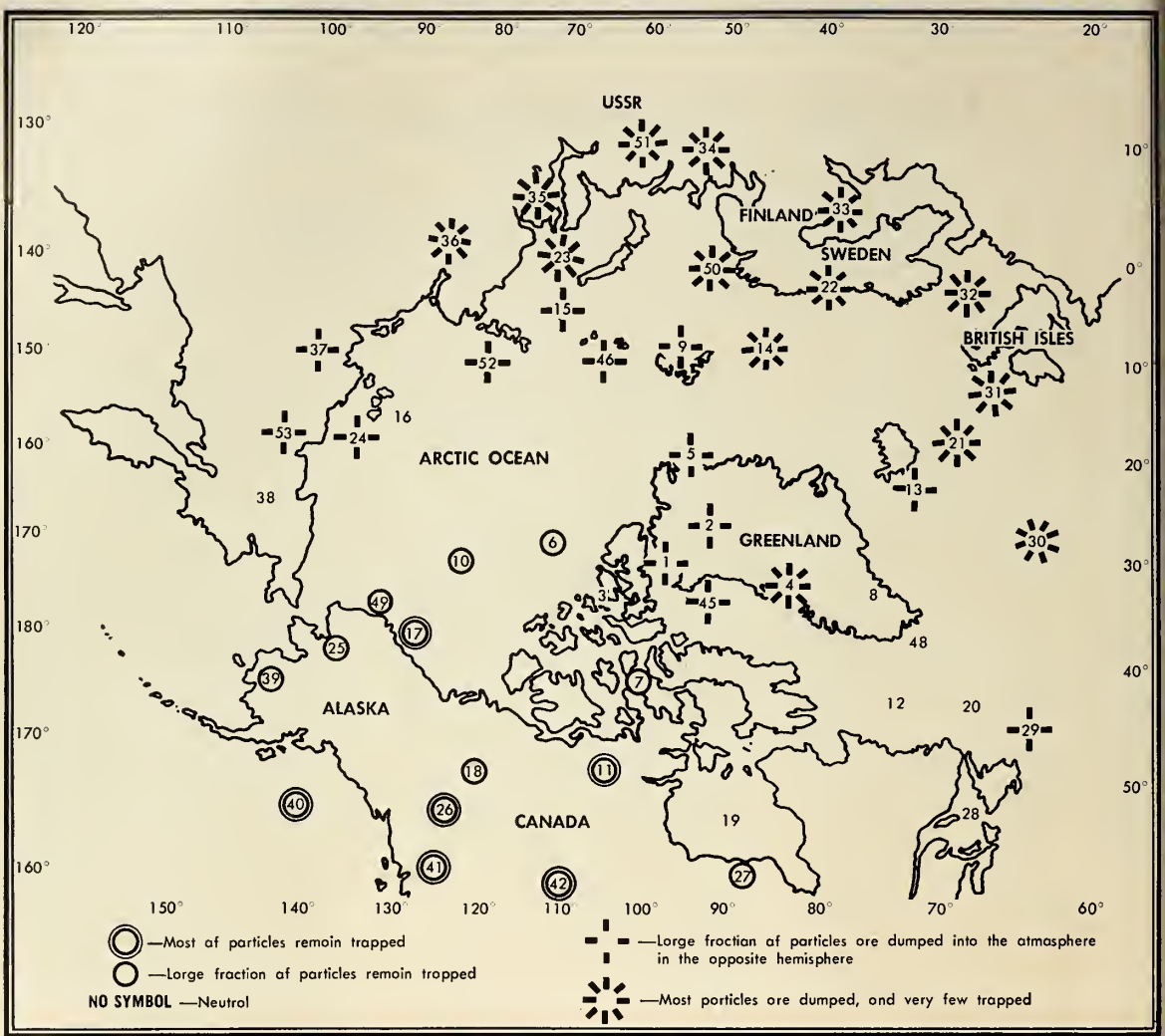


FIG. 1—Maps of the Northern and Southern Polar Regions. Numbered points show opposite end points of various magnetic lines of force. Each point has a code symbol (indicated on chart) showing effects of bomb burst at top of atmosphere.

It is obvious that particles emitted by the atomic burst will be "tied" to a line of force. But only the fission fragments and beta rays (electrons) are in fact guided by this line of force; the gamma rays and neutrons from the burst will escape.

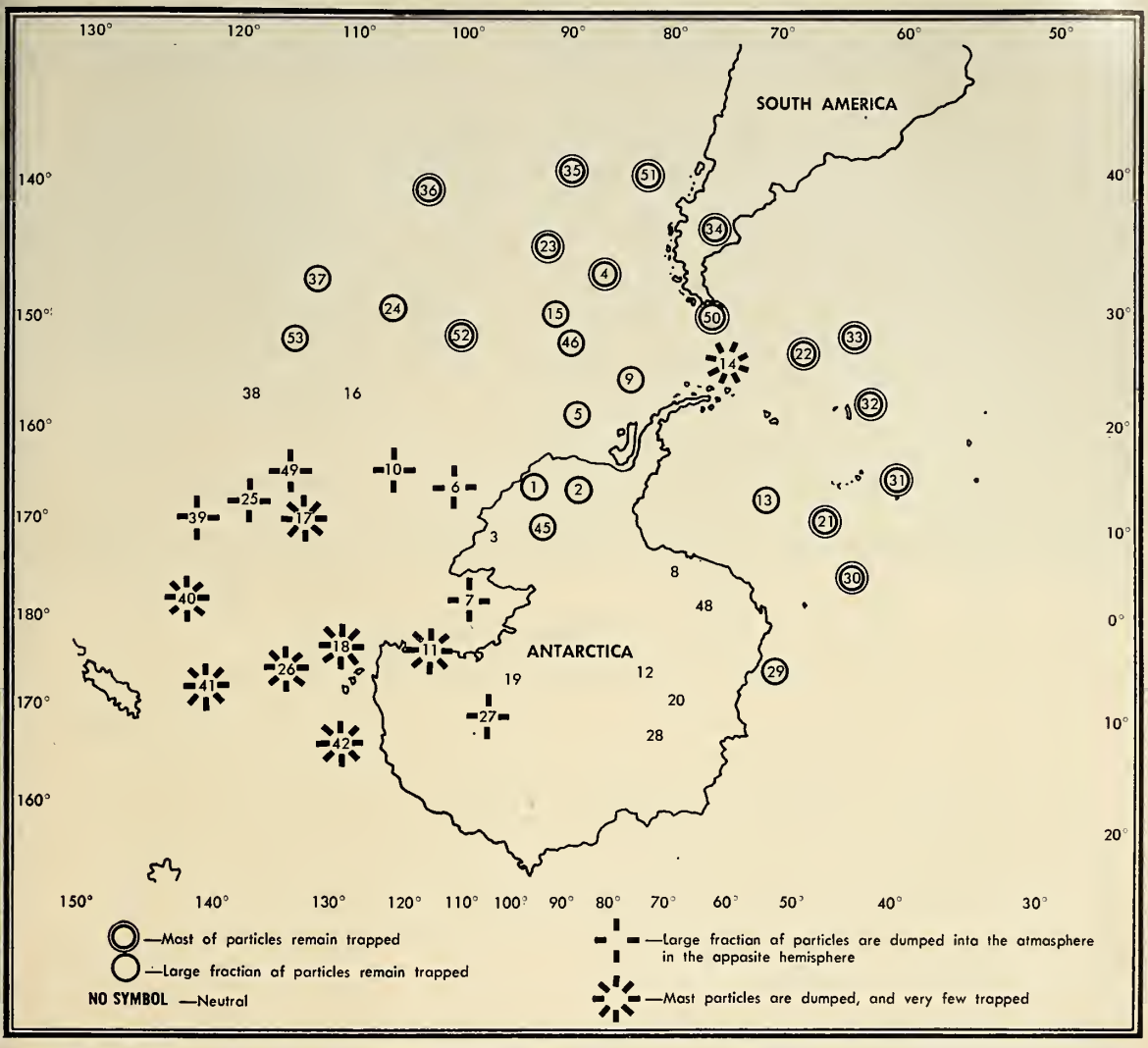
The earth's magnetic field has superimposed upon it various anomalies and the actual path of a line of force must be obtained from maps and calculations.

Fig. 1 shows the northern and southern polar regions and plots the end points of selected lines of force. The basic calculations were made by the Swedish physicists Block and Herlofson. Of course, these plots also show the point of incidence of radiation due to a distant burst point.

If the burst takes place at about 300 miles, very close to the top of the atmosphere, about half the energy is lost, since it will go straight down into the atmosphere at the burst point. But the other half is trapped along the line of force, propagates to the opposite hemisphere, and is dumped into the atmosphere.

If the aim is to dump the radiations of the atomic burst into the atmosphere in the opposite hemisphere, then the bomb burst should take place over a magnetic "high." In fact, if the magnetic anomaly is strong enough, one can transmit much more than 50% of the emitted energy by choosing a somewhat higher launching altitude and making use of reflection from the magnetic field below the burst. Fig. 1 indicates whether a burst at a given point will dump the radiations into the atmosphere, or whether they will remain trapped above the atmosphere.

• **Effects of close bursts**—It is quite difficult to calculate the distribution of ionization produced in the immediate vicinity of an atomic burst. All particles emitted in the burst generate ionization. These include fission fragments and neutrons, as well as gamma rays



and beta rays from the subsequent decay of the fission fragments.

The situation is complicated because the actual position of the release point plays an important role. For release points in the lower part of the ionosphere, the effects of the magnetic field of the earth are of lesser importance.

The fission fragments cannot carry the ionization too far since they have a very short range, approximately 0.5 cm of air at normal pressure (equivalent to a thickness of 5 x 10^{-4} gram per cm^2 of material; entering from above the atmosphere they might penetrate down to approximately 100 km).

But the gamma rays and neutrons can penetrate over very long distances, and therefore produce ionization far away from the atomic burst, while betas are more confined—their range is limited, about 0.1 and possibly up to 1 gram per cm^2.

The most intense ionization is produced by the fission fragments: first, because they carry 90% of the energy, and second, because their much shorter range concentrates the ionization into a smaller volume.

A good rule of thumb is that each ionization of an air atom or molecule requires about 30 electron volts. Therefore the products of a nuclear fission, where 180 Mev of energy is released, can create something like 6 million electrons and ions. A 1 kiloton atomic bomb produces 1.3 x 10^{23} fissions, and therefore 8 x 10^{29} ion pairs.

If we assume the burst point at 60 miles* and use an average range of

---

**At this altitude, the three important lengths—range and radius of gyration of the average fission fragment, and atmospheric scale height—are all of the same order of magnitude. At other altitudes, this is no longer true and the problem is somewhat more involved. Our example cannot be applied to the Johnson Island tests of August, 1958, because of different conditions, e.g. use of a large H-bomb.*

about 5 km, the volume in which the greatest ionization is produced amounts to something like 500 km^3, giving an average electron density of 10^{12} electrons per cm^3, about a million times the ambient value.

This rather rough estimate can vary by orders of magnitude depending on the point of the explosion and other factors. But it indicates the extremely high electron densities producible near atomic bursts. In our present example, a large fraction of the neutral atoms become ionized.

To relate electron densities to radio frequencies, the plasma frequency (or critical frequency) of an ionized gas is given by

$$f_c = 8.97 \sqrt{n_e}$$

(in kilocycles), where n_e is the electron density per cm^3. Thus an increase in electron density by a factor of 10^6 over normal values implies an increase in critical frequency by a factor of 10^3. It places the critical frequency in the region of some 10,000 megacycles.

• **Effects of distant bursts**—It is easier to calculate the upper atmosphere effects produced by radiation guided by the earth's magnetic field. Only fission fragments and beta particles (electrons) can be guided in this way. The betas will arrive first and their total energy per fission (spread over several electrons) is of the order of 5 Mev, possibly less, since not all fission fragments will have decayed.

In studying penetration of these beta particles into the atmosphere, their exact energy spectrum is of course of great importance. The highest energy beta rays will penetrate much deeper than low-energy rays.

In addition, the penetration depends, but not too strongly, on the pitch angle of the arriving particle. A particle with 0° pitch angle, i.e., moving along the line of force, will penetrate deepest. (At high latitudes we may assume to a good degree of approximation that the lines of force are vertically incident on the atmosphere.)

For example, a 2 Mev beta particle has a range of about 1 gram per cm^2 and therefore can penetrate to 50 km altitude. But a typical fission fragment with a range of 5 x 10^{-4} gram per cm^2 will penetrate down to about 100 km.

Some rough calculations can be made on the ionization produced by the incidence of these particles. Without specifying the distribution of energies of the beta rays and fission fragments, but for order-of-magnitude considerations, we will assume that the betas produce all of their ionization between altitudes of 50 and 100 km, while the fission fragments produce their ionization above 100 km up to about 200 km.

Using the basic data for a 1 kiloton bomb, recalling that only one-half of the particles are emitted into a direction where they can be carried by the magnetic field to the opposite hemisphere, and taking an area of incidence of approximately 1000 km^2, we derive the following electron density produced by the incidence of beta particles: about 2 x 10^8 per cm^3 in the region 50 to 100 km. This process requires in the order of 1 to 2 seconds.

It is followed a few seconds later by the arrival of the fragments. Detailed theoretical investigation reveals that their impact leads first to a compression of the ionosphere correlated with the ionization of the neutral components of the upper atmosphere. We are left then with an electron density of about 3 x 10^9 per cm^3 in the region of 100 to 200 km.

•**Removal of electrons**—The ionospheric problems raised by atomic bursts are very similar to those en-

(Continued on page 41)

TABLE 1. PROPERTIES OF "NORMAL" ATMOSPHERE

ALTITUDE (km)	TEMPERATURE °K	N_2 cm^{-3}	O_2 cm^{-3}	O cm^{-3}	Ne cm^{-3}
50	270	2.0×10^{16}	0.5×10^{16}	.....	.....
60	253	5.8×10^{15}	1.5×10^{15}	.....	.....
75	203	7.6×10^{14}	1.9×10^{14}	.....	.....
100	210	4.3×10^{12}	8.5×10^{11}	1.7×10^{12}	5×10^5
200	900	2.0×10^9	1.9×10^8	7.8×10^9	2×10^6
300	1400	9.8×10^7	6.5×10^6	1.2×10^9	2×10^6

TABLE 2:
UPPER ATMOSPHERE IONIZING AND DE-IONIZING REACTIONS

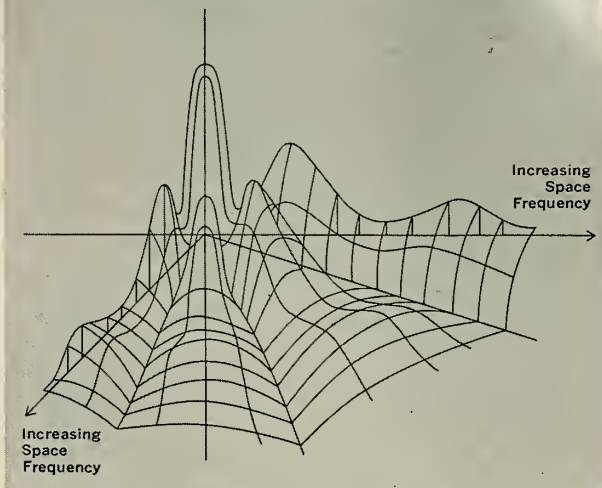
1. PHOTOIONIZATION: Creation of an electron-ion pair by absorption of an ultra-violet photon; e.g. O + photon → O^+ + e
2. IMPACT IONIZATION: Creation of an electron-ion pair by the impact of a very fast particle; e.g. N_2 + fission-fragment N_2^* + e + fission fragment
3. ATTACHMENT: Capture of a free electron by a neutral atom or molecule, mainly O_2; e.g. O_2 + e → O_2^-. The rate coefficient for this reaction is 10^{-13}—10^{-14} cm^3/sec.
4. PHOTODETACHMENT: Detachment of an attached electron by the absorption of a photon; e.g. O_2^- + photon → O_2 + e
5. DISSOCIATIVE RECOMBINATION: Capture of a free electron by a positive molecular ion, followed by dissociation of the molecule; e.g. N_2^+ + e → N* + N*. The rate coefficient is 3×10^{-8} cm^3/sec. which is quite large & gives a fast reaction.
6. RADIATIVE RECOMBINATION: Capture of a free electron by a positive atomic ion, followed by emission of a photon; e.g. O^+ + e → O + photon. The coefficient is 10^{-12} cm^3/sec. which is quite small; hence the reaction proceeds slowly.

Nuclear Reactor in Space

It is interesting to consider the artificial radiation belt produced by operating a nuclear reactor, e.g. in a communication and reconnaissance satellite. If the reactor's power level is 100 kilowatts, and its orbit 1000 miles above the equator, then the following estimates apply: Number of uranium fissions about 6 x 10^{15} per second, which also gives roughly the number of escaping neutrons.

Assuming these to be of thermal energy then, they travel an average distance of 200 miles before decaying radioactively into an electron and proton. The electrons are released with a mean energy of 0.5 Mev into a volume around the earth of about 6 x 10^{25} cm^3. Taking a lifetime of a few days, their concentration builds up to 10^{-4} per cm^3, but their flux will be something like 10^6 per cm^2 per second, 100 times greater than the maximum flux of the natural radiation belt.

Fortunately it is easy to shield against 0.5 Mev electrons; the reactor therefore produces no hazard. However, the phenomenon of trapped radiation can be used to detect the existence of an orbiting nuclear reactor.



Phosphor bronze reticle (actual size) and space frequency transfer characteristics of circular aperture reticle.

TARGET DISCRIMINATION IN INFRARED DETECTION SYSTEMS

The pioneering field of infrared detection offers many challenging opportunities to scientists and engineers at Ramo-Wooldridge for advanced studies in the solution of target discrimination problems. Research is continually under way at Ramo-Wooldridge in the integrating of infrared detection devices with the latest electronic systems techniques for enhanced target detection on the ground and in the air.

The phosphor bronze reticle, or image chopper, illustrated above was developed by Ramo-Wooldridge. It indicates a marked stride in space filtering discrimination concepts, and is used for target signal enhancement in guided missiles, anti-aircraft fire control and air collision warning applications.

The reticle is used in the focal plane of an infrared optical system and is rotated to chop the target image for the desired space filtering. It is also employed in time filtering, such as pulse length discrimination, or pulse bandwidth filtering.

Space filtering is critical to infrared systems, because of its ability to improve the detection of objects located in the midst of background interference. In a manner similar to that used in the modification of electronic waveforms by electrical filtering, space filtering enhances the two-dimensional space characteristics of a target. The size and features of the target are highlighted and the undesired background eliminated.

Scientists and engineers with backgrounds in infrared systems—or any of the other important areas of research and development listed below —are invited to inquire about current opportunities at Ramo-Wooldridge.

Electronic reconnaissance and countermeasures systems
Analog and digital computers
Air navigation and traffic control
Antisubmarine warfare
Basic research
Electronic language translation
Information processing systems
Advanced radio and wireline communications
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...NEWS IS HAPPENING AT NORTHROP

RADIOPLANE PRODUCES FIRST COMBAT-READY SURVEILLANCE DRONES

NEW SD-1 PROVIDES AN EYE IN THE SKY FOR ON-THE-SPOT BATTLEFIELD SURVEILLANCE

RADIOPLANE

In production and being delivered to the Army Signal Corps in operational quantities, the SD-1 is proved and ready to fly unmanned photo reconnaissance missions for tactical troops. Meeting tough Signal Corps standards, this Radioplane drone exemplifies Northrop Corporation's close cooperation with the U.S. Armed Services. Northrop-Armed Service teamwork provides an early awareness of future defense needs—enables a years-ahead start on vital research and development. Northrop management contributes cost-minded creativity, producing earlier effective answers to international defense problems – delivered at minimum cost.

NORTHROP CORPORATION
formerly Northrop Aircraft, Inc.
Beverly Hills, California

Northrop's N-156F Freedom Fighter is the first multi-purpose jet fighter American-designed for specific tactical and economic requirements of other free nations.

INTERNATIONAL

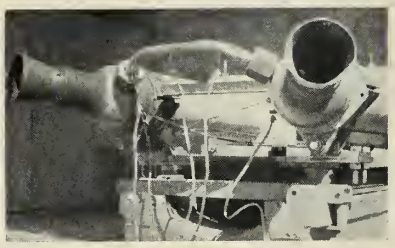
Nortronics Astronertial: the one guidance concept ready now for both interplanetary navigation and for the requirements of today's advanced weapon systems.

NORTRONICS

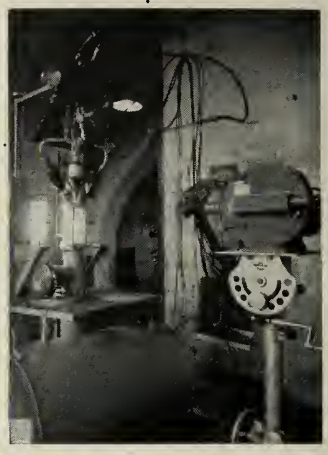
USAF's soon-to-fly T-38 Talon delivers combat-calibre performance at minimum cost; will train America's new generation of supersonic pilots and spacemen.

NORAIR

Test benches for liquid-propellant rockets.



Type 686 solid-propellant rocket.



Ignition test in transparent chamber.

FRENCH ASTRONAUTICS

S.E.P.R. test facilities are believed to be best on Continent; firm builds and tests both solid- and liquid-fueled engines

by Jean-Marie Riche

PARIS—S.E.P.R.—Société d'Etude de la Propulsion par Réaction—is fairly well-known for its unique experience in construction of small biliquid rockets used as booster engines on high-speed jet interceptors ("Trident" and "Mirage"). The extensive work conducted in this field by S.E.P.R. has now reached the production stage with the advent of the company's 841 model for use on the Dassault "Mirage III A" fighters.

Little is known, however, about the activity of S.E.P.R. in the field of solid-propulsion motors—this despite the fact that the company is the only one in Continental Europe to have built solid-propellant propulsion systems with an impulse of more than 100 tons/second, an achievement which is matched in the Old World only by Bristol in England. More than a thousand tests of such systems have now been made by the company, which has consumed more than 200 tons of solid propellants of miscellaneous descriptions.

Created in 1944 to study the techniques of jet propulsion, S.E.P.R. is exclusively a research company and has no facilities for mass production. Its headquarters have been established in a fort at Villejuif, a southeastern suburb of Paris, where all the research on solid-propellant rockets and on special projects (nuclear power, auxiliary powerplants, etc.) is conducted.

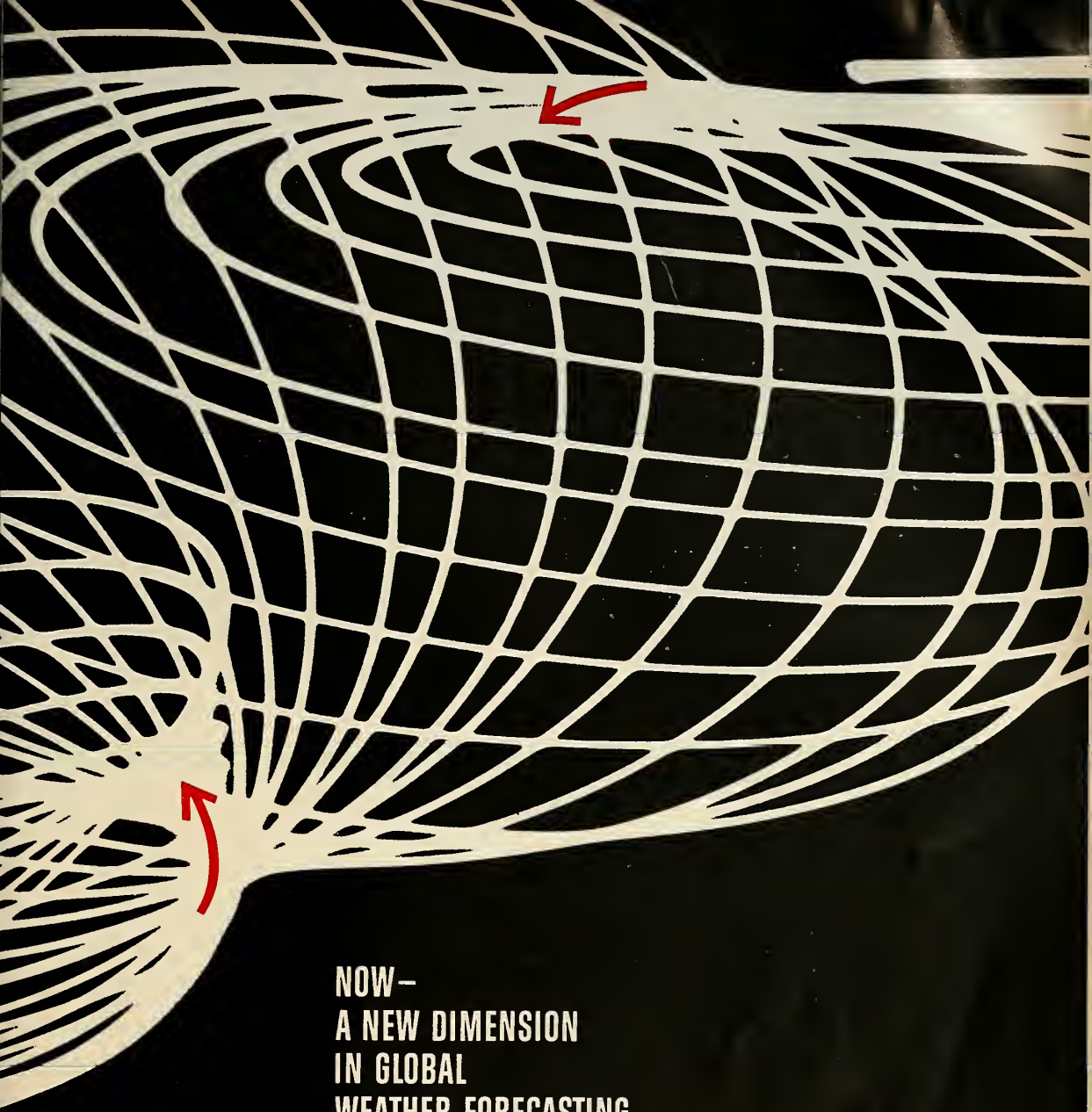
The engines designed at the headquarters are manufactured by a prototype shop in Argenteuil, a western outskirt of Paris. Liquid-propellant engines are tested at the center of Melun-Villaroche, where twelve test benches for propulsion units and six benches to test engine parts are installed. The center of Melun-Villaroche also includes a shop for the assembly and modification of power plants.

• **Heavy testing**—Finally, at the center of Istres, S.E.P.R. has created a maintenance and overhaul plant of aircraft rockets and test benches for solid-propellant engines. The company, which now employs 750 persons, has studied about 70 types of liquid- and solid-propellant engines. In addition to the tests conducted with solid-propellant rockets, 12,000 tons of nitric acid have been consumed during 45,000 tests with liquid-propellant engines.

The testing facilities of S.E.P.R. are believed to be unequalled on the continent. Besides benches for the measurement of thrust, the company operates stoves and cold chambers allowing tests between −22°F and +140°F, and acceleration benches on which 20g can be reached with a 330-lb. propulsion unit.

The company has built many measuring instruments whose precision and resistance are unique among products of the French industry.

S.E.P.R. is financially controlled by Sud-Aviation, the biggest French aircraft manufacturing company; Hispano-Suiza, an aircraft engine manufacturing company, and two of the main groups of the French chemical industry—Ugine and Air Liquide. The company does foreign (German, Italian) as well as French business.



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A NEW DIMENSION IN GLOBAL WEATHER FORECASTING

HIGH-SPEED BURROUGHS ELECTRONIC TELEPRINTERS ANSWER VITAL DEFENSE NEED

The instantaneous dissemination of up-to-the-minute and ever-changing weather data to the world-wide bases of the United States Air Force is a must in this space age. And the new Burroughs Electronic Teleprinter operating at speeds beyond 2,000 words per minute plays a key role in the Air Force's 433L Weather Observing System. Proof again of Burroughs leadership in another all-vital area of defense: high speed communications.

Burroughs Corporation

"NEW DIMENSIONS / in computation for military systems"

MOMENT IN HISTORY

THIS IS THE "FIRST FLIGHT" of the new Air Force TITAN, America's most powerful weapon and our No. 1 challenger in the big-missile field. Time: 2/6/59—4:22 p.m. EST.

The most important thing about this moment in history is not visible here—and it is this:

Three years to the day from the breaking of ground at Martin-Denver, TITAN No. 1 roared into the sky. Those 36 months saw the creation of the free world's most advanced ballistic missile facility—and the development, production, testing, delivery and launching of the first of an entirely new *generation of ballistic missile weapon systems, forerunner of the Global Ballistic Missile.*

TITAN is the result of an advanced engineering concept—developed by Martin under the direction of the Air Force's Ballistic Missile Division of the Air Research and Development Command—which provides the most extensive pre-flight testing of components, subassemblies and full scale missiles ever undertaken.

This method in the TITAN development, and in the generations of space systems to follow, may well be one of the most important single factors in speeding America's bid for space supremacy.

Seven Selected for NASA's Project *Mercury* Program

WASHINGTON—The National Aeronautics and Space Administration has reduced the number of astronauts to be used in the Project *Mercury* Man-In-Space program from twelve to seven.

NASA emphasized that the reduction was not caused by any unwillingness on the part of the candidates to take part in the program or because of difficulty in finding a greater number of qualified men.

A smaller number of astronauts was found to be desirable, NASA said, so that each could receive intense instruction in the engineering and scientific development of the vehicles, in the sub-orbital buildup missions, and in the techniques of the actual manned satellite flight.

The candidates were tested at the Lovelace Clinic in Albuquerque, N.M., and at the Wright Aeromedical Laboratories at the Wright-Patterson AFB. The seven astronauts will report in the near future to the Space Flight Activity at the Langley Research Center.

Tiny Photo Cells Provide Supersensitivity

NEW YORK—Small photo cells, one-quarter inch in diameter and one million times more sensitive than conventional vacuum tube types, will soon be produced by Clairex Corporation of Puerto Rico.

A. F. Deuth, president of Clairex Corporation, listed 12 different fields of application for the tiny photoconductors, including computers and data processing, industrial controls, medical electronics, aircraft and missiles.

Deuth predicted wide use of the new cells in photography. He noted that existing photo exposure meters and controls employing conventional photovoltaic cells have not kept pace in sensitivity with improvement in speed of films. However, he said a light sensitivity of greater than ten times is easily achieved with the Clairex cell, providing a sensitive area of less than 1/100 of the conventional type.

Polaris Test Amplifier Called World's Largest

BALTIMORE—A tremendous amplifier, capable of vibrating at predetermined frequencies, has been built for testing *Polaris* missile parts, Westinghouse Electric Corporation announced.

Described by its makers as the world's largest and most powerful amplifier, it has an output capacity of 200,000 watts and is valued at more

than $100,000. It weighs approximately 10 tons and is 24 feet long, 7 feet high, and 3 feet wide.

W. J. Delaney, Jr., manager of the company's X-ray and industrial electronics division here, said the amplifier will be used by Lockheed Aircraft Corporation at its Sunnyvale, Calif., plant for testing components and sub-assemblies of the Navy's *Polaris*.

Instead of being connected to a conventional speaker system, the amplifier will cause a platform to vibrate. This platform is three feet in diameter and is arranged so that missile parts can be attached. It vibrates at the required frequencies for the same reason that the cone in a loudspeaker vibrates to produce sound.

Recorder Operates Far below Sea Surface

WESTBORO, MASS.—Development of an instrument that detects and graphically records underwater information has been announced here by Alden Electronic and Impulse Recording Equipment Company, Inc. Known as the "Precision Graphic Recorder," the device can be operated thousands of feet below the surface, according to the company.

The Woods Hole Oceanographic Institute, Woods Hole, Mass., aided in development of the instrument, which can be used in detection of submarines, studying temperatures and the formation of the ocean floor, and locating mineral and oil deposits. Details of the device were not described, but the company said "unusual techniques" of the recorder would make it useful in such fields as radar, ultrasonics, infrared, spectrum analysis, radio astronomy, satellite tracking, and propagation studies.

About the Cover

Titan A-4X is shown roaring off the launch pad April 3 in 300-mile shot testing its first-stage engine.

This was the third "successful" test within two months of the Martin Co.'s ICBM, which is 90 ft. long and weighs 110 tons. Rapid progress has brought *Titan* to the point where second-stage testing is about to start.

Engines for both stages develop 380,000 pounds of thrust and are made by Aerojet-General Corp. They are reported to be capable of pushing the big rocket with a nuclear warhead 9000 miles.

Earlier successful firings came on Feb. 6 and Feb. 25.

Mahon to Demand More *Atlases*

by James Baar

WASHINGTON—Chairman George H. Mahon (D-Tex.) of the House Defense Appropriations Subcommittee favors greatly boosting production of *Atlas* to match Russia ICBM for ICBM during the next four years.

The powerful Congressional leader told M/R the deliberate decision by the Administration not to maintain ICBM parity with Russia would weaken U.S. deterrent power and would tend to shake "our confidence in ourselves and the confidence of our allies in us."

He said his subcommittee when it drafts the defense appropriations bill for FY 1960 would seriously consider adding hundreds of millions of dollars for more of the Convair missiles.

• **How much**—Mahon said he has yet to decide how much more he thought should be pumped into the *Atlas* program. But he made unmistakably clear that he favored attempting to match more or less Soviet ICBM production.

A number of key Congressmen—members of the subcommittee as well as others—are known to be deeply worried over the ICBM issue. It could easily result in one of the most momentous debates in recent American history.

The great question that the nation faces is:

• Should the United States use its full productive capacity to turn out *Atlas* in hardened bases to attain ICBM parity with Russia?

• Or, should the United States rely on its overall striking power to deter Russia for the next four years while waiting for the Boeing *Minuteman* to become operational?

Defense Secretary Neil H. McElroy and Gen. Nathan F. Twining, chairman of the Joint Chiefs of Staff, have given the Administration's answer in a series of lengthy appearances before congressional committees in the last few months.

They contend America's overall striking power is great enough and will continue to be great enough to deter Russia even if the Russians use their full capacity to produce ICBM's. This overall power is based primarily on SAC's manned bombers, the nine planned *Atlas* bases, the planned *Polaris* submarine force and the soft IRBM bases in Europe.

McElroy also insists that the defense program was not trimmed to keep it within goals set by President Eisenhower's balanced budget. The Secretary insists that he asked for all the ICBM's he thought the nation needed—and that if he ever thought more were needed he would ask for them.

• **Air alert**—However, McElroy and Twining have said that the threat of Russia's increasing ICBM arsenal may become so acute within a year or so that SAC may have to maintain a 24-hour air alert.

Both also conceded that the United States could approximately match Russia ICBM for ICBM if the *Atlas* program were greatly accelerated.

Convair at present is turning out *Atlas* on only one shift. The company has said it could easily go to two shifts, indicating that production could be doubled.

Twining told the Mahon Subcommittee the principal problems in a speed-up involved training of crews and building hardened bases—not production. However, he said these problems could be overcome if the program were put on a crash basis.

But both Twining and McElroy insisted repeatedly that this course was unnecessary.

• **Increasing danger**—Gen. Thomas S. Power, SAC commander, disagreed. He told the subcommittee America's overall retaliatory power as now programmed over the next four years is deteriorating compared to Russia.

He called for maximum production of *Atlas*, more B-52's and more B-58's and he called for it all faster. He said failure to provide them meant "risking the whole country."

Subcommittee members—already concerned after listening to McElroy—were extremely impressed by Power's statements.

Also, a number of Congressmen have been questioning privately and publicly the validity of claiming the *Polaris* submarine and overseas IRBM bases as plus factors in estimating overall U.S. retaliatory power. They argue the *Polaris* is still unproven and the soft IRBM bases are easy targets for Soviet medium range missiles.

Finally, they stress that deterrent power no matter how great is obviously only successful if it deters.

They argue the United States may be cutting the margin of deterrence too thin for comfort by holding down ICBM production. And that even if the margin isn't too thin, Russia might think it is.

"The psychological factor is extremely important," Mahon said. "It isn't good to be behind."

"COMPUTER PROGRAMMING *at SDC is a fundamental discipline rather than a service. This approach to programming reflects the special nature of SDC's work—developing large-scale computer-centered systems.*

"Our computing facility is the largest in the world. Our work includes programming for real time systems, studies of automatic programming, machine translation, pattern recognition, information retrieval, simulation, and a variety of other data processing problems. SDC is one of the few organizations that carries on such broad research and development in programming.

"When we consider a complex system that involves a high speed computer, we look on the computer program as a system component—one requiring the same attention as the hardware, and designed to mesh with other components. We feel that the program must not simply be patched in later. This point of view means that SDC programmers are participants in the development of a system and that they influence the design of components such as computers and communication links, in much the same way as hardware design influences computer programs.

"Major expansion in our work has created a number of new positions for those who wish to accept new challenges in programming. Senior positions are open. I suggest you write directly to Mr. William Keefer at the address below. He is responsible for prompt response to your correspondence."

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Senior Computer Systems Specialist

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PMR Investment to Reach $250 Million In 1962

Extra $75 million probably will be funded in next two years for base construction

by Robert Mount

VANDENBERG AFB, CALIF.—Investment in the development of this first operational ballistic missile base of the Strategic Air Command will reach a quarter of a billion dollars by the end of 1962, including construction of at least 26 pads.

The disclosures were made during a recent meeting here where published charges of waste were refuted by Rep. Charles M. Teague of California's Thirteenth District, and Maj. Gen. David Wade, Commander of the First Missile Division at Vandenberg. Assisting with presentation of data to newsmen and local civic leaders were Col. W. E. Leonhard, Deputy Director of Installations, AFBMD, and Col. C. T. Newton, Los Angeles area district engineer, Corps of Army Engineers.

Of chief interest were reports that all overtime salaries to date total only about one percent of total salary expenditures, and that contingency allowances of 10 to 20% over base contract costs have been exceeded only on one Vandenberg contract. In that instance, the contingency costs were about 30%.

The impact of Vandenberg on the area was illustrated by the disclosure that there are now 11,000 persons at the base and the number is rapidly increasing. Those employed at present include some 4000 to 4500 military, 3000 construction and 2800 technical contractor personnel. General Wade told newsmen he sees "no end to the construction program."

He pointed out that projects in the works or in planning stages include *Thor, Atlas, Titan, Minuteman,* and later programs. Reports distributed to newsmen also listed *Sentry* pads, now under construction for the Air Force and ARPA by the Eleventh Naval District at the Naval Missile Facility, Point Arguello. Works already in the ground are valued at $77.7 million. By the end of the current fiscal year, the total cost will be $173.1 million. Another $75 million probably will be funded in the next two years, according to Col. Newton.

• **Spending breakdown**—Of the $173.1 million total, $113.9 million is for technical facilities, $32.7 million for base support, and $26.5 million for family housing. Of interest economy-wise was the total pre-bid estimate of work now under contract, $109.1 million against the actual bids of $98 million, indicating a paper saving of about $11 million.

Programs discussed included:

Thor—Two wet pads and five dry pads. Total cost $6.2 million. Two static captive firing stands complete, three operational training stands complete, two special purpose stands for *Thor* boosted vehicles complete.

Atlas—Three wet pads and seven dry pads. Total cost $59.7 million. Three launch stands complete, now

100 CPS X-Y RECORDING

with immediate readout

THE NEW SANBORN MODEL 670 OPTICAL X-Y RECORDER HAS

- 1% linearity
- frequency response 3 db down at 130 cps independent of amplitude
- writing speeds to 2500 in/sec.
- 8" x 8" direct print paper chart
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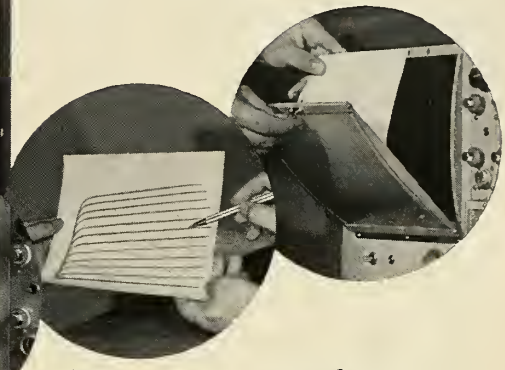
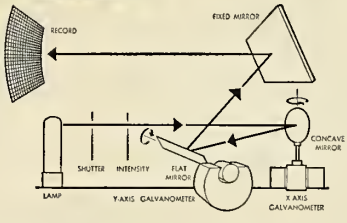




X-Y RECORDING never before possible with electro-mechanical instruments can now be done with the new Sanborn Model 670 X-Y Recorder. Direct writing on ultraviolet-sensitive recording paper by a beam deflected by optical galvanometers makes possible the combination of fast writing speed and 130 cps frequency response not found in any other X-Y recorder. Transistor characteristics, acceleration and vibration of mechanical parts and events of similar short duration can be recorded with linearity of *1% of full-scale* and at trace speeds as fast as *2500 inches per second*. Square wave response exhibits no greater than ½% overshoot *at any amplitude;* sensitivities as high as 62.5 uv/inch (depending on preamplifier used).

PLOTS OCCUPY AN 8" x 8" RECORDING AREA and can be previewed or monitored on the instrument's phosphorescent screen. An Axis Record switch to print X and Y axes on the record, and a Beam Intensity Control to assure maximum trace clarity, are among the front panel controls provided. An 8" x 8" sheet of the ultraviolet-sensitive chart paper (stored in drawer at base of cabinet) is easily placed on the back of the hinged screen. Brief post exposure in normal room light is the only developing process.

OPTIONAL INTERCHANGEABLE PREAMPLIFIERS for each axis presently include the Model 850-1300B DC Coupling and Model 850-1200 Phase Sensitive Demodulator; a Carrier Preamplifier, High Gain Preamplifier and a time base generator are now in development. Driver Amplifiers are compact, fully transistorized plug-in units with single-ended input and output. Galvanometers are low resistance, low voltage units of rugged, enclosed construction; sensitivity and damping are independent of coil temperature. Accessible, unitized circuitry also extends to the power supplies—a front-panel plug-in for both preamplifiers and a second supply for both driver amplifiers. A built-in blower provides constant, forced filtered air cooling. The Recorder can be rack mounted in 15¾" of panel space, or housed in its own 20" x 20" x 21¼" optional portable cabinet.

Ask your local Sanborn Sales-Engineering Representative for complete information on the Model 670 X-Y Recorder, or write the Industrial Division in Waltham, Mass.

SANBORN COMPANY

INDUSTRIAL DIVISION

175 WYMAN STREET, WALTHAM 54, MASS.

being checked out to be ready July 1. Three launch stands to be completed soon, technical equipment installations begun. Four launch stands being designed.

Titan—Two soft launch and two hard launch pads. Total program cost $28.3 million. Two soft launch silos and support facilities under construction. Two additional training silos—believed however not for operational use and probably incomplete—planned.

Research and development facilities program, cost $19.8 million, includes: 1. Tracking and telemetry station, $2.6 million under construction; 2. Launch facility No. 1 at Point Arguello—two launch stands, operations bldg. & utilities costing $6 million, an ARPA project (listed in report as Project *Sentry*); 3. Launch facility No. 2 at Vandenberg—three launch stands and service buildings, one block house, complex service building, vehicle storage building, power, utilities and roads. Cost $7.5 million. [Although this project was not identified, it might be for *Minuteman,* which was mentioned by General Wade. Design, scheduled to start this month, would appear to fit the *Minuteman* schedule. Instrumentation and range safety system cost $3 million, for which construction of major units is virtually complete.]

AEC is Recovering Valuable Cerium 144

WASHINGTON—The Atomic Energy Commission has announced that it is now producing, on a routine basis, nuclear heat sources for use with small thermoelectric generators. (Partial breakthroughs have been indicated recently by several manufacturers in development of this type of generator, which will be used in satellites and future spacecraft to operate equipment requiring low power, long life, and high reliability.)

At its Oak Ridge, Tenn., Laboratory, the AEC is separating several different radioactive materials from what otherwise would be waste products of nuclear reactors.

One is Cerium 144, which is preferred over deadly Polonium 210.

Last January, the White House exhibited a five-pound device called Snap III. Heat from radioactive polonium stimulated a flow of electricity in thermocouples. Although it had a capacity of five watts, this early device had two serious faults: Polonium 210 is an extremely poisonous substance and its half-life is only 140 days.

Despite short life, the polonium generator was said to be able to produce as much electricity in 280 days as 1450 pounds of the best conventional batteries. The AEC also said the polonium was welded into a rupture-proof capsule that made the device completely safe to handle.

The commission conceded, however, that Cerium 144 would be a better material. Cerium's half-life is 285 days, and it can be capsuled in an insoluble ceramic form that enhances its safety. The AEC in safety tests has fired welded capsules of cerium against granite without breaking them.

Cerium 144 and other materials are being separated from radioactive waste at AEC's new $2.2 million fission products pilot plant.

The commission said operations "currently are directed toward large-scale concentration" of cerium as a source of "auxiliary electric power for space missiles." The commission is offering radioactive materials from the Oak Ridge plant for peacetime applications at prices about 10% of those formerly in effect.

NASA Reports Successful 5-Stage Sounding Rocket

WASHINGTON—Using off-the-shelf components, the National Aeronautics and Space Administration has developed a five-stage solid-fuel sounding rocket capable of boosting 25 pounds to 525 nautical miles and 100 pounds to 300 nautical miles.

The first-stage motor of the vehicle is an *Honest John* JATO unit M6. The second- and third-stage motors are *Nike* missile boosters, JATO unit X216A2. The fourth-stage rocket motor is a *Recruit*, JATO unit XM19, and the fifth-stage is a JATO unit T55.

A recent paper by Andrew G. Swanson of NASA's Langley Research Center states that several successful operational firings of the new rocket have been made at Wallops Island.

The rocket was launched at an 80° elevation angle with a 49-pound payload and reached a measured apogee of 409.8 nautical miles.

A higher altitude was not attained, according to Swanson, because deviations from the flight path due to wind and thrust misalignments caused the flight path to be slightly lower than nominal value.

The nominal stage impact points for the rocket in a no-wind trajectory would be three miles for the first stage, 5 miles for the second, 60 miles for the third, 200 miles for the fourth, and 500 miles for the fifth.

Velocity of the vehicles was 13,150 fps at fifth-stage burnout and axial accelerations with the 49-pound payload were from 70g to 120g.

Operational capability of *Snark* again was checked out successfully April 7 with combat troops performing the launch from Cape Canaveral. Missile made programmed flight to Ascension Island in about eight hours —covering 5,000 miles at 700 mph.

Contractors undertaking research involving advancement of the state-of-the-art are assuming a calculated risk, the Armed Services Board of Contract Appeals has ruled. Failure to come up with a breakthrough can mean they have failed to fulfill the contract. ASBCA made this finding in holding that Aerosonic Instrument Corp. had defaulted on an AF contract to design a portable tester. Aerosonic was unable to meet weight specifications set by the AF.

The Commerce Department's Office of Export Supply has placed Raytheon Mfg. Co. on 12 months probation. Action stems from an investigation of export of television microwave link equipment and parts to Pye Telecommunications Ltd., Cambridge, England, and subsequent trans-shipment of some of the goods to "unauthorized" destinations.

Boron hydride authority Dr. Hermann I. Schlesinger of the University of Chicago has won the American Chemical Society's 1959 Priestly Medal.

Summer school: Yale's Dynamical Astronomy four-week course opens July 6. Registration deadline is April 30. A 10-day Army R&D-sponsored missile and rocket technology institute starts July 26 at the University of Connecticut.

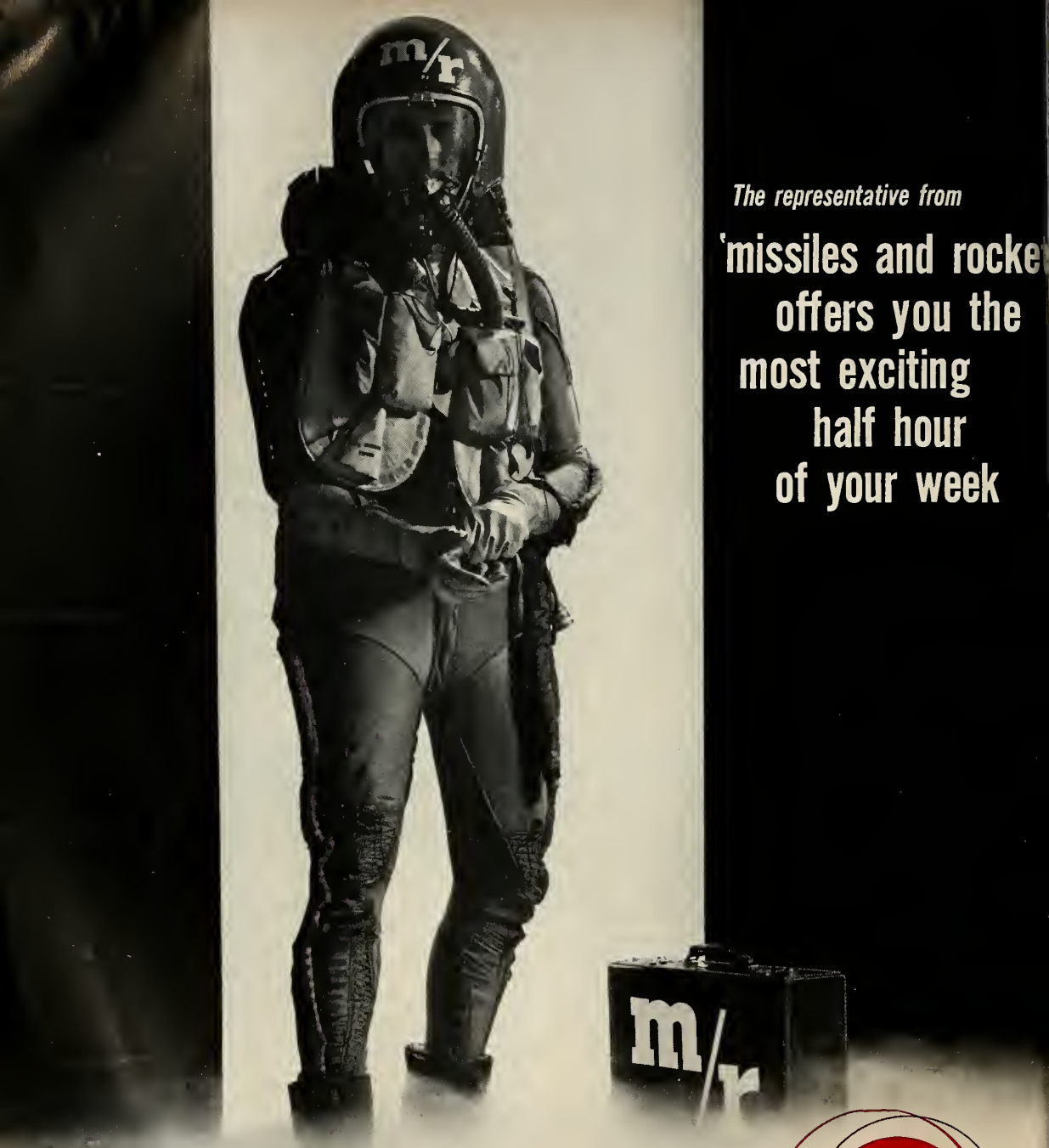
On April 25, the Roswell, N.M., Museum and Art Center is dedicating its new Rocket and Space wing to rocket pioneer Dr. Robert H. Goddard.

General Electric is selling its plastics plant at Taunton, Mass., and the equipment and business of its Decatur, Ill., operation to Haveg Industries, Inc., of Wilmington, Del. Transaction means GE is withdrawing from the custom molded plastics field.

Direct conversion of nuclear energy into electricity with plasma thermocouple has been achieved by AEC in container the size of a frozen orange juice can. Unit produced by SNAP (Systems of Nuclear Auxiliary Power) program is improvement on earlier SNAP III. It could be unlimited power source for spacecraft. Output of 3.8 volts was generated by inserting uranium-enriched rod in vaporized cesium and bombarding entire unit with neutrons in a reactor. AEC also has unveiled a Martin-designed SNAP-powered radio station (W8NPC, 29.06 mc). Generator uses Plutonium 210 as did SNAP III, but is lighter and 5-6½% more efficient.

"Substantial" number more *Thor-Able* tests are likely despite first nose cone recovery on 12th shot, which went 5,000 miles April 8. Miniaturized cone was made of reinforced ceramic-AVCOite.

A contract of unspecified amount has been awarded Sylvania's Electronic Systems division by the Rome, N.Y., Air Development Center to study methods of defensively classifying and tracking enemy ICBM's.



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missiles and rocke

AMERICAN AVIATION PUBLICATIONS,

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(Continued from page 24)

countered by upper atmosphere physicists who study (1) the normal ionosphere, (2) the ionosphere disturbed by ultraviolet radiation from solar flares which gives occasional radio blackouts, and (3) the ionosphere disturbed by the incidence of a large flux of charged particles from the sun, for example by low-energy cosmic rays.

The fundamental atomic processes which enter, such as ionization, recombination, attachment and detachment of electrons are basically the same as for the normal ionosphere (See Table 2). The difference in the atomic burst case is mainly due to the fact that the source function occurs very suddenly and then disappears, and that the removal processes of electrons follow thereafter.

Because of the extremely high electron densities encountered, it is quite permissible to neglect the normally existing electron densities, and this simplifies the problem to some extent.

Table 1 collects the important and pertinent data about the concentration of nitrogen and oxygen molecules, oxygen atoms, and of electrons in the upper atmosphere. From these data we can draw some immediate conclusions concerning the fate of the electrons. Table 2 defines some atomic processes which can change the electron density and gives their rate constants.

Below 100 km, we can see immediately that the electrons must have been produced by ionization of oxygen and nitrogen molecules. But only a small percentage of these has been destroyed, most of the oxygen molecules for example are still left intact. Hence there will be two competing processes which remove electrons: (1) A fast process of recombination with molecules. (2) Attachment of the electron to an oxygen molecule; this does not really remove it permanently but, so to speak, stores it and makes it ineffective as far as radio propagation effects are concerned.

At 65 km, however, and at altitudes below this level, attachment begins to predominate over recombination and we are therefore faced with the problem of electrons surviving for longer periods of time. From the attached condition they can be released either by a collisional detachment or by photodetachment when they are struck by sunlight.

It is conceivable therefore that electrons could be stored overnight and then released by the sun. However, since there is no further source of supply at the time they will of course quickly recombine.

We can easily show that *dissociative recombination* removes electrons very rapidly at all altitudes up to about 150 km. But at the very highest altitudes there are not enough molecules left for this process since most of the ionization came from the more abundant oxygen atoms. This depletion of molecules then means that *radiative recombinations* are the only means for removing particles and these proceed at a very slow rate. Therefore high electron densities may persist at altitudes of 200 km for some considerable time.

This slow recombination rate at 200 km explains why we observe an ionosphere at night when the sun's ultraviolet radiation is absent and no further ionization is produced.

• **Countermeasures**—This suggests a possible countermeasure to the high electron densities, namely the release of molecules by artificial means, for example by containers carried up into the high atmosphere with small rockets. These molecules will quickly scavenge or sweep up the free electrons.

We have made some estimates on the possibility of neutralizing the high electron density by the release of nitric oxide. Unfortunately large quantities are necessary. Ideally one would like a catalyst which speeds up recombination without being used up. Here is a field where additional research might be very fruitful.

In the meantime we must examine how we can circumvent the high altitude electron clouds by electronic means.

If complete ionization at 100 km were possible, leading to about 6 x 10^{12} electrons per cm^3, then serious difficulties could arise; but at low altitudes most of the electrons will be removed quickly by dissociative recombination and by attachment.

At higher altitudes the electron densities could be 10^9 to 10^{10} per cm^3, i.e. 1000 to perhaps as much as 10,000 times higher than the normal electron densities.

But their effects, even if they were to persist for long times, will be serious only for low-frequency communications and radar gear. The frequencies affected will be in the range of 100 to 1000 megacycles; at much higher frequencies there should be little interference with radar defense against missiles.

contract awards

NASA

WASHINGTON—The civilian space agency announced it would buy liquid hydrogen for rockets from the **Linde Co., Div. of Union Carbide Corp.**, for the next five years. Although no guaranteed amounts were given in the contract, it could total more than $1,000,000 annually.

Linde agreed to finance expansion of a plant at Torrance, Calif., to supply NASA's requirements.

Consolidated Systems Corp., Monrovia, Calif., subsidiary of **Consolidated Electrodynamics Corp.**, received a $348,700 NASA contract for an automatic data-recording and monitoring system to acquire and process data from rocket motors being tested by JPL at Edwards AFB.

Other awards:

ARMY

$6,372,000—**Western Electric Co., Inc.**, for R&D on *Nike-Zeus* program (Bell Telephone Laboratories, Inc., will carry out work).

$5,044,080—**Firestone Tire & Rubber Co.**, for guided missile artillery.

$2,687,725—**Western Electric Co., Inc.**, for *Nike* spare parts and components (18 contracts).

$2,645,000—**North American Aviation, Inc., Rocketdyne Div.**, for rocket engines.

$2,078,000—**The Martin Co.**, for continuation of R&D on *Pershing*.

$984,000—**Avco Manufacturing Corp.**, for research in re-entry physics.

$657,296—**Raytheon Manufacturing Co.**, for electronic assemblies for *Hawk*.

AIR FORCE

$4,000,000—**Goodyear Aircraft Corp.**, for *Atlas* ground support and launching equipment (add-on orders from Convair).

$2,000,000—**Marquardt Aircraft Co.**, for radar signal simulators.

$1,324,172—**International Business Machines Corp.**, for SAGE data processing equipment.

$752,000—**IBM**, for study for SAC Subsystem 438L.

$491,174—**Hewlett-Packard Co.**, Palo Alto, Calif., for various electronic items.

$300,000—**Bogue Electric of Canada, Ltd.**, Ottawa, for power supplies for SAGE data processing equipment (subcontract from Burroughs Corp.).

$211,275—**Ampex Corp.**, for tape recorder/reproducer, components and spare parts.

$116,630—**Boeing Airplane Co., Pilotless Aircraft Div.**, for technical data for *Bomarc* components (two contracts).

(Sylvania Electric Products, Inc., received a contract from the Rome Air Development Center for ICBM detection study. Amount was not disclosed.)

(Avion Div., ACF Industries, Inc., received an ARDC contract to study detection of infrared radiations from satellite vehicles. Amount was not disclosed.)

NAVY

(RCA received a contract totaling several million dollars for development of new communications systems for submarine-based *Polaris* missiles. Exact amount was not disclosed. Work will last several years and involve a number of subcontractors.)

$1,000,000—**American Potash & Chemical Corp.**, for ammonium perchlorate (letter of intent).

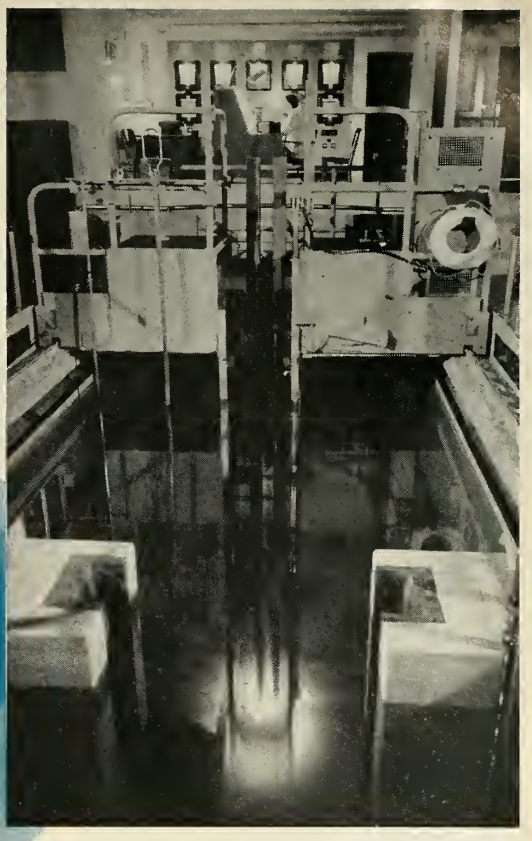
$391,938—**New Mexico State College**, for research on the upper atmosphere.

$209,373—**Cooper Development Corp.**, Monrovia, Calif., for research on measurement of solar flare phenomena.

$172,121—**Technical Appliance Corp.**, Sherburne, N.Y., for Minitrack satellite tracking system.

$106,639—**Raytheon Manufacturing Co.**, for 66 man-months of engineering services to support *Sparrow III*, and associated equipment.

$103,591—**Barnes Engineering Co.**, Stamford, Conn., for design, test and production of three models of an infrared free air thermometer system.



Ford Nucleor Reactor at
the University of Michigan

COMMUNICATION SYSTEMS

that resist nuclear radiation

Positive and reliable communications are the lifelines of new strategic weapons, hypersonic aircraft, satellites, and air defense. Resistance to nuclear radiation damage is an additional prerequisite for some of these advanced weapon systems.

The Bendix Systems Division, using the Ford Nuclear Reactor at the nearby University of Michigan, is developing radiation-resistant Mission and Traffic Control equipment. This work is being conducted by Bendix as a contractor to the Air Force. The objective is an M&TC subsystem providing extreme reliability under severe environmental conditions and over long operating periods.

Hypersonic aircraft and re-entry vehicles require that communications overcome the attenuation of surrounding ionized air. Bendix is carrying out propagation investigations and experimenting with designing special digital and voice communication systems. This work is under way at the Systems Division. Radio Division, and Pacific Division of the Bendix Aviation Corporation.

Positive communications also require resistance to jamming. Advanced research at the Bendix Systems Division has evolved techniques that combine jamming resistance and security of transmission.

Advanced communications know-how is being applied to additional programs for which the Systems Division has system management and engineering responsibility—such as the Navy EAGLE System and the Air Force AN/AMQ-15 Weather Reconnaissance System—and is applicable to many others.

Bendix Systems Division
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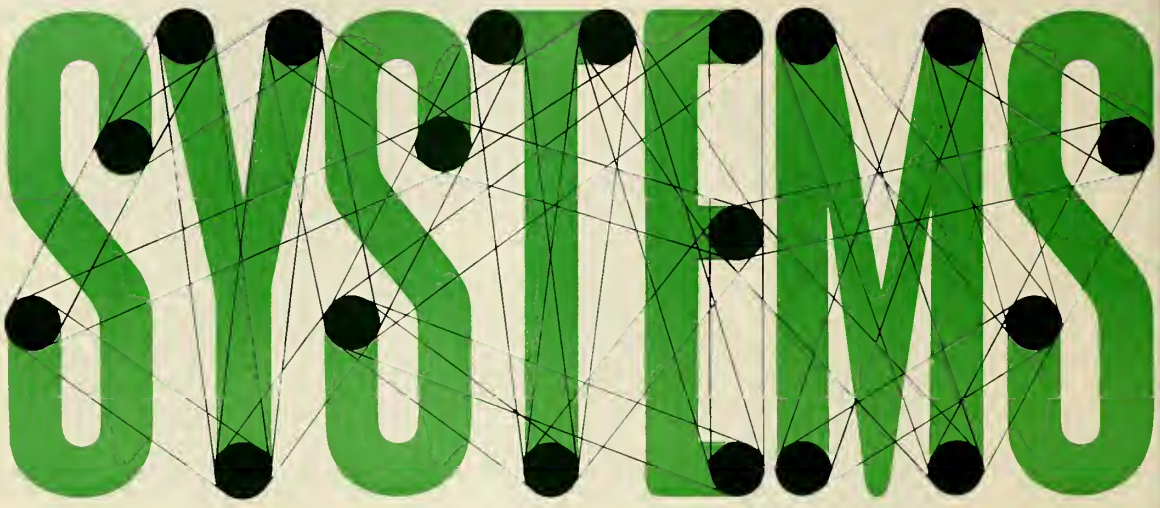

Electronic systems engineering covers the full spectrum of applied research and development at IBM. With this broad, flexible range, and IBM's outstanding resources and facilities, your own imagination and creativeness will find unusual opportunity for expression. Currently, IBM engineers and scientists concerned with broad systems problems in business, science and government are working toward self-optimizing computers. These computers may some day program themselves and arrive at the one solution to a problem. Digital computers are being applied to simulate all the problems of a business firm operating under specified economic and statistical conditions. Progress is being made in advanced studies for radically different data systems for terrestrial and stellar navigational problems. For problems like these, and many others, IBM needs people who want to convert challenges into careers.

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people

The National Aeronautics and Space Administration has named 13 government, university and industrial scientists to two working groups which will correlate research propects with future satellite and space probe payloads.

One group, charged with the problem of orbiting astronomical observatories, will be headed by **Dr. Nancy Roman** of NASA, and includes **Dr. J. E. Kupperian,** NASA; **Dr. A. Code,** University of Wisconsin; **Dr. L. Goldberg,** University of Michigan; **Dr. A. B. Meinel,** Association of Universities for Research in Astronomy, Inc.; **J. E. Milligan,** NASA; **Dr. L. Spitzer,** Princeton University, and **Dr. F. L. Whipple,** Smithsonian Astrophysical Observatory.

This group will explore X-ray, ultra violet and infrared regions of the electromagnetic spectrum.

The other group, working on the problem of orbiting satellite ionospheric beacons, will be headed by **J. C. Seddon** of NASA, and includes **Dr. C. G. Little,** National Bureau of Standards; **Dr. W. J. Ross,** Pennsylvania State University; **Dr. G. W. Swenson,** University of Illinois, and **Dr. O. G. Villard,** Stanford University.

This group will study the distribution of electrically-charged particles and electron concentration in the ionosphere, and will work to put multi-frequency radio beacons into a 200 to 500 mile orbit.


THIEL

Dr. Adolph K. Thiel has been appointed Program Director for Space Missions, Space Technology Laboratories, Inc. Formerly director of the *Thor* Program Office, Thiel, 44, will direct STL programs including fabrication, assembly and flight test responsibilities associated with space projects.

Appointment of **D. Brainerd Holmes** as Manager, BMEWS, has been announced by Missiles and Surface Radar Division, Radio Corp. of America. He will coordinate design, development and production phases of the Ballistic Missile Early Warning System.

Robert W. Bratt is chief of Douglas Aircraft Company's new $10-million Aerophysics Laboratory and **Dr. James S. Murphy** has been named assistant chief. The new center will be utilized in high-speed research on missile development as well as commercial and military aircraft.


MURPHY

meeting of minds

to find the means...

Recent contributions of the Aeronautical Division of A. O. Smith include assignments in research and/or production for the Atlas, Polaris, Jupiter, Nike-Zeus and Vanguard projects. A. O. Smith has also helped pioneer heat exchanger design for nuclear seaborne vessels.

A. O. Smith Aeronautical Division continues to demonstrate unique capabilities to work with research and development groups in government agencies and prime and sub contractors in the airframe, propulsion and missile fields.

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propulsion engineering

Vast increases in I_{sp} into ranges recently considered impractical, will soon be revealed by a fairly new propellant company that has been working with aluminized perchlorates. The company won't say whether these perchlorates are involved with the radically new fuels it has developed. The propellants will be solids.

Long-duration solids for Navy use will also be announced by the same firm. Additives will at least triple and quadruple present burning time, a company official says.

Metal particles 1000 times smaller than any previously produced are paving the way for wide use of metal as additives to solid propellants. National Research Corporation is considering putting its process for making extremely fine aluminum powder into commercial operation. So far, NRC has produced aluminum, iron and nickel particles a millionth of an inch in diameter. The chemical industry wants the iron and nickel powders, as well as aluminum, for catalysts in commercial operations.

Super insulation race is on in earnest. National Research Corporation has revealed a lightweight cryogenic insulating powder it says is 15 times better than any powder announced so far. Until now, the record has been held by Linde Company with a powder 26 times more effective than vacuum insulation (Propulsion Engineering, April 6). Neither firm will reveal details. However, it's known that both systems involve very fine powders (for point contact to reduce heat flow) in combination with high vacuum. NRC points especially to the newest material's low density—2.2 lb/ft^3—which makes air transportation of LOX, liquid H_2, etc., more practical.

Make-up of NASA's Chemical Energy Processes Research Advisory Committee has been announced. The 14-chemist committee is headed by Astrodyne executive vice president James A. Reid, formerly a Phillips Petroleum research chemist, later director of research, and high official in the national synthetic rubber program. Other members are: E. J. Froehlich, JPL; David Altman, Aeronutronic Systems; John Drake, Marquardt Aircraft; R. J. Thompson, Rocketdyne; A. L. Antonio, Aerojet; Allen R. Deschere, Rohm and Haas Chemical; Prof. Farrington Daniels, University of Wisconsin; B. H. Sage, Caltech; W. H. Avery, Johns Hopkins Applied Physics Lab; Frank Tanczos, Navy BuOrd; C. M. Hudson, Army Ordnance; John Longwell, Esso Research and Engineering; Marc P. Dunnam, Wright Air Development Command. NASA headquarters staffer chosen as permanent secretary is Harold Hipsher.

Zone refining techniques used to purify germanium and silicon for transistors are now applied by a British firm to purifying organic compounds and liquids. L. Light & Co., Colnbrook, has not applied the technique to fuels, but says it works well on compounds structurally similar to some fuels. To purify liquids, Light first freezes them and then zone-melts these solids.

Mine Safety Appliances Company—a parent of Callery Chemical—has developed a device that detects 0.5-10.0 ppm of UDMH in a plant or at a launching site.

New ozone production details are out and confirm that the National Bureau of Standards technique revealed in this column (March 16) actually will greatly reduce cost. High price has kept ozone in the laboratory and out of large-scale missile development. The process—microwave dissociation of oxygen cooled by liquid nitrogen—resulted from studies on trapped free radicals. The Bureau gives credit to R. A. Ruehrwein and J. W. Edwards of Monsanto Chemical, and J. S. Hashman of Callery Chemical, who were industry guest workers in the Bureau's free radical program.

missile business

by William E. Howard

Moving into the research "gap" in anti-submarine warfare for the Navy are two special task-force-type organizations set up by Lockheed Aircraft and General Dynamics. Both companies will draw on their full resources to tackle the complexities of ASW technology. Lockheed has designated its operations as LAWSO (Lockheed Anti-Submarine Warfare Systems Organization). There is no special name for the General Dynamics program.

LAWSO will function as part of the company's California Division under the overall supervision of Burt C. Monesmith, Lockheed vice-president and divisional manager. Edward M. Davis, former naval officer and chief of Lockheed's advanced ASW design projects for the past nine years, will manage LAWSO. He will have a group of from 12 to 25 specialists who have already put about 18 years and a quarter-million man-hours into investigations in the field.

Lockheed is putting the scientific resources of its four divisions—embracing aircraft, missiles and electronics—at the disposal of LAWSO when specific problems arise. The new unit will be an element of the California division's advanced systems research organization headed by W. H. Statler.

He says LAWSO will make a "complete systems" approach—involving detection, classification, communications, armament, vehicle and logistics support equipment in addition to personnel. Small specialist groups will cover underwater acoustics, nuclear physics, aircraft design and equipment, electronic data processing, electromagnetics, oceanography and related areas.

In the week before LAWSO was announced, Lockheed disclosed that it had acquired control of the Pudget Sound Bridge & Dredging Co. with an eye toward building nuclear-powered ships and providing ground support facilities for missiles and space vehicles. What role this new addition could play in the ASW set up was not specified by the company.

Statler says LAWSO will be seeking balanced systems abilities as a top goal. "Each must function at the optimum level in relation to each of the others." This will entail working with Navy scientific and administrative agencies and with special groups in other companies. Lockheed specialists involved include Vice Admiral A. B. Vosseller, USN (Ret.); and Drs. J. E. Lipp, Lewis Larmore and Leon Aloglu.

Their studies may involve combining weapons with detection and destruction equipment; extra long-range alarm systems and perhaps manned stations on the ocean bottom for biological and "ocean climate" research. Statler says there will not be any large-scale hirings but a few experts are required in oceanography, acoustics and other areas.

General Dynamics, in a somewhat similar organization, has established a company-wide coordinating committee of 20 to 25 persons headed by Lawrence B. Richardson—engineering senior vice-president. The committee is charged with guiding and directing divisional activity in future ASW planning. It assigns responsibility for action. And individual committee members have department command authority to back up decisions with orders, rather than just requests for action. The coordinator for the committee is James G. Wenzel, vice-president of Convair-San Diego.

G-D has had an ASW program group since 1957. The new set up is designed, says Wenzel, to cover the "whole spectrum" of problems in submarines, missiles, electronics, airplanes, surface craft and communications. He adds, "each of our divisions already has made some outstanding contributions in some part of the spectrum—but not all of it." The committee's job is to tie the program together.

A key tool in the program will be a $250,000 underwater acoustic testing laboratory the company is building at its Stromberg-Carlson Division. G-D funded, this will be the nation's largest indoor unit of its kind.

when and where

APRIL

Aeronautical Training Society, 17th Annual Meeting, Desert Inn, Las Vegas, Apr. 16-17.

Institute of Radio Engineers, 11th Annual Southwestern Conference and Electronics Show, Memorial Auditorium, Dallas, Apr. 16-18.

Third National Conference, Aviation Education, Riverside, Calif., Apr. 17-18.

Institute of Radio Engineers, Spring Technical Conference on Electronic Data Processing, Cincinnati Section, Engineering Society, Bldg., Cincinnati, Apr. 21-22.

Institute of Environmental Engineers, 1959 Annual Meeting, La Salle Hotel, Chicago, Apr. 22-24.

American Society of Mechanical Engineers, First National Metals Engineering Conference, Hotel Sheraton-Ten Eyck, Albany, N.Y., Apr. 29-May 1.

American Rocket Society, Controllable Satellite Conference, Massachusetts Institute of Technology, Cambridge, Apr. 30-May 1.

MAY

Air Force Office Scientific Research/-Chemistry Div. and Electromechanical Society, Symposium on Electrode Processes, Philadelphia, May 3-7.

Institute of Radio Engineers, 11th National Aeronautical Electronics Conference, Dayton, Ohio, May 4-6.

Instrument Society of America, 5th National Instrumentation Flight Test Symposium, Olympic Hotel, Seattle, May 4-8.

International Scientific Radio Union, Spring Meeting, Willard Hotel, Washington, D.C., May 5-7.

1959 Electronic Components Conference, Benjamin Franklin Hotel, Philadelphia, May 6-8.

Institute of Radio Engineers, Seventh Regional Conference and Trade Show, University of New Mexico, Albuquerque, May 6-8.

Armed Forces Day, Observances scheduled throughout week of May 9-17.

Aviation Writers Association, 21st Annual Meeting and News Conference, Washington and Willard Hotel, Washington, D.C., May 10-16.

The Atomic Energy Commission, Technical Information Meeting on Test Reactors, National Reactor Testing Station, Idaho Falls, Idaho, May 13-15.

Society of Aircraft Materials and Processing Engineering—Eastern Div., Spring Meeting, Hotel Statler, New York City, May 15.

Society of Aeronautical Weight Engineers, 18th Annual National Conference, Hotel Henry Grady, Atlanta, May 18-21.

The Society for Experimental Stress Analysis, 1959 National Spring Meeting, Sheraton Park Hotel, Washington, D.C., May 20-22.

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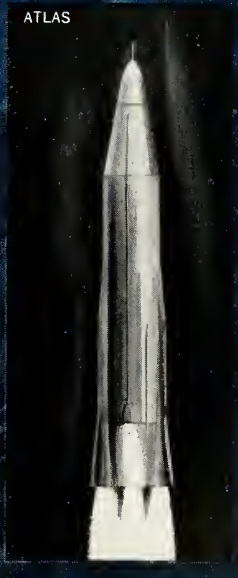

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WESTERN GEAR CORPORATION

The earth from 100 miles up, taken by Navy scanners shows 200,000 square miles of U. S. and Mexico.

5912

SERGEANT

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